The Ultimate Design Challenge

By Sabrina Giustino

What is this project about? Designing/Math

Scimatics 8 – Ultimate Design Challenge Evaluation Rubric

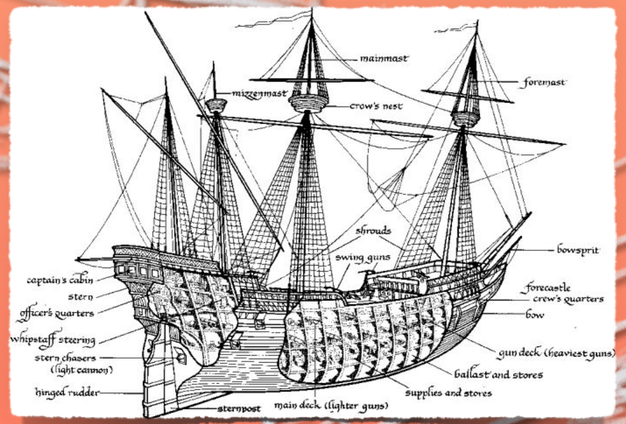
Big Idea: The relationship between surface area and volume of 3D objects can be used to describe, measure, and compare spatial relationships.

Curricular Competencies	Emerging/ developing	Proficient	Extending
Applying and innovating: Contribute to care for self, others, community, and world through personal or collaborative approaches.		All class time is used efficiently for learning without distractions.	
Reasoning and Analyzing: Model mathematics in contextualized experiences		A 3D object is designed using TinkerCad or other design software. The design is optimized for either maximum volume or maximum surface area. The design should include at least 10 basic 3D shapes. (you should each design components/parts of a larger model or scene for groups of 2 or 3)	
Communicating and Representing: Explain and justify mathematical ideas and decisions		The surface area and volume are measured, calculated, and compared by ratio. These factors are explained in detail in a keynote presentation to the class.	

For this project we were tasked with create a design that would use the maximum surface area or volume. The website we were using to create the design was named tinkercad and is basically a free online builder website that allows you to move and mess with 3rd objects. At the end of the project we are meant to calculate the total of surface area and volume and compare them in a ratio. Even though this project was very difficult I had very fun time planning out in my head what the final object should look like.

