Example Fin Calculation

The following set of calculations is meant to highlight the process for the completion of your assignment. This example uses different values to generate a fin that is improperly shaped. Thus following the calculations conducted in this example verbatim will not help with the completion of the assignment.

The following tables are provided as reference tables for the calculations that follow:

Table 1. *Reference distances based on Figure 3 in technical report*

d_{body}	Distance of the C_g of the body from a reference point	18cm = 0.18 m
d_{cone}	Distance of the C_g of the nose cone from a reference point	4 cm = 0.04 m
d_{fins}	Distance of the C_g of *all* the rocket's fins from a ref point	28 cm = 0.28 m

Table 2. *Surface area values of rocket components*

sa_{body}	Surface area of the body	385 cm^2 = 0.0385 m^2
sa_{cone}	Surface area of the cone	75 cm^2 = 0.0075 m ^2
sa_{fins}	Surface area of the fins	**You will calculate this**

Table 3. *Rocket diameter value and symbol*

⌀	Diameter of the Rocket	3.00 cm = 0.03 m

Table 4. *Given equations for fin surface area calculation*

#	Equation Name	Given Equations
Eq. 1	Stability Margin (S)	$S = (Cp - Cg)/\varnothing$
Eq. 2	Center of Pressure (Cp)	$C_p = \frac{sa_{body} * d_{body} + sa_{fins} * d_{fins} + sa_{cone} * d_{cone}}{sa_{fins} + sa_{body} + sa_{cone}}$
Eq. 3	Cross Sectional Area of 1 Fin (CA_{1fins})	$CA_{1\ fins} = \frac{(sa_{fins})}{(\#\ fins\ *\ 2)}$
Eq. 4	Fin Shape Area Equations	$a_{trapezoid} = 1/2 * (t + b) * h$ $a_{rectangle} = l * w$ $a_{triangle} = 1/2\ (b * h)$

Table 5. *Given variables for fin surface area calculation*

Variables and Givens for Model Rocket		
Code	**Description**	**Value**
$f_{thickness}$	Fin thickness	0.3 cm = 0.003 m
S	Stability	**Based on JAC**
C_p	Center of Pressure	**You will calculate this**
C_g	Center of Gravity	**Based on JAC**
⌀	Diameter of the Rocket	3 cm = 0.03 m
sa_{body}	Surface area of the body	385 cm^2 = 0.0385 m^2
sa_{cone}	Surface area of the cone	75 cm^2 = 0.0075 m^2
sa_{fins}	Surface area of the fins	**You will calculate this**
d_{body}	Distance of the body CG from ref point	18 cm = 0.18 m
d_{cone}	Distance of the cone CG from ref point	4 cm = 0.04 m
d_{fins}	Distance of fins CG from ref point	28 cm = 0.28 m
#fins	Number of fins	**You will select how many fins**
CA1fin	Cross sectional area of a fin	**You will calculate this**

Step 1: Center of Pressure (C_p) Calculation

(Assuming a Stability margin of 2 and a C_g of 0.2m)

$S = (C_p - C_g)/ ⌀$; (Equation 1)

$C_p = (Cg + S * ⌀)$; (Equation 1a from technical report)

$C_p = (0.2\text{ m} + 2 * 0.03\text{ m})$

$\boldsymbol{C_p = 0.26\text{ m}}$

Step 2: Fin Surface Area (sa_{fins}) Calculation

$$C_p = \frac{sa_{body} * d_{body} + sa_{fins} * d_{fins} + sa_{cone} * d_{cone}}{sa_{fins} + sa_{body} + sa_{cone}} \text{ (Equation 2)}$$

$$sa_{fins} = \frac{sa_{body} * d_{body} + sa_{cone} * d_{cone} - C_p * sa_{cone} - C_p * sa_{body}}{C_p - d_{fins}} \text{ (Equation 2a)}$$

$$sa_{fins} = \frac{0.0385 * 0.18 + 0.0075 * 0.04 - 0.26 * 0.0075 - 0.26 * 0.0385}{0.26 - 0.28}$$

$$\boldsymbol{sa_{fins} = 0.2365\ m^2}$$

Step 3: Calculate Fin Cross-Sectional Area ($CA_{1\ fins}$)

(Assume 6 fins)

$$CA_{1\ fins} = \frac{(sa_{fins})}{(\#\ fins * 2)} \text{ (Equation 3)}$$

$$CA_{1\ fins} = \frac{(0.2365)}{(6\ *\ 2)}$$

$$\boldsymbol{CA_{1\ fins} = 0.01971\ m^2}$$

Step 4: Sketch Design using area formulas.

$$CA_{1\ fins} = 0.01971\ m^2 = l * w \text{ (Equation 4: for rectangles)}$$

$$CA_{1\ fins} = 0.01971\ m^2 = 0.4\ m * 0.049271\ m$$

Step 5: SolidWorks Model (sketch cross section)

The given part will have a rectangular cross section that has a length of 0.4 m and a width of 0.05475 m.

