Baja

Concept Generation and Selection

Fahad Alajmi, Sean Collins, Peng Li, Auston Solway,
Maximillian Whipple, Jingyuan Zhang

Srinivas Kosaraju
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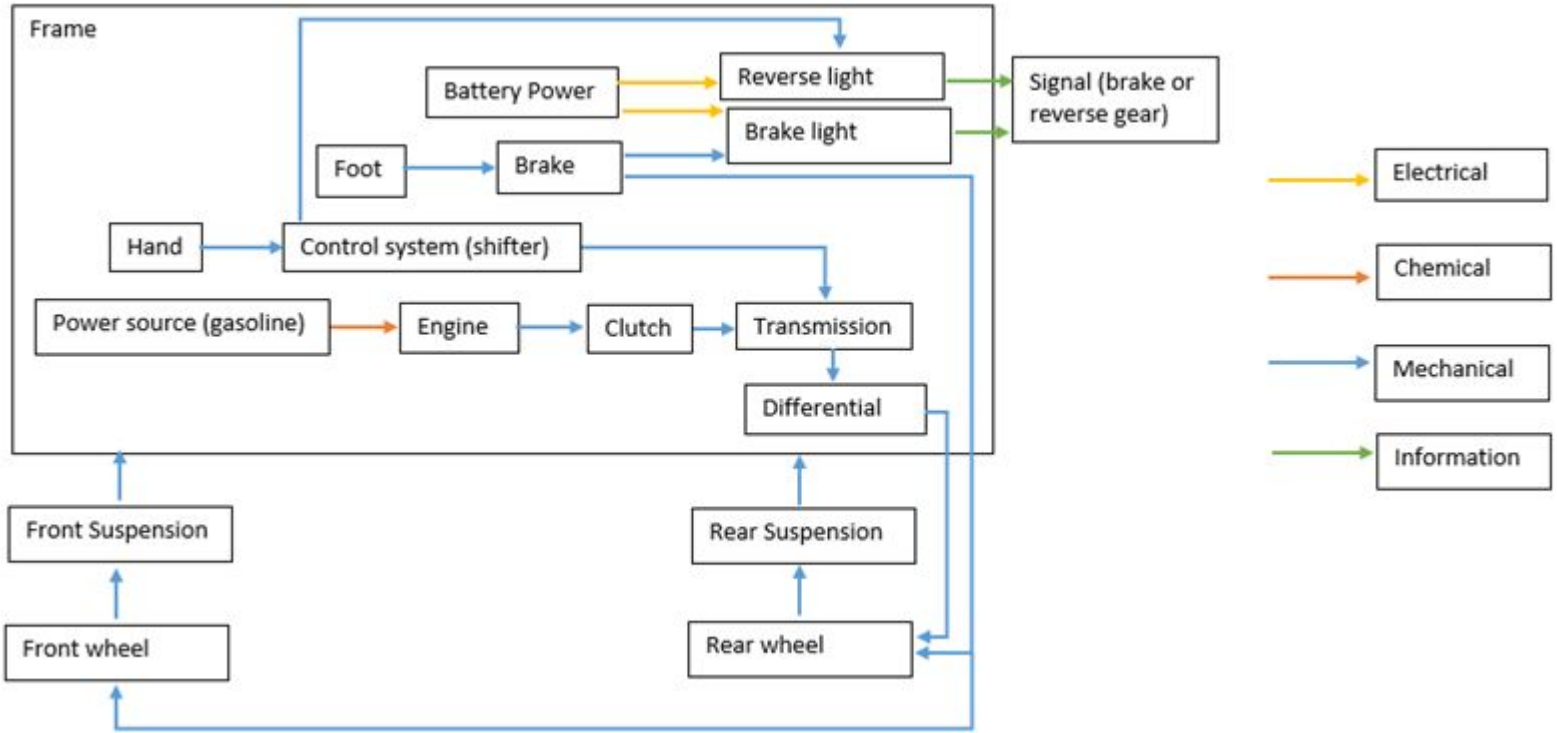
Introduction

- Dr.Kosaraju requested the development of the rear suspension, clutch mechanism, and transmission by 15 NOV.
- The vehicle must comply with SAE Baja 2016 rules and must be fully operational by March 1st, 2016.
- The Quality Function Development identified multiple engineering and customer requirements.