The Object

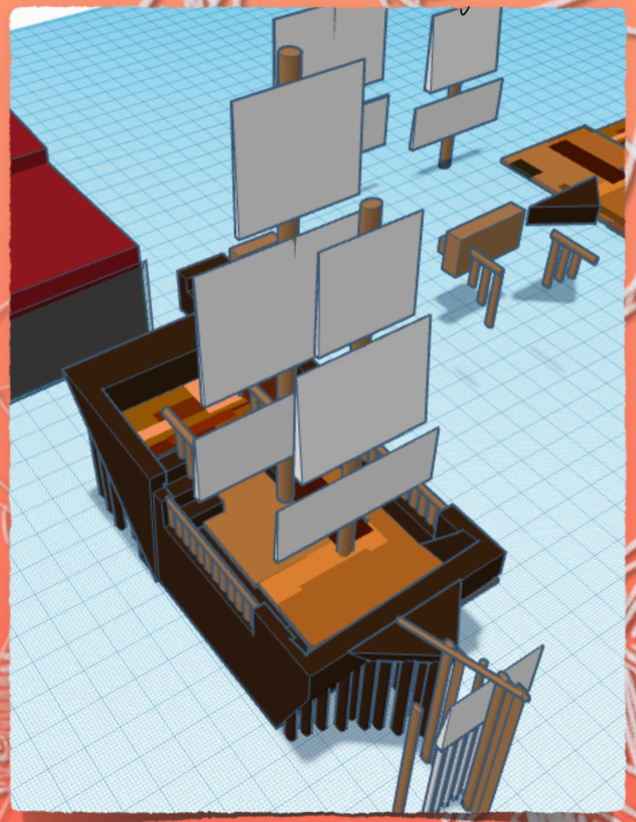
A Pirate Ship

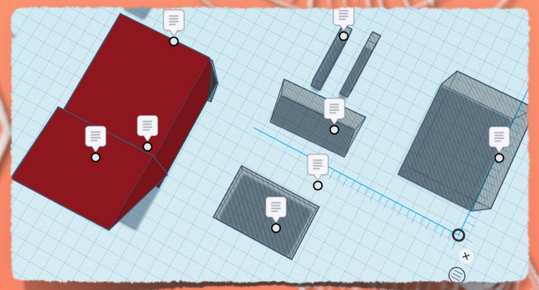


At the start of the project I really don't know what I should design. I was thinking some sort of animal because I thought is would be a fun design to create. However, I was inspired to do a pirate ship instead due to taking a tutorial in which you had to create a simple boat, how much volume and surface area it would take up and how much fun it would be to create one! I instantly started looking at design and reference photos I could use to build an accurate but simple Pirate ship in tinkercad. If I were to be able to redo this part of the project I wished I create a clear blueprint of the ship with measurements for each shape before starting to build. However, I think I did a good job in getting photos of what I want in my design and learning how an average pirate ship look like.

