



Baja SAE Preliminary Design

Front End + Rear End

Project Description Front/Rear End

- SAE Baja is a collegiate competition in which teams design, build, and test off-roading vehicles
- Vehicles are presented in competition to a fictitious firm for possible manufacturing
- Designs must abide by Baja SAE competition rules in order to compete
- Must be able to perform well in Dynamic and Static events
 - Acceleration Test
 - Braking Test
 - Hillclimb
 - Endurance
- Sponsors include W.L. Gore, NAU and SAE International



Project Background & Benchmarking

Front End

- Double-Wishbone Suspension:
 - Equal or unequal length A-arms
 - Shock centered in A-arms
 - Used on NAU car 44 and several top-placing SAE baja teams
- J-Arm Suspension:
 - Upper arm curves around shock
 - Used on NAU car 52



Figure 1: NAU Car 44

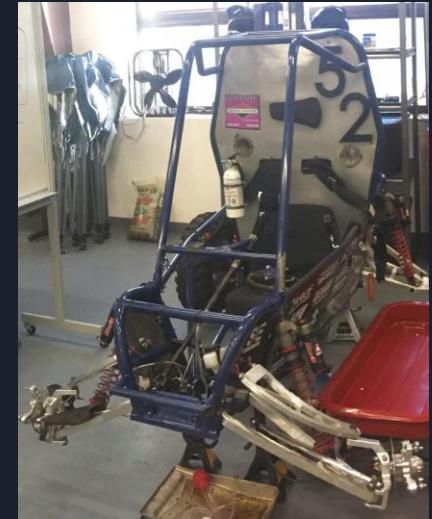


Figure 2: NAU Car 52

Project Background & Benchmarking Rear End

Car 44: Trailing arms, the most common of rear end suspension in terms of baja and high-speed off-roading vehicles

Car 52 & Michigan: double wishbone, allows for the most control in terms of toe and camber, but is very heavy, expensive, and difficult to design.



Figure 2: NAU Car 44

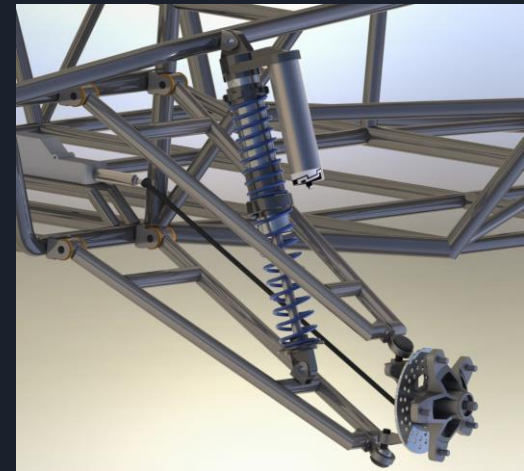


Figure 3: Double wishbone [1]

[Aaron/SAE-Baja/9-17-2019] 4



Literature Review Front End

- Fundamental analysis of different braking systems (Will Preston) [2]
- Pros and cons of ackermann, parallel and reverse steering geometries specific to the Baja SAE project in low and high speeds. (Michael Edirmannasinghe) [3]
- Complete report of designing a rack and pinion steering system. Specific to the SAE Baja competition - 2017. (Michael Edirmannasinghe) [4]
- Design and computation of many suspension geometries. (Jake Grudynski and Jesse Summers) [5]



Literature Review Rear End

- Performance of a Semi-Trailing Arm with Two Lateral Links [6]. Lucas Cramer
- Rear Suspension Systems [7]. Lucas Cramer
- Lotus Shark Suspension Analysis - Jacob Ruiz
- Baja SAE Rulebook [8] - Aaron King

