

SAE Mini Baja

Concept Generation and Selection

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Overview

- Design Problem
- Tubing Size and Material
- Frame Geometry
- Welding Method
- Project Plan
- Conclusion

Problem Statement

- NAU has not won an SAE Baja event.
- Goal is to design the lightest possible frame within the SAE rules.

Tubing Selection

- SAE specifies AISI 1018 Steel
 - 1" Outside Diameter
 - 0.120" Wall Thickness
- Other Sizes Allowed
 - Equivalent Bending Strength
 - Equivalent Bending Stiffness
 - 0.062" Minimum Wall Thickness

Bending Strength and Stiffness

$$\textit{Stiffness} = E \cdot I$$

$$\textit{Strength} = \frac{S_y \cdot I}{c}$$

$E = 29,700$ ksi for all steel

$I =$ second moment of area

$S_y =$ yield strength

$c =$ distance from neutral axis to extreme fiber

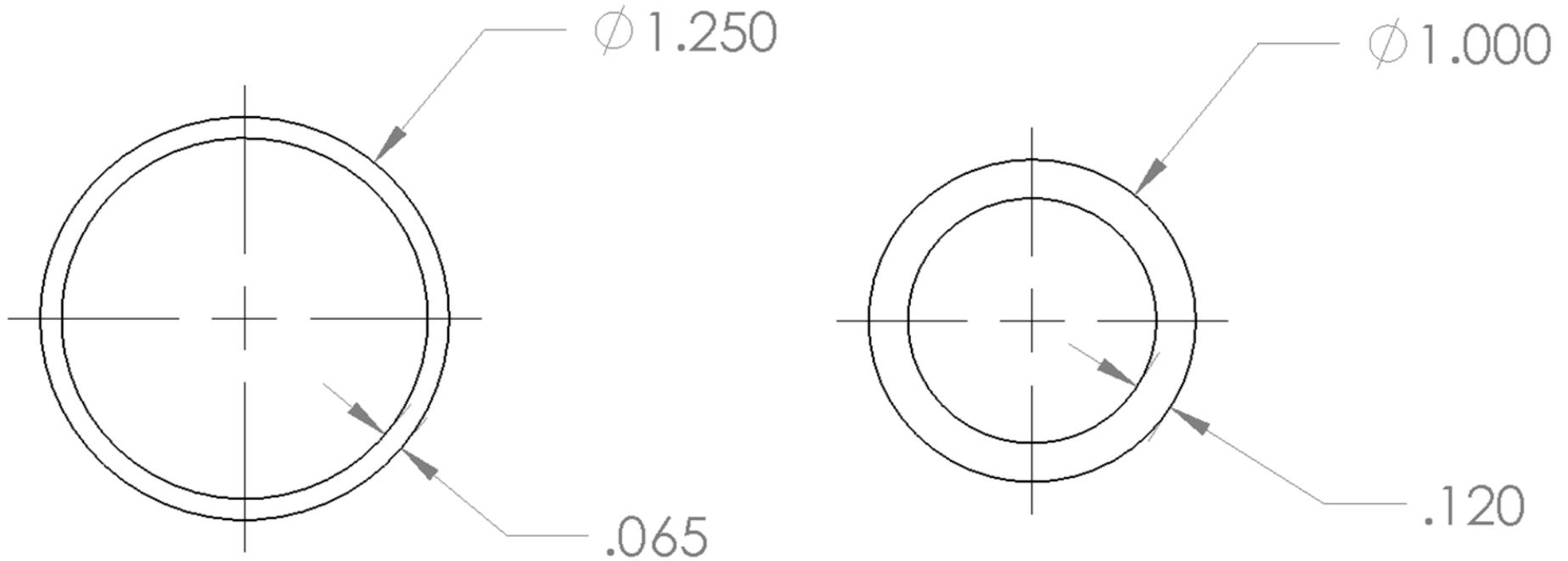
AISI 1018

Diameter [in]	Wall Thickness [in]	Stiffness [in-lb]	Strength [in ² -lb]
1.000	0.120	971.5	3.513