Creating a Pirate Ship

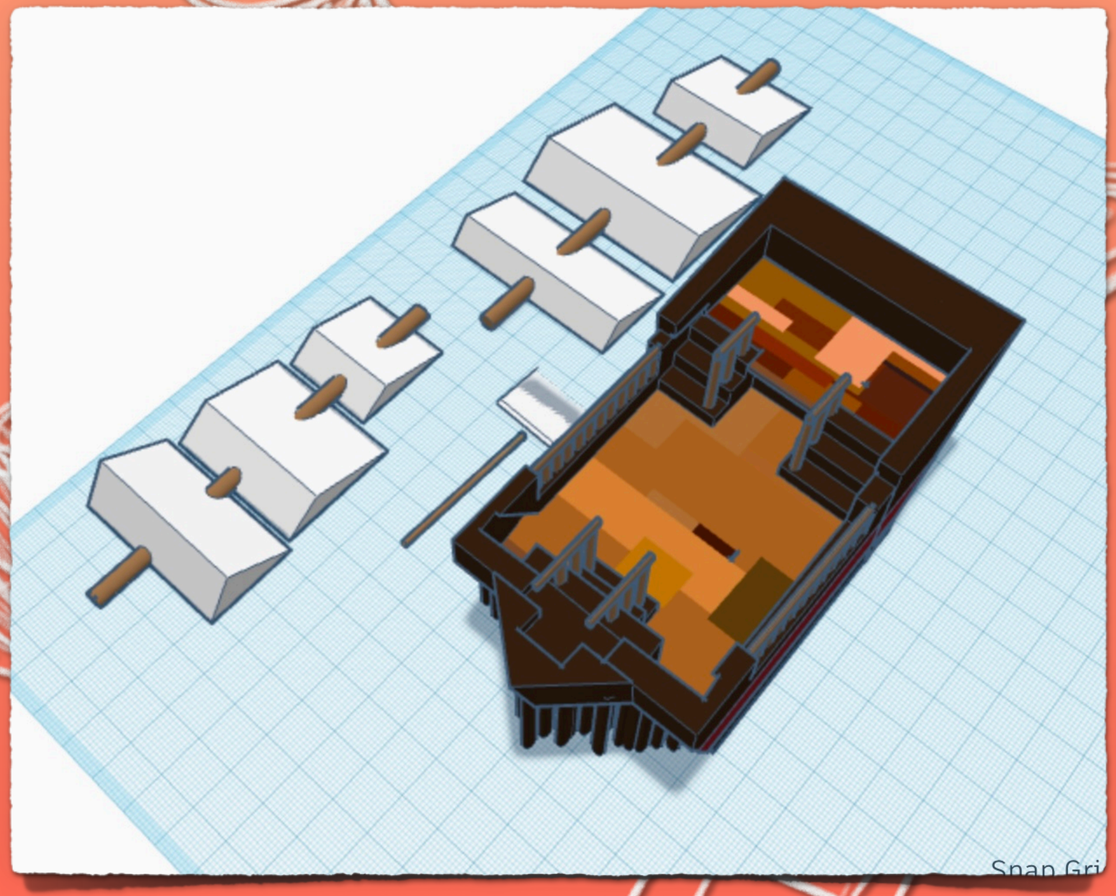
Actually building the ship using tinkercad was the hardest part of the project for me. At the start of the project I made sure to create copy's of the shapes I was merging together and measuring each individually thus the math at the end of the project will be much easier. I used notes to record the height, length and width of each shape included in my final ship. To make it even easier to calculate my goal was to only include triangles, cylinders and rectangles in my design. I included in final design around 30 to 50 shapes these include railings, stairs and poles. Overall, finishing the final draft for printing was difficult and took way more effort than expected however, I am glad I had the challenge.