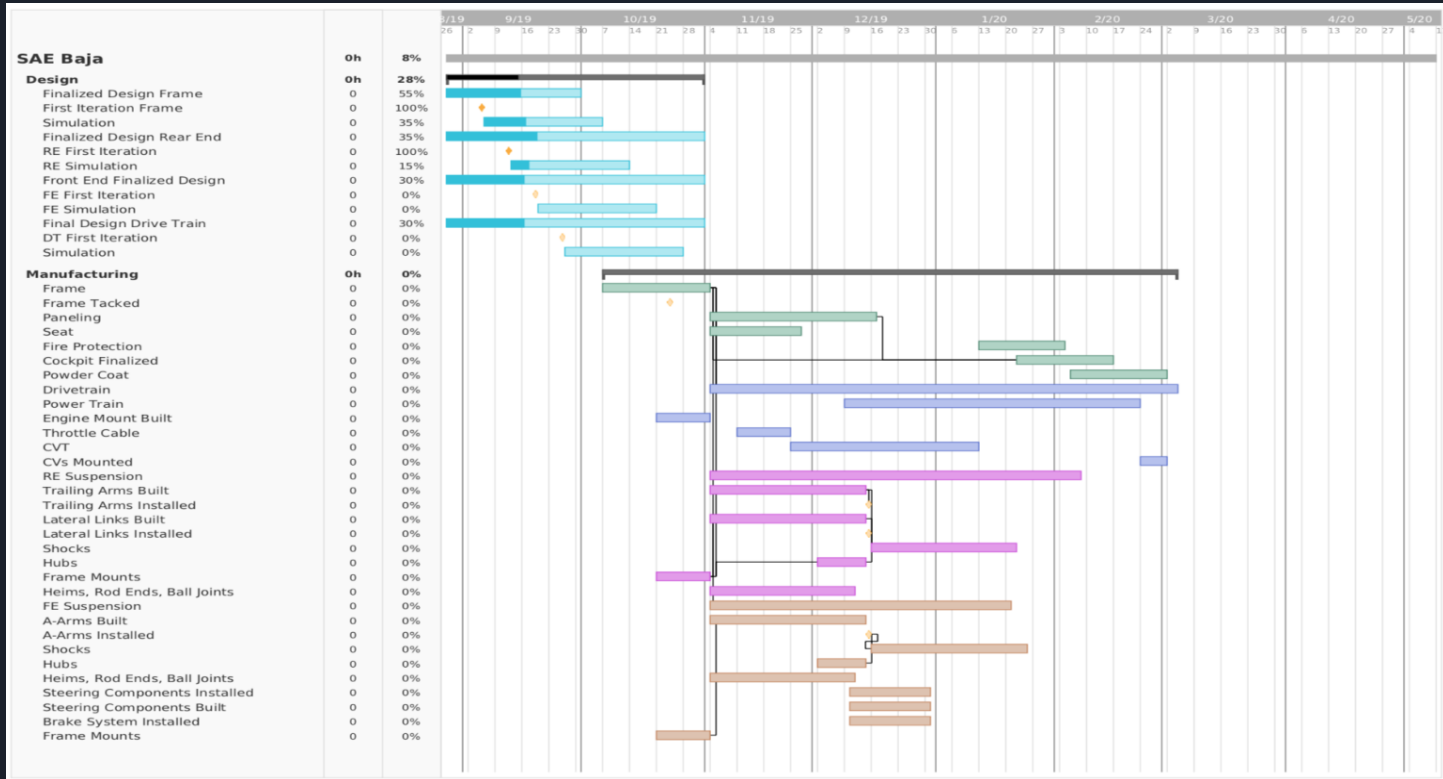
Customer & Engineering Requirements

Technical Requirements										
Customer Needs	Customer Weights	Cycles till Failure -->	Material Properties -->	Weight <--	Wheel Base <--	Cost <--	Fasteners <--	Stopping Distance <--	Ride Height *	Track Width <--
Reliable	5	9	9	1		3	3	9	3	3
Durable	5	9	9	1		3	3	3		
Lightweight	4		3	9	3	9	9	3		3
Manuverable	4			9	9	1		1	1	9
Low Cost	5	1	3	3	1	9	3			3
Easy to Repair	3	3		3	1	3	9			1
Short Stopping Distance	4							9		3
Short Wheel Base	4			9	9			3		
Ride Height	4			3					9	
Track Width	4			1				1		9
Safe to Operate	5		3	3	1			9		
Technical Requirement Units										
		#	kpsi	lbs	inches	\$	#	feet	inches	inches
Technical Requirement Targets										
		150	50	450	60	7000	N/A	6	10	53
Absolute Technical Importance		104	132	169	97	124	108	169	55	93
Relative Technical Importance		5	2	1	6	3	4	1	8	7

