SAE Baja: Suspension & Steering

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Wednesday, October 9, 2013

Overview

- Introduction
- Operating Environment
- Recognizing the Need
  - Need Statement
  - Goals
  - Objectives
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Overview (cont’d)

- QFD
  - Suspension
  - Steering
- House of Quality
- Gantt Chart
- Conclusion

Introduction

Client: Professor John Tester

Why: passion for automobile motorsports

His research projects include:

- Manufacturing
- Rapid prototyping
- Injection molding
- CAD/CAM application

Operating Environment

- Competition
  - El Paso, Tx
- Off road course environment
- Traverse over several natural terrains

Recognizing the Need: Need Statement

- Need = client requests
- Maneuverability
  - Reduce turning radius while sustaining proper suspension
- Weight Reduction from Previous Design
  - Possibly use lighter material for A arms, hubs and suspension

Recognizing the Need: Need Statement (cont'd)

- Economical
  - Within budget and functional
- Safe
  - Within safety standards (Article 12, SAE 2014 Collegiate Design Series)
- Durable
  - Low maintenance & Strength Tested

Defining the Problem: Goals

- Design an inexpensive, durable off road vehicle suspension/steering systems for competition use

Defining the Problem: Objectives

- Increase individual component strength while decreasing weight
  - All component weights combined should not weigh more than the frame
- Inexpensive to produce and manufacture
  - use materials that are both strong while remaining light

Defining the Problem: Objectives

- Decrease turning radius
  - Within 66% of the current baja
  - Current Baja is at nearly 14ft for its turning radius
- Pick and design a suspension that would be competitive in a race setting
  - Could use an innovative but risky design or use a simple design that is more likely to work well

Defining the Problem: Constraints (Client)

- Steering
  - Must be able to manuever vehicle
  - Smaller turning radius than previous design
    - ~ 14ft
- Weight
  - less than previous “tank”
    - ~ 600lb

Defining the Problem: Constraints (Client)

- w/o 300lb
  - light design for suspension/steering
- Suspension dimensions
  - w/ comparison to frame
    - previous design
  - Travel Length (for driver)
  - Must be able to function after drop from 3ft

Defining the Problem: Constraints (Client)

Current Vehicle Suspension:

* Provided by: ENG 386w Team 61

Defining the Problem: Constraints (SAE)

Constraints relative to SAE rules

- Vehicle
  - Four wheel (not linear)
- Dimensions
  - Width: 162 cm (64 in)
- Length : not restricted

Defining the Problem: Constraints (SAE)

- Suspension
  - Ground Clearance/Traction
- Safety
  - Safely traverse over rough terrain
  - Snow, mud, shallow water, rain

