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F/K Scientific Data Visualization

Lab-1

Measuring the Real World

Lab Model:

The purpose of this lab was to understand different type of errors in measurements by measuring an enclosed 2D area using different devices.

Procedure:

The area was measured using four different tools and methods, with at least three measurements for each device. While measuring it was assumed that the enclosed area is of rectangular ship, measured value of each side from the right angles. The length of each side was measured by first marking the vertexes to increase accuracy. Length of each side was recorded, and later was used to find the area of enclosed rectangular ship. After finding the area in square feet it was converted to SI, square meters, and then the average for each measuring device was found.

Assumptions:

Below are the assumptions taken while measuring the enclosed area:

1. Surface to be flat due to small area
2. It's a rectangular ship
3. Or it's a trapezoid with at least two right angles

Observations & Data:

Non-technology-at-all-device: each of the side was measured in my fast walk steps, assumed to be 3 feet long. First I put a mark on each right angle corners in order to have a precise starting and ending points. Start walking from one corner to the other, counting each step I take. When I walk fast I tend to take longer length steps; however, in order to make sure I walk on straight line, instead I walked slowly keeping same distance. Please see Appendixes A table IV for Raw data.

Length of side = # of steps * 3ft (length of steps). Same procedure was fallowed for measuring lengths of other sides of rectangle as well as for two more trails.

Measuring Using Big Wheel: I used the same marks that were set for collecting data using non-technology-at-all with big wheel. First the height of the wheel was adjusted to the comfort level, and the measuring scale was set to zero. First I measured length of one side by walking fast, and observed that the wheel moved all around. Therefore, I started all over again by rolling the wheel very carefully and slowly on the edge of walking path to increase accuracy. Measurements for length of each of sides were recorded by stopping at every marked edge. Same procedure was followed for two more trails. Please see appendixes A Table I for measurements.

Measuring Using Small Wheel: Here I followed pretty much the same procedure as I did using big wheel. However, there were more things that needed to be taken into consideration, such as, broken edges, harsh surface, and debris. Please see appendix A table II for data.

Measuring Using Tape: In order to hold the starting point of tape on ground I used a reasonable size rock. I laid the tape along the edge of walking path, assuming it was approximately straight line. Length of each side was recorded and the same procedure was followed for measuring the other lengths and trails. Please see appendixes A table III.

Appendix A: Raw Measurements Data in ft

Table I

Measurements Using Big Wheel			
Sides	**Trail 1**	**Trail 2**	**Trail 3**
North	202.9	202.4	202.7
West	151.21	152.5	151.6
South	204.69	203.4	204.1
East	147.2	147.7	147.5

Table II

Measurements Using Small Wheel			
Sides	**Trail 1**	**Trail 2**	**Trail 3**
North	204.2	204.5	204
West	154	152.4	152.3
South	205.5	204.6	204.5
East	149.1	148.8	148.9

Table III

Measurements Using Meter			
Sides	**Trail 1**	**Trail 2**	**Trail 3**
North	201.5	202.7	203.1
West	158.6	157.6	158.3
South	206.6	207.3	205.1
East	147.2	146.6	147

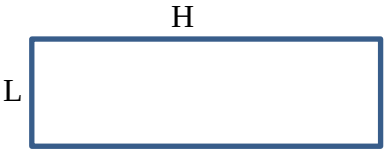
Table IV

Non-Technology Measurements			
Sides	**Trail 1**	**Trail 2**	**Trail 3**
North	198	199.5	201
West	141	150	150.9
South	199.8	201	204
East	144	150	144

Analysis:

Two methods were used to calculate the area: first using the formula for finding area of a rectangle (area = length * width), assuming the enclosed 2D area is of rectangular ship. It was assumed that the base lines were parallel. In this procedure, the average length of parallel lines was calculated and used with the height to calculate the area in square feet. The calculated area in square feet was converted to square meter and the average of both was calculated.