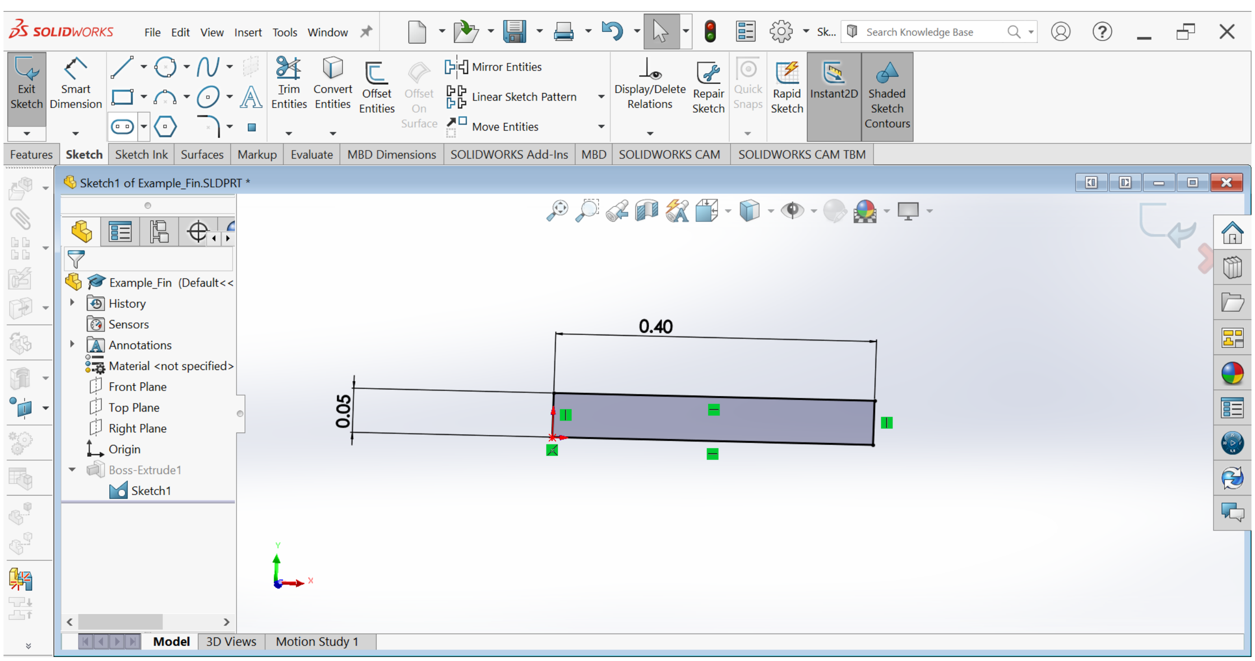

Figure 1. *SolidWorks Model of Fin Cross-Sectional Area based on Step 4 Calculation*

Step 6: SolidWorks Model

Extrude into full fin shape.

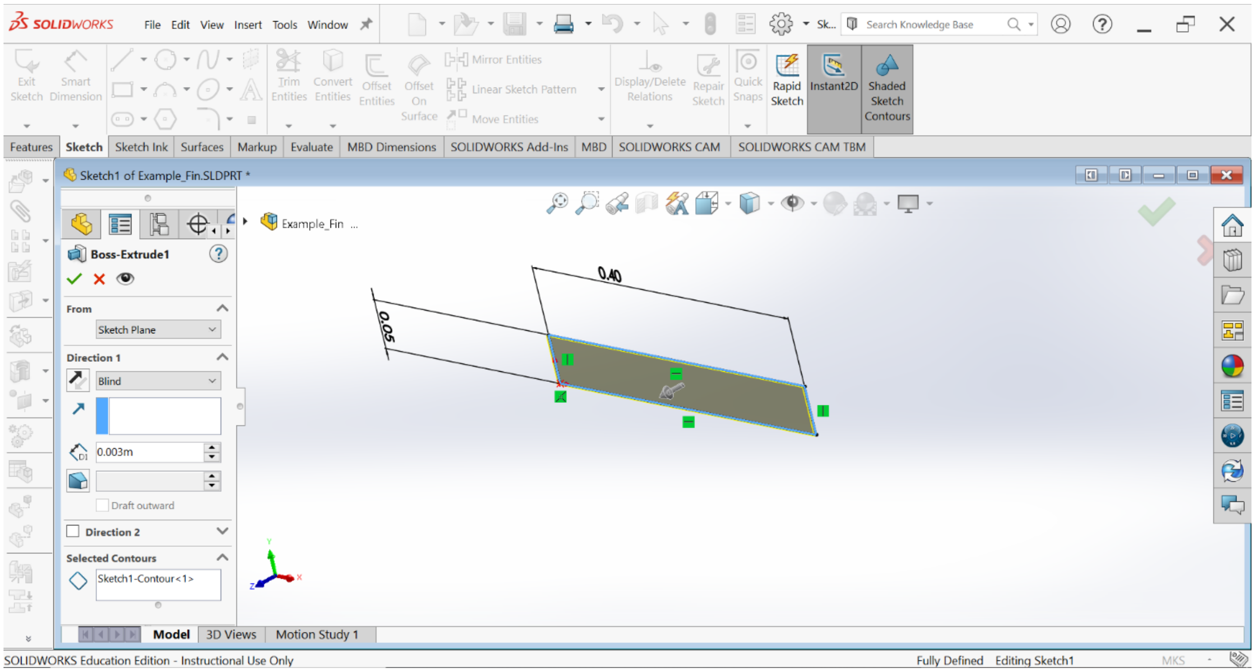

Figure 2. *SolidWorks Model of Extruded Fin*

Step 7: Take Parameters Produced and Reenter into MATLAB

Parameters developed by SolidWorks should be plugged back into MATLAB to verify it meets the set standards. To do this, reverse engineering of the process will have to be done.

Based on this process, it was determined that the fins did meet the design parameter set by the stability margin constraint to have a value of 2.

Step 8: Access Feasibility of Design

Major Feasibility Statement Basis:

[The rocket has a stability margin of <u>__#__</u>and has <u>_#__</u> fins in the shape of a <u>_shape</u>]

This design, however, **<u>is / is not</u>** feasible. The design **<u>is / is not</u>** feasible because

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As an engineering student, I would **<u>recommend / not recommend</u>** this design for use on a model. This assessment is based on what I researched.

The following benchmarked rocket **<u>is /is not</u>** similar to mine due to the following attribute similarities:

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