QFD: Suspension

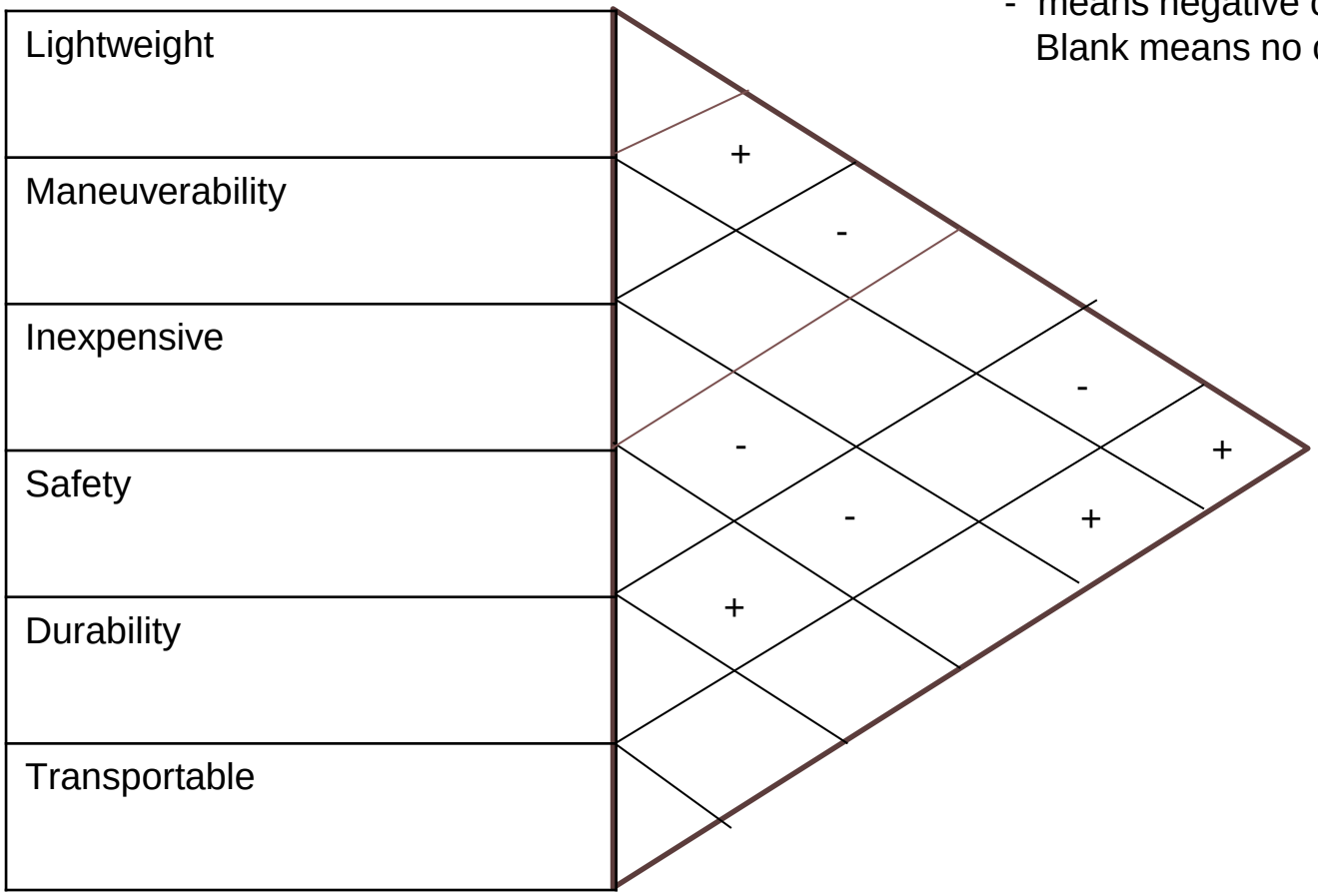
		Engineering Requirements for given design						
Suspension	**Customer Needs**	**Customer Weights**	Ground Clearance	Suspension Travel	Y.S.	Stiffness	Spring Rate	Cost	Weight
	1. Lightweight	10					3	3	9
	2. Maneuverability	10	9	9		3	9	3	9
	3.Relatively inexpensive	6		1				9	
	4. Must be safe	7	3	1	9	3		1	
	5. Must be durable	8			9	9		3	
	6. Transportable	8	3	3					3
	Raw score		135	127	135	123	120	145	204
	Relative Weight		14%	13%	14%	12%	12%	15%	21%
	Unit of Measure		in	in	in	lb	lb/in	$	ft
	Technical Target								