$A = L * H$

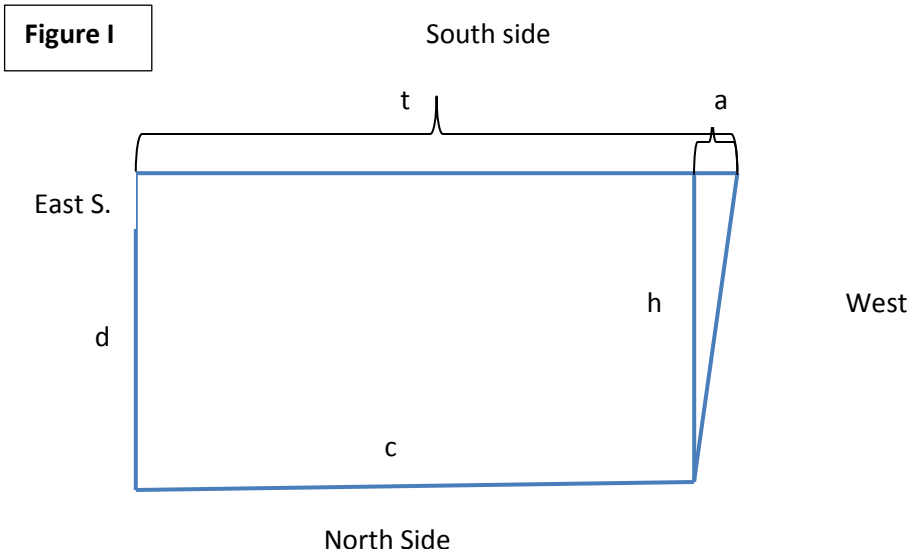


Second assuming the area is trapezoid shape, because most the sides have different lengths, using formula $A = \frac{(t+c)*h}{2}$

Since the lengths of sides are not the same, especially since one side is bit longer than its respective parallel we need to use the following formula for more accuracy. Using this formula

one need to find height (h), before finding the area of rectangular ship as shown in Figure I. Even though second procedure is bit longer, I believe it's more accurate than using the area of rectangle formula.

Figure I



Calculations:

Sides	**Trail 1 ft**
North (short base or c)	202.9
West	151.21
South (long base or t)	204.69
East (height)	147.2

Example using area of rectangle formula:

$A = (202.9 + 204.69)/2$ $A = l * h$ $A =$ 203.795 * 147.2

$A =$ 203.795 $\boldsymbol{A}$ = 29998.624 ft^2 * 0.0929 m^2

$h =$ 147.2 $\boldsymbol{A}$ = **2786.87217** m^2

Example using trapezoid formula:

Using method 2 one need to first find the height (h), and then using that height to find the area.

$a = t - c$

$a = 206.6 - 201.5$

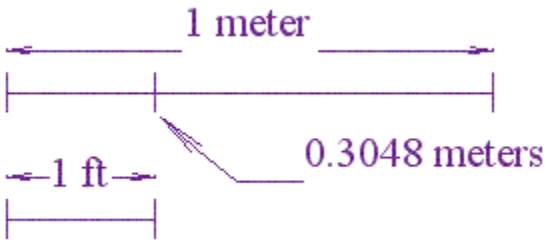
$a = 5.99$

$h^2 = d^2 - a^2$

$h^2 = (147.2)^2 - (5.99)^2$

$\sqrt[2]{h^2} = \sqrt[2]{(147.2)^2 - (5.99)^2}$

Converting from square feet to meter multiplying number of ft^2 by 0.0929 m^2



$h = 147.07807$

$$Area = \frac{(c + t) * h}{2}$$

$$Area = \frac{(202.9 + 204.69) * (147.07807)}{2}$$

$Area = \ 29973.7752757 ft^2$
$Area = 29973.7752757 ft^2 * \ 0.0929$
$Area$ = 2784.56372311 m^2

Appendix D: Final Calculation in Feet and in IS (meters)

Table I

Non-Technology Measurements				
Sides		**Trail 1 in ft**	**Trail 2 in ft**	**Trail 3 in ft**
North: small base (c)		198	199.5	201
West: height (h)		141	150	150.9
South: long base (t)		199.8	201	204
East: 90* angle side (d)		144	150	144
Results of Calculation				
a =	t –c	1.8	1.5	3
height (h)	$h^2 = d^2 - a^2$	143.9887496	149.9925	143.9687
Area =	$Area = \frac{(c + t) * h}{2}$	28639.36229 ft^2	30036 ft^2	29153.67 ft^2
Area =	sq. meters = sq.ft * 0.0929	2660.596757 m^2	2790.344m^2	2708.376m^2