AISI 4130

Diameter [in]	Wall Thickness [in]	Stiffness [%]	Strength [%]	Weight [%]
1.000	0.120	100	118	100
1.125	0.083	113	119	81.9
1.125	0.095	126	131	92.7
1.250	0.065	130	122	72.9
1.375	0.065	176	150	80.6
1.500	0.065	231	181	88.3

Final Selection



Frame Geometry

- Lightweight
- Stability
- Rigidity
- Simplicity
- Driver Safety

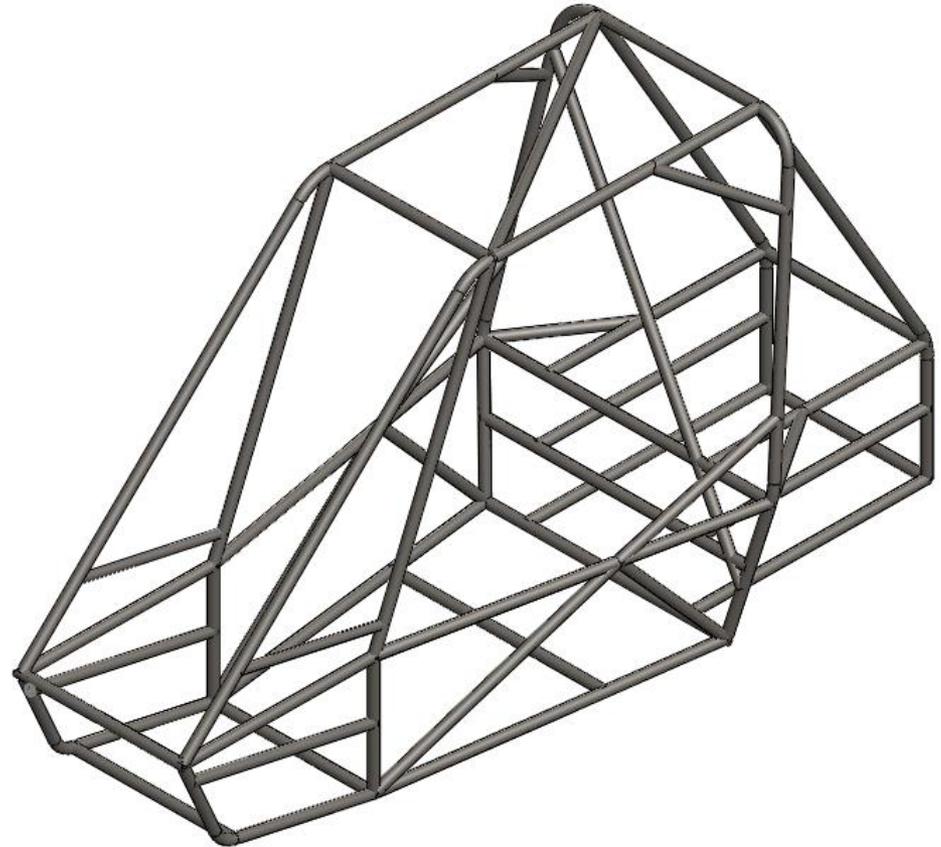
Design 1

Advantages:

- Rigidity
- Driver safety
- Maneuverability

Disadvantages:

- Heavy
- Unstable
- Manufacturability



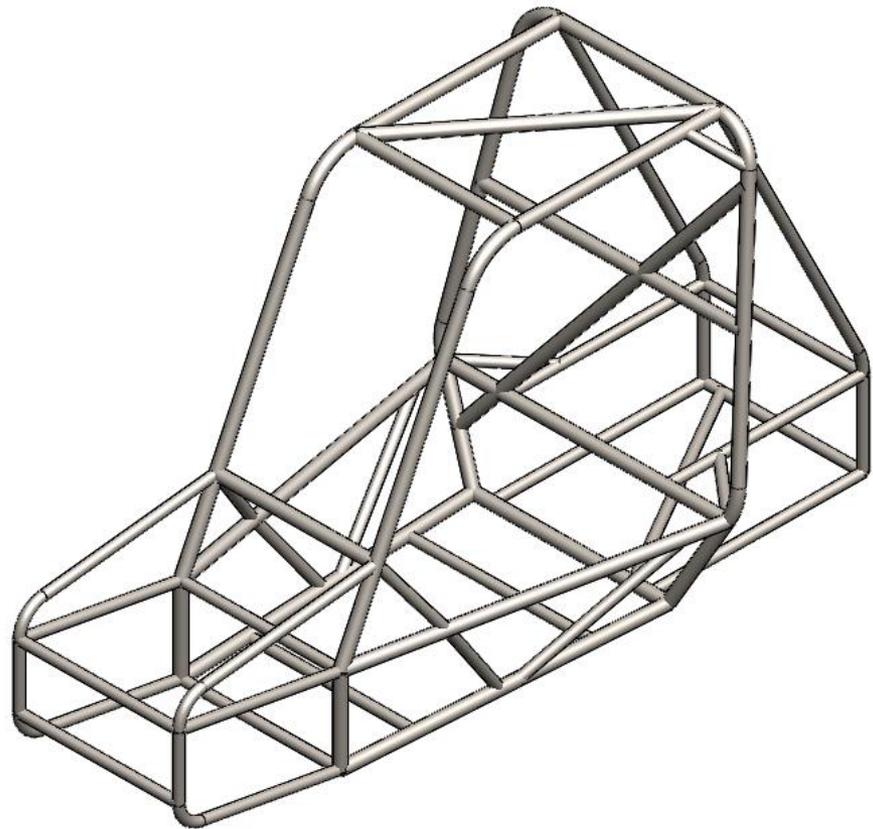
Design 2

Advantages:

- Lightweight
- Maneuverability
- Manufacturability

Disadvantages:

- Less Rigid
- Unstable



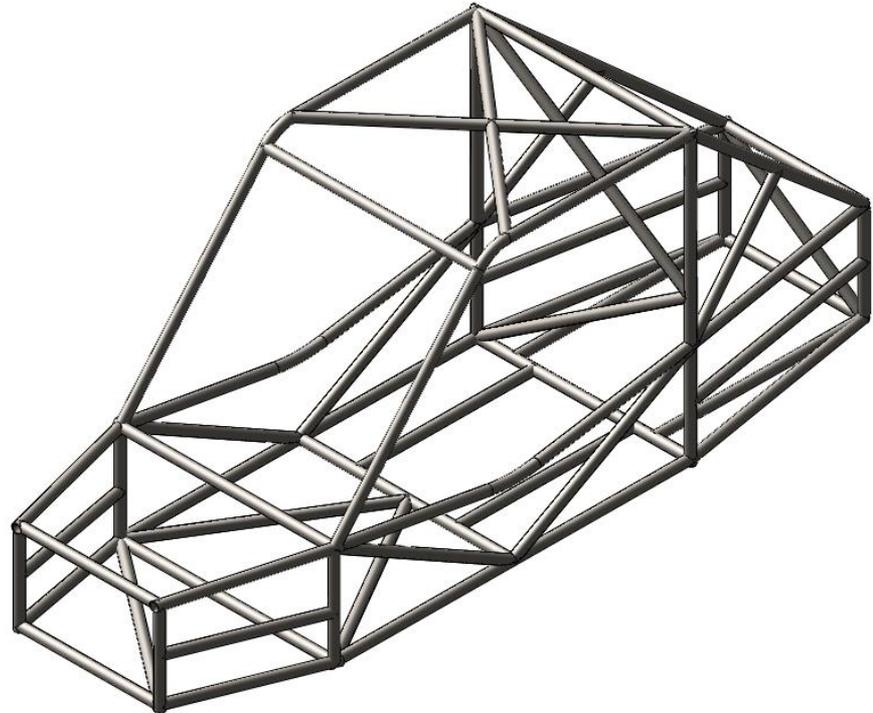
Design 3

Advantages:

- Stability
- Interior space
- Rigidity

Disadvantages:

- Maneuverability
- Heavy
- Manufacturability



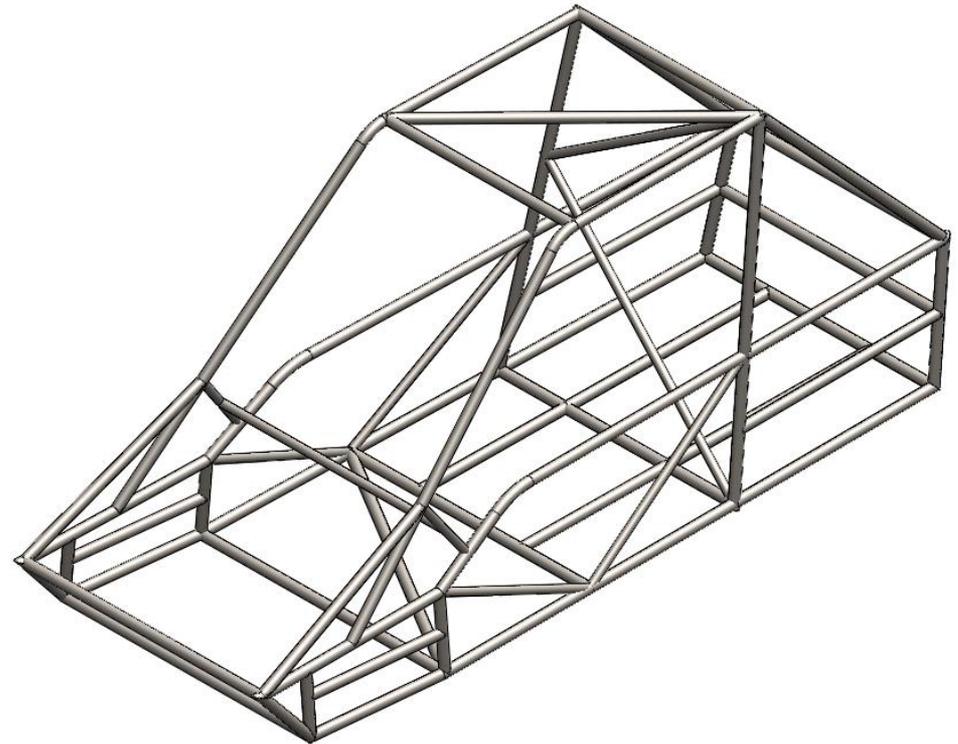
Design 4

Advantages:

- Stability
- Interior space
- Rigidity

Disadvantages:

- Less Maneuverable
- Unstable
- Manufacturability



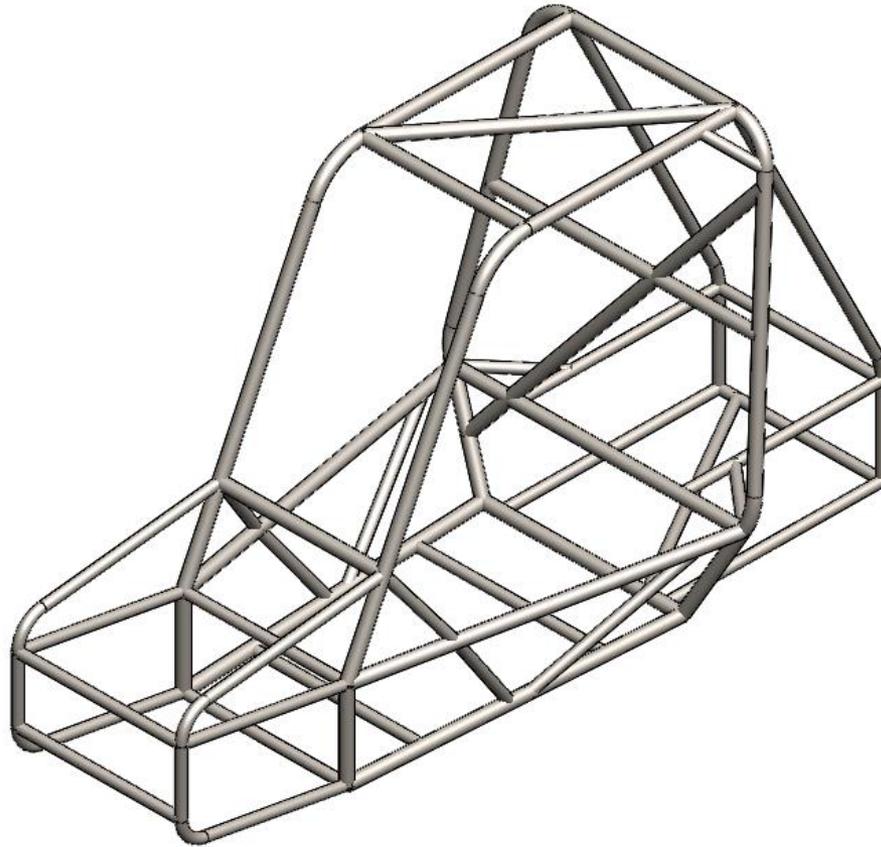
Frame Design Criteria

- Amount of material [feet]
- Length [inches]
- Width [inches]
- Height [inches]
- Number of Bends
- Number of individual tubes

Decision Matrix

	Weight	Design 1	Design 2	Design 3	Design 4
Amount of Material [ft]	9	109	94	105	107
Length [in]	5	83	78	100	100
Width [in]	1	32	33	30	31
Height [in]	5	45	44	39	44
Number of Bends	1	10	10	4	4
Number of individual tubes	1	65	43	50	55
Total		1728	1542	1724	1773

Final Design



Concept Selection - Welding

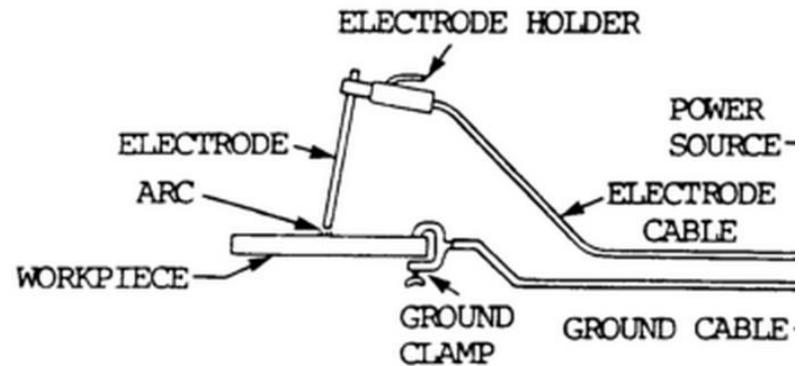
- 3 types of welding processes
 - Shielded Metal Arc Welding (SMAW)
 - Gas Metal Arc Welding (GMAW)
 - Gas Tungsten Arc Welding (GTAW)

Design Criteria for Welding Selection

- Ease of process
- Prep work required for welding
- Clean up required after welding