Functional Diagram



Criteria

Rear Suspension

1. Travel
2. Deflection
3. Durability
4. Cost
5. Maintenance/Repair

Clutch

1. Durability
2. Maintenance/Repair
3. Starting Torque
4. User Friendly
5. Cost

Shifter

1. Degrees of Throw
2. Shifting Speed
3. Shifting Force
4. Cost
5. Simplicity

Relative Weights of Criteria

Suspension	
Criteria	**Average Normalized Weight**
Travel	0.14
Deflection	0.13
Durability	0.37
Cost	0.12
Maintenance and Repair	0.24
Total	**1.00**

Clutch	
Criteria	**Average Normalized Weight**
Durability	0.30
Maintenance and Repair	0.12
Starting Torque	0.21
User Friendly	0.13
Cost	0.24
Total	**1.00**

Shifter	
Criteria	**Average Normalized Weight**
Degrees of Throw	0.18
Shifting Speed	0.13
Shifting Force	0.45
Cost	0.15
Simplicity	0.09
Total	**1.00**

Concept Generation: Suspension

Three Link:

Concept Generation: Suspension

Single Trailing Arm:

Concept Generation: Suspension

Independent Rear Suspension (A-Arm):

Decision Matrix: Suspension

Ratings for Suspension Criteria:

Rear Suspension						
Performance Level	Rating	Travel (in)	Deflection (in)	Durability (hours)	Cost	Maintenance/Repair (min)
Perfect	10	20	0	30	≤ $150	≤ 15
Excellent	9	18	0.25	27	$300	30
Very Good	8	16	0.5	24	$450	45
Good	7	14	0.75	21	$600	60
Satisfactory	6	12	1	18	$750	75
Adequate	5	10	1.25	15	$900	90
Tolerable	4	8	1.5	12	$1,050	105
Poor	3	6	1.75	9	$1,200	120
Very Poor	2	4	2	6	$1,350	135
Inadequate	1	2	2.25	3	$1,500	150
Useless	0	0	≥ 2.5	0	> $1500	> 150

Decision Matrix: Suspension

- Ranking Suspension Options:

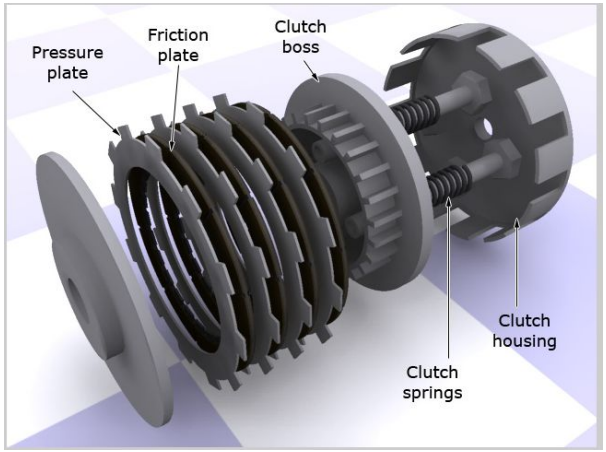
Criteria Ranking			
Criteria	**Three Link**	**Single Trailing Arm**	**A-Arm**
Travel	10	10	6
Deflection	8	0	8
Durability	7	3	7
Cost	6	10	7
Maintenance/Repair	6	8	5
Total	**37**	**31**	**33**

- Normalized Matrix:

Criteria Normalization			
Criteria	**Three Link**	**Single Trailing Arm**	**A-Arm**
Travel	1.4	1.4	0.84
Deflection	1.04	0	1.04
Durability	2.59	1.11	2.59
Cost	0.72	1.2	0.84
Maintenance/Repair	1.44	1.92	1.2
Total	**7.19**	**5.63**	**6.51**

Concept Generation: Clutch

- Basket Clutch:



Carbibles.com

- Centrifugal Clutch:

Heeters.com

Decision Matrix: Clutch

Ratings for Clutch Criteria:

Clutch					
Performance Level	**Rating**	**Durability**	**Maintenance/Repair**	**Starting Torque (ft-lb)**	**Cost**
Perfect	**10**	100 hrs.	≤ 15 min.	≥ 30	≤ $150
Excellent	**9**	90 hrs.	30 min.	28.5	$300
Very Good	**8**	80 hrs.	45 min.	27	$450
Good	**7**	70 hrs.	60 min.	25.5	$600
Satisfactory	**6**	60 hrs.	75 min.	24	$750
Adequate	**5**	50 hrs.	90 min.	22.5	$900
Tolerable	**4**	40 hrs.	105 min.	21	$1,050
Poor	**3**	30 hrs.	120 min.	19.5	$1,200
Very Poor	**2**	20 hrs.	135 min.	18	$1,350
Inadequate	**1**	10 hrs.	150 min.	16.5	$1,500
Useless	**0**	0 hrs.	> 150 min.	≤ 15	> $1500

Decision Matrix: Clutch

- Ranking Clutch Options:

Criteria Ranking		
Criteria	**Centrifugal**	**Basket Clutch**
Durability	7	10
Maintenance/Repair	10	2
Torque	10	10
User Friendly	10	5
Cost	9	3
Total	**46**	**30**

- Normalized Matrix:

Criteria Normalization		
Criteria	**Centrifugal**	**Basket Clutch**
Durability	2.1	3
Maintenance/Repair	1.2	0.24
Torque	2.1	2.1
User Friendly	1.3	0.65
Cost	2.16	0.72
Total	**8.86**	**6.71**

Concept Generation: Shifter

- Rachet Shifter:

Bmracing.com

- Gate Shifter:

Racereadyproducts.com

Decision Matrix: Shifter

Ratings for Shifter Criteria:

Shifter					
Performance Level	**Rating**	**Degrees of Throw**	**Shifting Speed (s)**	**Shifting Force (lb)**	**Cost**
Perfect	**10**	<10	1	<4	≤ $100
Excellent	**9**	10	2	4	$125
Very Good	**8**	20	3	6	$150
Good	**7**	30	4	8	$175
Satisfactory	**6**	40	5	10	$200
Adequate	**5**	50	6	12	$225
Tolerable	**4**	60	7	14	$250
Poor	**3**	70	8	16	$275
Very Poor	**2**	80	9	18	$300
Inadequate	**1**	90	10	20	$325
Useless	**0**	>90	> 10	>20	>$325