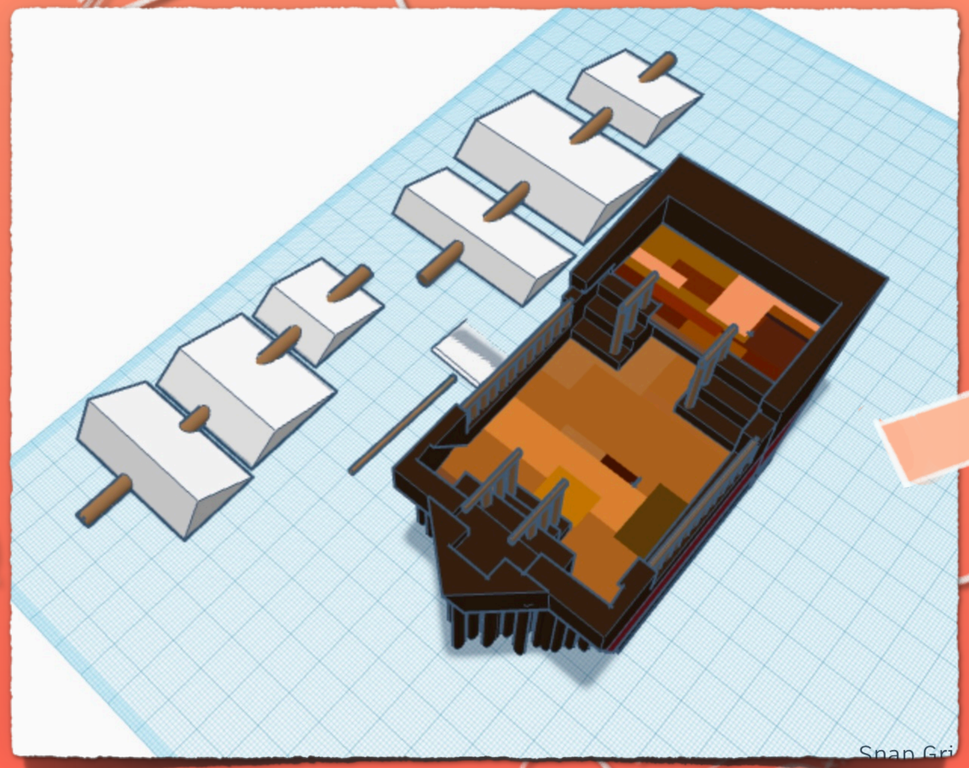
Printing the Pirate Ship

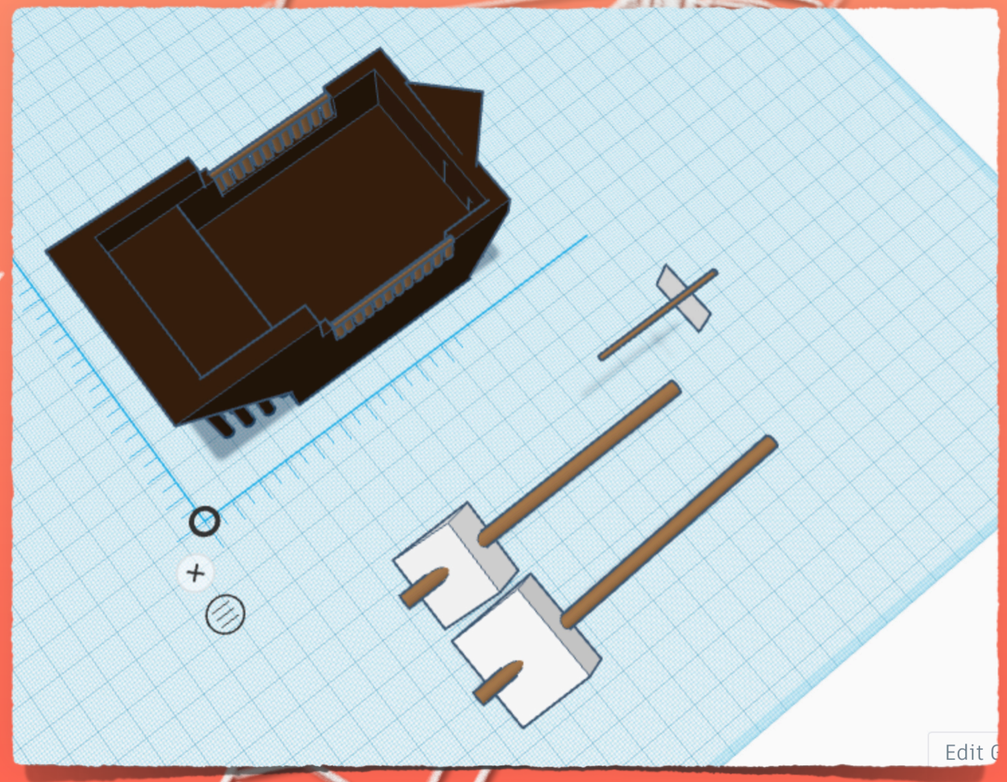
Making changes to the pirate ship for printing was difficult. When I submitted to Mr. Gross I had to change details that had to do with the flag poles since they most likely would fall apart in the printing process. This cause me to make changes with the sizes of the flag so they would stick on to the poles and to put it next to my pirate ship thus I could use hot glue to stick it on. Overall, if I could redo this I would try to spend less time trying to not change the design as much as possible.



Simplifying for math

Due to the complexity of the shape I took away most of my flags and railing. However, I completely got rid of the stairs and floorboards!