Figure 4 - House of Quality



Schedule

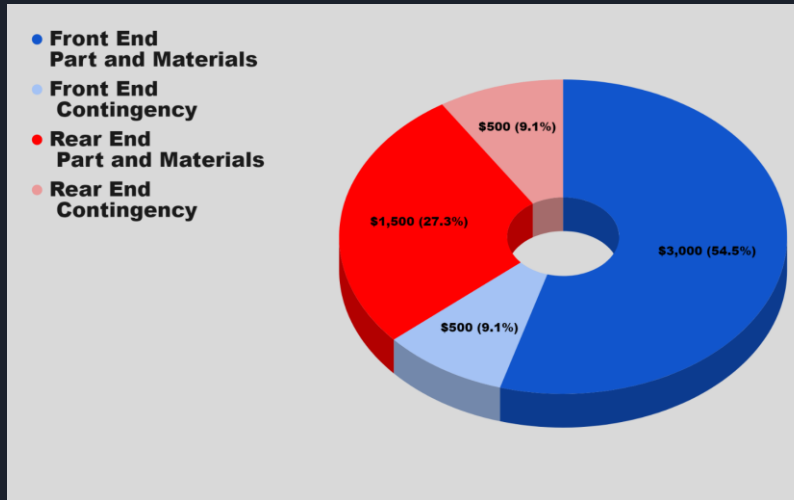


Budget

Total Available: **\$6,000** provided by W.L. Gore

Last year front end: \$4,000

- Anticipated costs
 - Parts & Materials - \$3,000
 - Manufacturing (Insourced/ Outsourced) - \$0
 - Contingency - \$500



Last year rear end: \$2,500

- Anticipated costs
 - Parts & Materials - \$1,500
 - Manufacturing (Insourced/ Outsourced) - \$0
 - Contingency - \$500

Questions?



References

- [1] Grabcad, <https://grabcad.com/library/off-road-buggy-front-suspension-1>, 16 September 2019
- [2] R. Limpert, *Brake design and safety*, 3rd ed. Warrendale, Pa. (400 Commonwealth Dr., Wallendale PA USA): Society of Automotive Engineers, 2011.
- [3] D. Colgrove, "Steering System for SAE Baja" (2019). Undergraduate Honors Theses. 64. https://scholarsarchive.byu.edu/studentpub_uht/64
- [4] O. Suryavanshi, P. Prasad Sathe and M. Takey, "DESIGNING OF THE RACK AND PINION GEARBOX FOR ALL TERRAIN VEHICLE FOR THE COMPETITION BAJA SAE INDIA AND ENDURO STUDENT INDIA", *International Journal of Research in Engineering and Technology*, vol. 06, no. 09, pp. 79-84, 2017. Available: 10.15623/ijret.2017.0609014 [Accessed 13 September 2019].
- [5] J. Dixon, *Suspension Analysis and Computational Geometry*. Chichester: John Wiley & Sons, 2009



References Cont...

[6] N. Brockman, "Baja SAE Rear Suspension Design," SAE International, Cincinnati, 2013.

[7] General Spring, "General Spring of Kansas City," 2019. [Online]. Available:
https://www.generalspringkc.com/How_to_Upgrade_Your_Suspension_for_Off_Roadings/3092.htm.
[Accessed 13 September 2019].

[8] S. international, Baja SAE Rulebook, SAE, 2019.