SMAW

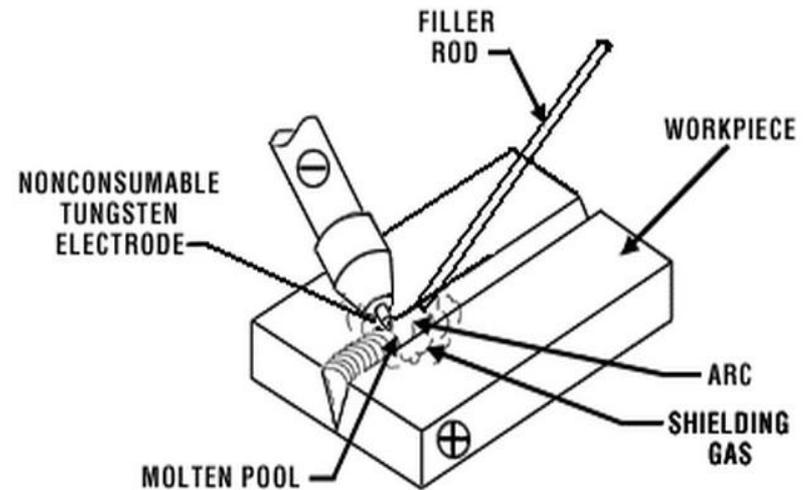
- Requires no prep work
- Requires a lot of cleaning once done
- Need special welding rod
- Can be difficult to weld in awkward positions



Wikimedia

GTAW

- A lot of prep work required
- No clean up after welding
- Very difficult to weld in tight spots

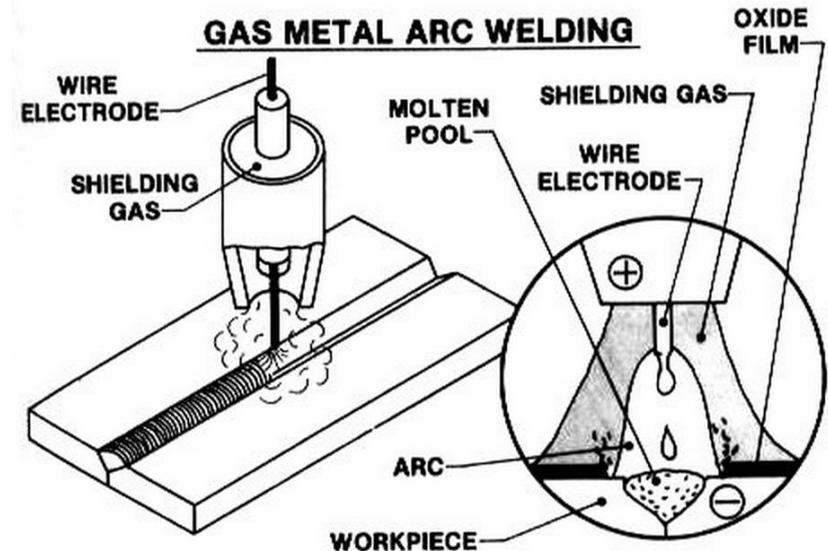


TIG WELDING PROCESS

Advantage Fabricated Metals

GMAW

- Require no prep work
- Very little cleaning after welding
- No special welding wire needed
- Easy to weld all positions



Ever Last Generators

Conclusion

- Design Problem – NAU has not won a Mini Baja competition in recent years. Team will design a light frame to maximize performance.
- Tubing Size and Material – AISI 4130 1.25” x 0.065 was chosen as the tube diameter and thickness. It is stronger and 27% lighter than the stock tubing.
- Frame Geometry – Design 2 was chosen because it is the lightest and easiest to construct.

Conclusion Continued

- Welding Method – GMAW was chosen due to its simple set up, operation, and cleanup.
- Project Plan – Preliminary frame design and ordering materials deadlines had to be pushed back. Team is on schedule to complete the frame by the end of the semester.

References

- http://upload.wikimedia.org/wikipedia/commons/f/fc/SM_AW_setup.PNG
- <http://www.everlastgenerators.com/arc-welding-process.php>
- <http://www.advantagefabricatedmetals.com/tig-welding.html>