The Main Body

V=

upper triangular prism. L=50 h=46.53 W=60.83

$50 \times 46.53 \times 60.83$

$= 141520.995$

$= 70760 mm^3$

SA= Outside upper triangle

top ledge: $(60 \times 45) - (50 - 33)$

$= 2700 - 1650$

$= 1050 mm^2$

Sides $= (34 \times 44.96) + 2(16.96 \times 10$

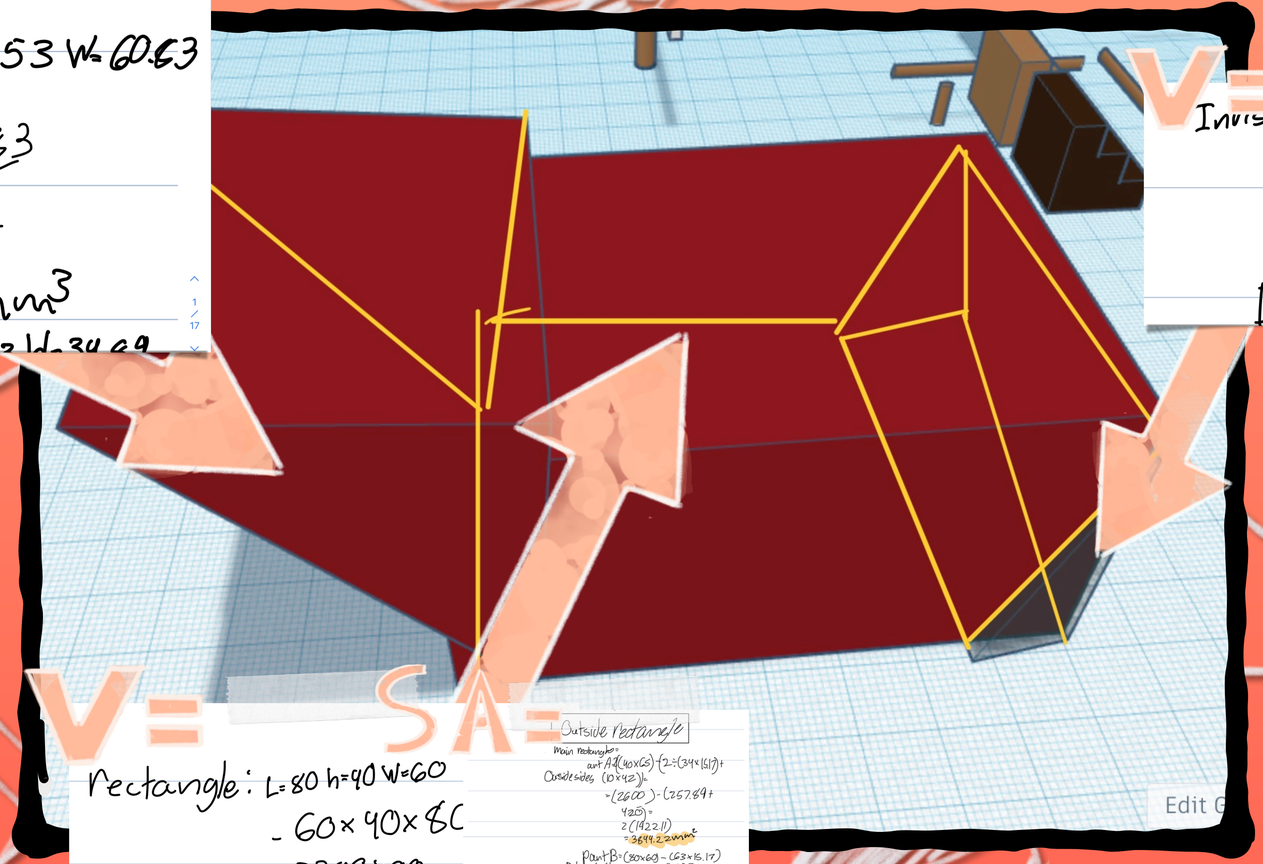
$= 1528.64 + 2(181.81)$

$1528.64 + 363.62$

$= 1692 mm^2$

back $= 60 \times 51.65$

$= 3099 mm^2$



V= Invisible triangular prism = L=63.99 W=15.63 H=34.89

$\frac{63.99 \times 15.63 \times 34.89}{2}$

$= 34695.21$

$= 17447.7 mm^3$

Invisable

V= Rectangle: L=80 h=40 W=60

$60 \times 40 \times 80$

$= 240 \times 80$

$= 192000 mm^3$

SA= Outside Rectangle

Main Rectangle = aut A2 $(40 \times 60) + (2 \div (34 \times 16.17) +$

Outside sides $(10 \times 42)) +$

$= (2600) - (257.89 +$

$420) +$

$2(1422.11)$

$= 3699.22 mm^2$

part B $= (80 \times 60) - (63 \times 15.17)$

Outside bottom $= 4800 - 955.71$

$= 3844.29 mm^2$

part C

Main back triangle $= (15 \times 14.46) + (15.18 \times 60.9) + (60.9 \times 14.95) =$