QFD: Steering

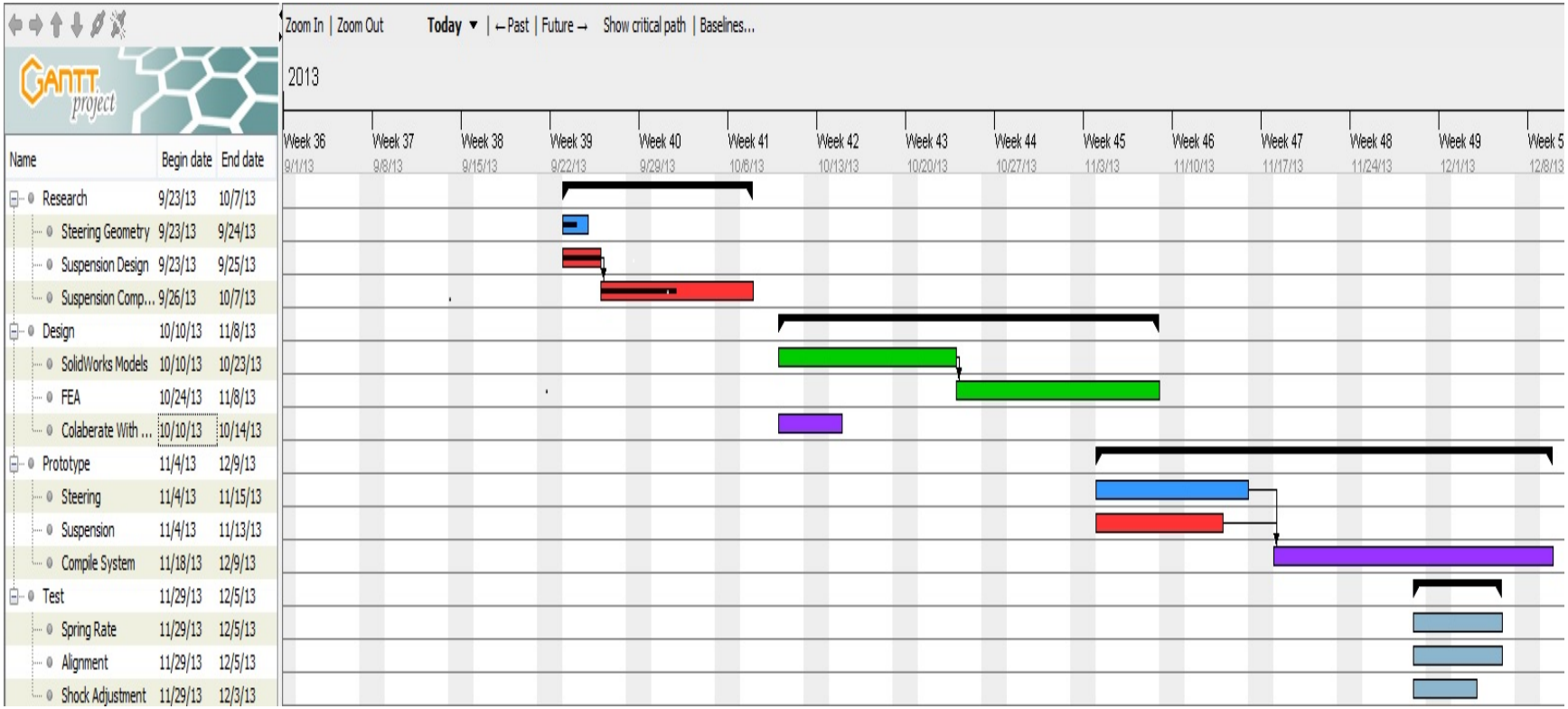
Steering	Engineering Requirements for given design								
	Customer Needs	**Customer Weights**	Y.S.	Caster Angle	Ackerman Angle	Turning Radius	Cost	Bolt Shear Stress	Width
	1. Lightweight	10					3	1	
	2. Maneuverability	10		9	9	9			9
	3. Relatively inexpensive	6	9				9	3	
	4. Stable/safe	9		9	9	3			9
	5. Must be durable	8	9				9	3	
	6. Transportable	8				3			3
		Raw score	126	171	171	141	156	52	195
		Relative Weight	12%	17%	17%	14%	15%	5%	19%
		Unit of Measure	psi	degrees	degrees	ft	$	psi	lb
		Technical Target							

House of Quality

+ means positive correlation
- means negative correlation
Blank means no correlation



Gantt Chart


Zoom In | Zoom Out
Today
← Past | Future →
Show critical path | Baselines...
2013
Week 36 9/1/13
Week 37 9/8/13
Week 38 9/15/13
Week 39 9/22/13
Week 40 9/29/13
Week 41 10/6/13
Week 42 10/13/13
Week 43 10/20/13
Week 44 10/27/13
Week 45 11/3/13
Week 46 11/10/13
Week 47 11/17/13
Week 48 11/24/13
Week 49 12/1/13
Week 5 12/8/13
Name
Begin date
End date
Research 9/23/13 10/7/13
Steering Geometry 9/23/13 9/24/13
Suspension Design 9/23/13 9/25/13
Suspension Comp... 9/26/13 10/7/13
Design 10/10/13 11/8/13
SolidWorks Models 10/10/13 10/23/13
FEA 10/24/13 11/8/13
Colaberate With ... 10/10/13 10/14/13
Prototype 11/4/13 12/9/13
Steering 11/4/13 11/15/13
Suspension 11/4/13 11/13/13
Compile System 11/18/13 12/9/13
Test 11/29/13 12/5/13
Spring Rate 11/29/13 12/5/13
Alignment 11/29/13 12/5/13
Shock Adjustment 11/29/13 12/3/13

Conclusion

- Our client John Tester
- The competition in El Paso TX
- Need Statement
  - Maneuverability
  - weight

Conclusion (cont’d)

- Goals
  - Inexpensive
  - durable
- Objectives
  - Decrease turning radius
  - Be competitive
- Constraints
  - Width Ground
  - Clearance
  - Fasteners

Conclusion (cont’d)

- QFD
  - Suspension
  - Steering
- House of Quality
- Gantt Chart

References

- 2014 Baja Rules
  - SAE International 2014 Collegiate Design Series
    - Baja SAE Rules
      - http://www.sae.org/students/2014_baja_rules_8-2103.pdf
- Dr. John Tester
  - College of Forestry, Engineering and Natural Sciences
    - http://nau.edu/CEFNS/Engineering/Mechanical/Faculty-Staff/John-Tester/