Table II

Measurements Using Small Wheel				
Sides		**Trail 1**	**Trail 2**	**Trail 3**
North: small base (c)		204.2	204.5	204
West: height (h)		154	152.4	152.3
South: long base (t)		205.5	204.6	204.5
East: 90* angle side (d)		149.1	148.8	148.9
Results of Calculation				
a =	t –c	1.3	0.1	0.5
height (h)	$h^2 = d^2 - a^2$	149.0943326	148.8	148.8992
Area =	$Area = \frac{(c + t) * h}{2}$	30541.974 ft^2	30437.03ft^2	30412.65ft^2
Area =	sq. meters = sq.ft * 0.0929	2837.349387 m^2	2827.6m^2	2825.336m^2

Table III

Measurements Using Meter				
Sides		**Trail 1**	**Trail 2**	**Trail 3**
North: small base (c)		201.5	202.7	203.1
West: height (h)		158.6	157.6	158.3
South: long base (t)		206.6	207.3	205.1
East: 90* angle side (d)		147.2	146.6	147
Results of Calculation				
a =	t -c	5.1	4.6	2
height (h)	$h^2 = d^2 - a^2$	147.1116243	146.5278	146.986394
Area =	$Area = \frac{(c+t)*h}{2}$	30018.12694ft^2	30038.2ft^2	29999.923ft^2
Area =	sq. meters = sq.ft * 0.0929	2788.683992 m^2	2790.549 m^2	2786.993 m^2

Table IV

Measurements Using Big Wheel				
Sides		**Trail 1**	**Trail 2**	**Trail 3**
North: small base (c)		202.9	202.4	202.7
West: height (h)		151.21	152.5	151.6
South: long base (t)		204.69	203.4	204.1
East: 90* angle side (d)		147.5	147.7	147.2
Results of Calculation				
a =	t -c	1.79	1	1.4
height (h)	$h^2 = d^2 - a^2$	147.4891382	147.6966	147.193342
Area =	$Area = \frac{(c+t)*h}{2}$	30057.54893ft^2	29967.64 ft^2	29939.126 ft^2
Area =	sq. meters = sq.ft * 0.0929	2792.346295 m^2	2783.994 m^2	2781.3448m^2

Calculating Average:

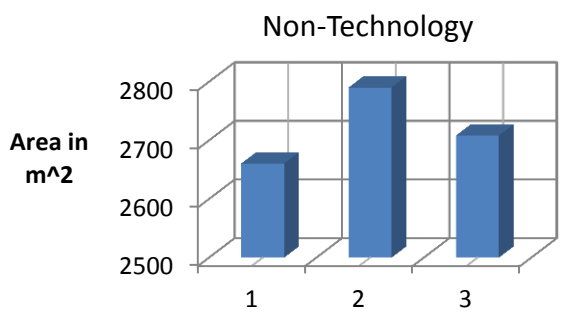
Table V:

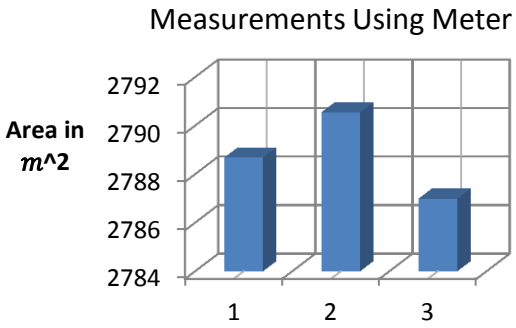
Tools	Average in ft^2	Average in m^2
No-technology	29276.34385	2719.772344
Big Wheel	29988.10596	2785.895043
Small Wheel	30463.88689	2830.095093
Tape	30018.75054	2788.741925

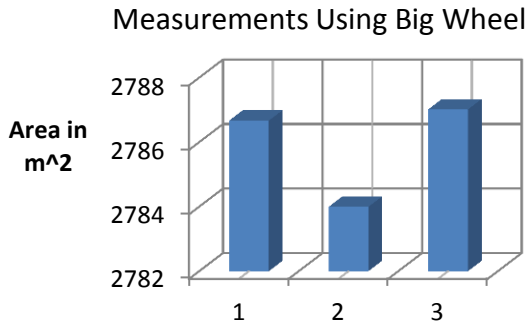
To further illustrate the relationship between measurement tools, accuracy and precession the collected measurements and calculations were graphed. Looking at the graphs for each trail one could easily see the variation in data for each trail as well as for each measuring tool were used. Therefore, in order to make assumptions based on a statistical data, one must take as many

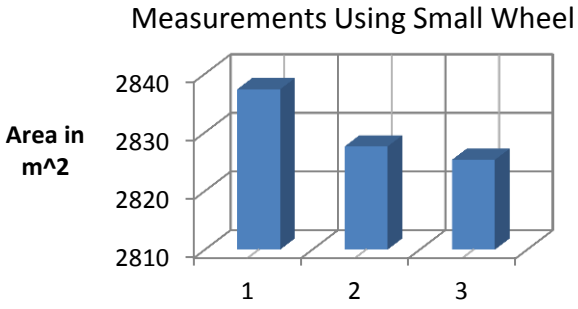
samples as possible. The more sample you get the most accurate or approximate will be the average.