$(216.75) + (921.417) + (660) = 2016 mm^2$

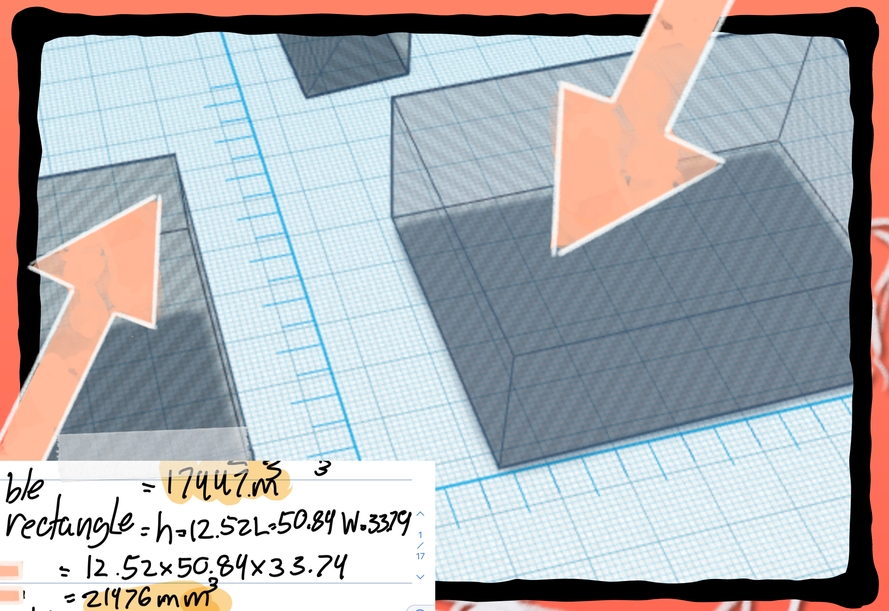
part D

front Outside $(60 \times 40) = 240 mm^2$

The Main Body Inside/invisible filler

Main invisable rectangle = L=69.09 W=52.89 H=22.98

V= 69.09x52.89 x 22.46
= 82145.74mm³



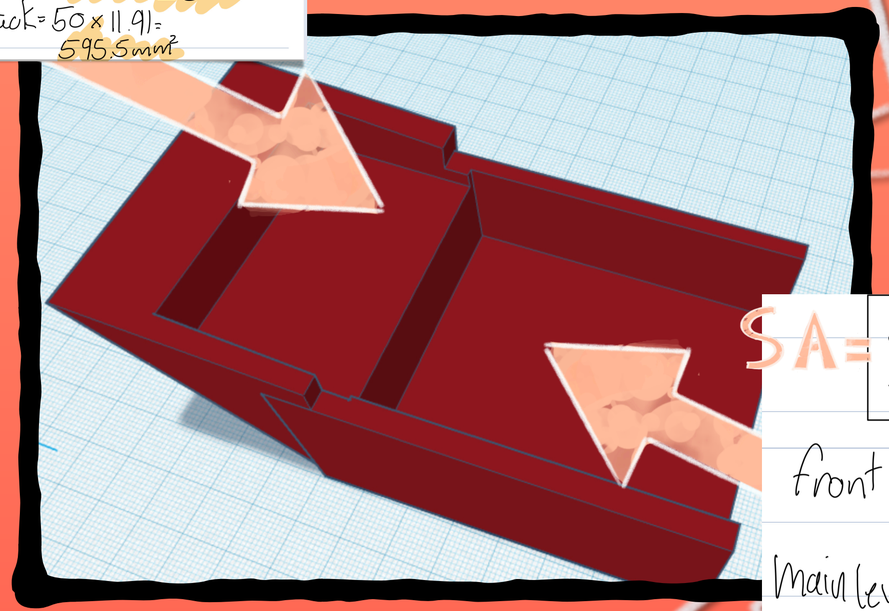
Invisable upper rectangle = h=12.52 L=50.84 W=33.79