Decision Matrix: Shifter

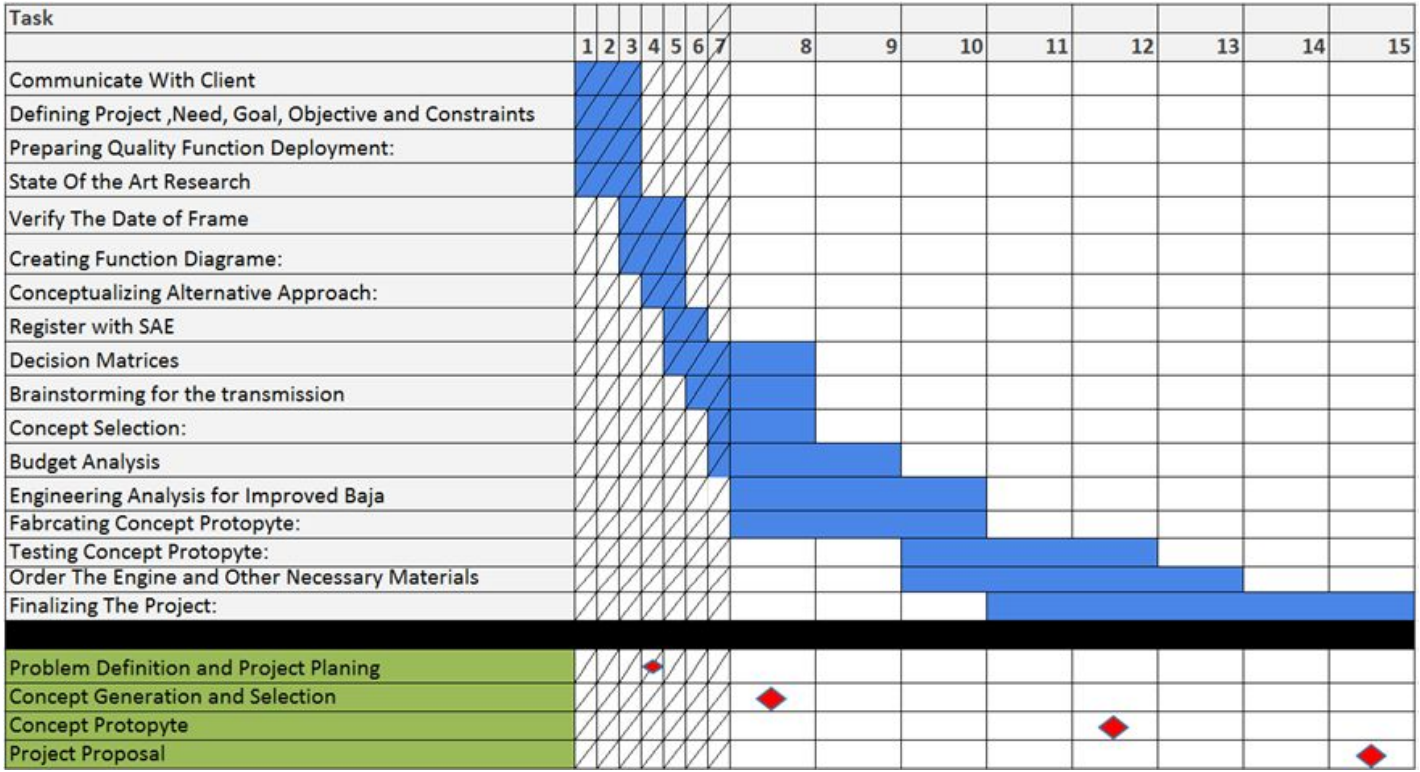
- Ranking Shifter Options:

Criteria Ranking		
Criteria	**Rachet**	**Gate**
Degrees of Throw	4	8.5
Shifting Speed	5	5
Shifting Force	7	4
Cost	3	10
Simplicity	4	8
Total	**23**	**35.5**

- Normalized Matrix:

Criteria Normalization		
Criteria	**Rachet**	**Gate**
Degrees of Throw	0.72	1.53
Shifting Speed	0.78	0.65
Shifting Force	3.15	1.8
Cost	0.45	1.5
Simplicity	0.36	0.72
Total	**5.46**	**6.2**

Updated Project Plan:



Conclusions:

- Functional Diagram is helpful to the presenter to, to know how the baja is work, and what the main sources of energies used in.
- Criteria and Relative Weights of Criteria: helps us evaluate criteria importance
- Concepts: suspension, clutch, and shifter
- Decision Matrices of Concepts: use the weighted criteria we developed to evaluate our concepts
- Updated project plan: timelines that have changed

References:

- Erickson, Wallace D. Belt Selection and Application for Engineers. New York: M. Dekker, 1987.

- Naunheimer, Harald. Automotive Transmissions Fundamentals, Selection, Design and Application. 2nd ed. Berlin: Springer, 2011.