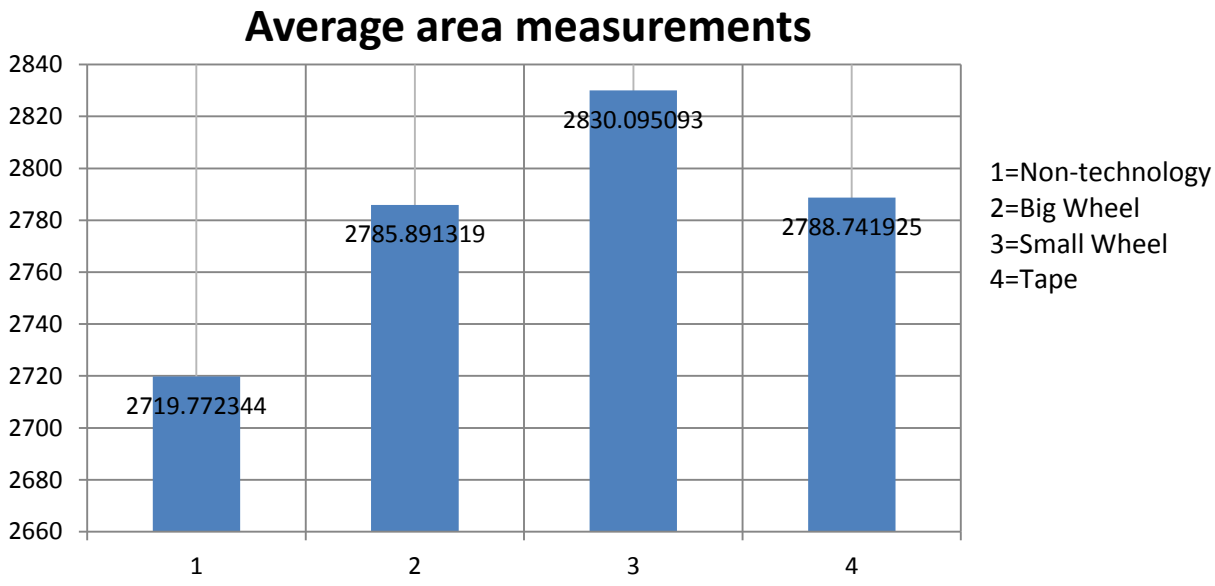
Appendix C: Graphs representing the area calculated in by each measuring device.











Source of Errors:

The data that was collected may have errors in it either from flaws in the measuring tool or from systematic errors in reading the measuring devices. Most of the errors can be caused by human error, measurement tools, calculations, assumptions, and many others that we may not know of.

Human errors:

- Assuming the area to be a perfect rectangle
- Not walking straight
- Getting distracted by other people and objects around

Measurement tool errors:

- It largely depends on which tools are being used, some are more precise than others
    - I believe there might exist a standard for making measurement tools, however, it still depends on who makes them, and how much do the pay attention the details
- What surface to be used
    - If your measured line seem like waves, adds extra distance
    - Tools precession could be affected by the debris, broken edges
    - I found out that if you walk on grass while rolling the either wheels you will have less precessions. Your measured line will seem like ocean waves. However, if you are on the foot path and try to keep the wheel against the edge, you can obtain a much better data.
    - Rolling the devices back, picking it up and rolling again

Calculations errors:

- First of all how exact is the measurement data
- What type of technology is being used to do calculations, is there rounding involve?
- Like in my case I was not sure which method to use in order to get a more approximate result.

Conclusion:

The calculations and the graphs show that it's very important to pay considerable attention to details for caring out such experiments. It's almost impossible to be exact, but at least we can try to be more approximate. In order to improve the experiment one could use recently developed modern technological devices, take more trails, and use the most appropriate tools for visualization and calculations.