V= 12.52x50.84x33.74
= 21476mm³

= 17447.8mm³

upper triangle Inside

SA= front: 60x35=2100mm²
sides: 2(34x44.96)=
2(1528.64)=
3057.28mm²
back=50x11.91=
595.5mm²



SA= Inside rectangle

front: 60x19.66
= 1179.6mm²
main level: 60x59.29=
3557.4mm²

The Main Body Inside/invisible filler

pole2 = 2(3.14×2.405×
+ 2(3.14×(2.405)²
=(84.92)+2(1
=(1569.84)+(36.
=1606.16mm²

pole 2 flag:
bottom: 25×26.9 back=25×9.7
=672.5mm² =241.75mm²
sides: 26.9×6
=161.4mm²
front: 25×19.14 = 1554.15mm²
=478.5mm²

pole 1: h=121.55 D=3.81
2(3.14×1.905×121.55)+
2(3.14(1.905)²)
=2(727.07)+2(11.395)
=1454.14+22.79
=1476.93mm²

pole 1
flag:
bottom: 32.06×30.16=
966mm²
sides: 29.78×8=
234.24mm²
front: 29.78×31.1
=770.65mm²
back: 31.11×18.51
=575.84mm²
= 2546.73

pole 3: h=40.36 D=1.58
=(3.14×0.79×40.36)
+2(3.14(0.79)²
=2(100.11)+2(1.95
=200.22 +3.92
=204.14mm²

pole 3
flag: bottom = 14.38×18
=258.84mm²
sides 14.36×6.6
=8.61mm² = 536.55mm²
front = 2.05×17.65
=36
back = 18×12.95 = 233.1

pole 2 = h=103.94 D=4.81
=3.14×2.4²×103.94
18×103.94
=1879.9

pole 2 first triangular prism: L=25 h=6 W=26.9
25×6×26.9
2
=40.35
2
2017.5mm³

pole 1 = h=121.55 D=3.8
=(2÷(3.81)²)×121.55
=(1.9)²×121.55
=3.63×121.55
=441.23mm³

pole 1 first triangular prism: h=8 W=31 L=30.83
=8×31×30.83
2
=7645.84
2
=3822.92mm³

pole 3: h=40.36 D=1.58
=(2÷(1.58)²×40.36
=(1.27)²×40.36
=1.61×40.36
=65.097mm³

pole 3 flag: L=14.36 W=18 H=0.6
14.36×18×0.6
2
=155.08
2
=77.54mm³

Railings

V= Ledge

Little ledge: h=9.1 D=2.31

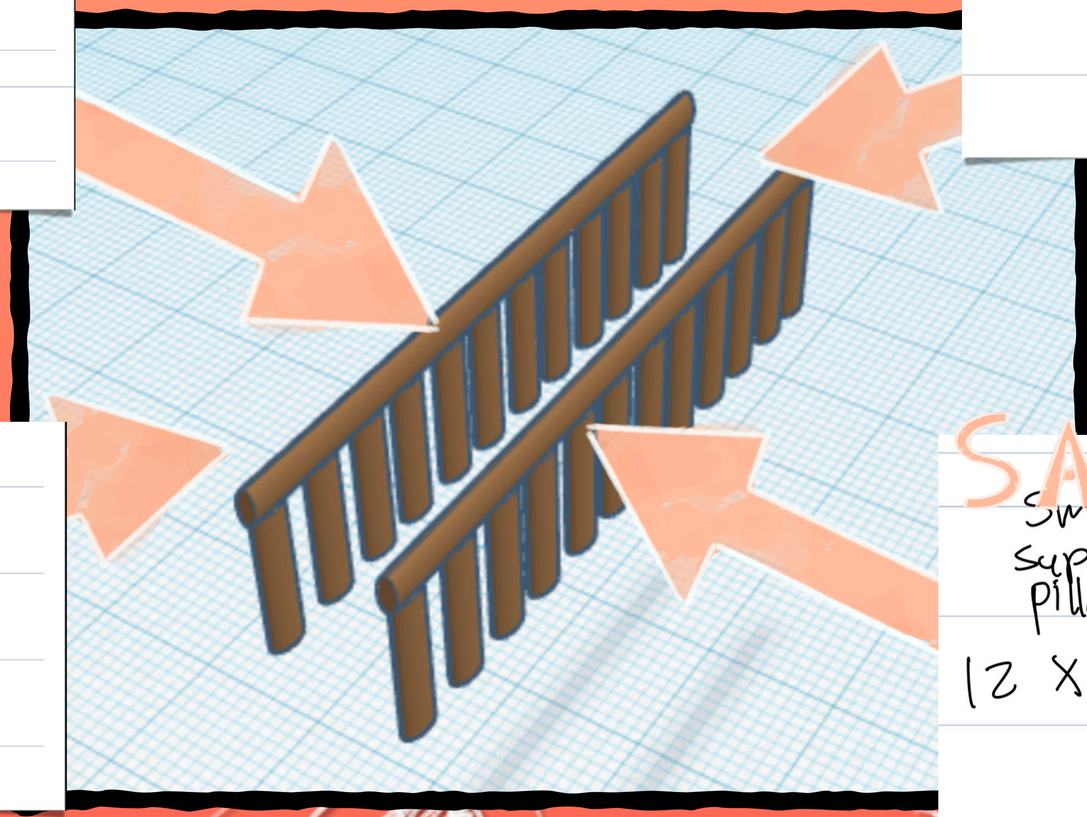
$= 12(\pi \div (2.3)^2 \times 9.1)$

$= 12(\pi \div (1.15)^2 \times 9.1)$

$= 12(1.32 \times 9.1)$

$12(1203mm^3)$

$= 14436mm^3$



V= Long ledge = H=41 D=2.19

$= 2(\pi \div (2.19)^2 \times 41)$

$= 2(1.09^2 \times 41)$

$= 2(1.199 \times 41)$

$= 2(49.16mm^3)$

$= 98.32mm^3$

SA= Small ledge H=9.1 D=2.19

$2 \times (2(3.14 \times 1.09 \times 41) + 2(3.14 \times (1.09)^2))$

$= 2(140.97) + 2(3.765)$

$= 281.94 + 7.53$

$= 2(289.47mm^2)$

$578.94mm^2$

SA= Small ledge = h = 9.1 D. 2.31

supporters/pillers $2(3.14 \times 1.15 \times 9.1)$

$12 \times (+2(3.14 \times (1.15)^2)$

$= 2(32.86) + 2(4.152)$

$= 12(65.72 + 8.3)$

$= 888.24mm^2$

The Math

The math for the project was long and complicated. One thing I should of kept in mine before starting the calculations was organization. A lot of the math I did was messy which made it hard for me at the end of the project to add all the surface area and volume together. My goal at the start of the project was to have a big volume and I was fortunately able to achieve this at the end of the project. Moreover, I could of improved on is double checking my calculations more. I feel like my final calculation may not be fully accurate since as soon as I got the final ratio I submitted the project in Showbie. The object in project that had the most volume was most likely my main ship body and However, I think I did an amazing job of showing all my equations in my work. Overall, the math was difficult however, I think it greatly improved my mathematical skills.

Final Ratio

$SA = 37994.08 mm^2$

$V = 149279.94 mm^3$

$37994.08 mm^2 : 149274.94 mm^3$

$= 0.255 mm^2 : 1 mm^3$

$37994.08 \div 149274.94 =$

$0.255 mm^2$

$149274.94 \div 37994.0 =$

$= 3.928 m^3 : 1$

Thank you

For listening!!