Baja SAE®- Frame Team

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Baja SAE® Overview

- Annual Collegiate Design Series Competion:
  - In Portland, Oregon: May 27-30, 2015
  - University of Wyoming competes annually (interative design challenge)
  - Very rule prescribed competion
- 4 Dynamic Events:
  - Acceleration
  - Hill Climb
  - Maneuverability
  - Rock Crawl
- Endurance Race
  - 4 hours

Photo Source: http://overdrive.in/news/team-gs-racers-from-indore-win-baja-sae-india-2014/

Budget

2014-15 Baja SAE Budget

Item	Quantity	Cost
Simpson Latch and Link Driver Restraint System (re-used)	1	$0.00
UHMW 48" x 120" 1/4 Thick Sheet	1	$437.82
UHMW 48" x 120" 1/8 Thick Sheet	1	$222.87
4130 Alloy Steel Tube (1.25" OD X 0.65" Thickness) 8 ft. Length	15.125	$670.17
4131 Alloy Steel Tube (1" OD X 0.35" Thickness) 8 ft. Length	3	$100.71
Fiberglass Seat	1	$70.00
	TOTAL	$1,501.57
	Amount Allotted:	$2,500.00

Design Objectives

- Weight reduction
- Safety/Rule compliance
- Interfacing
- Aesthetics

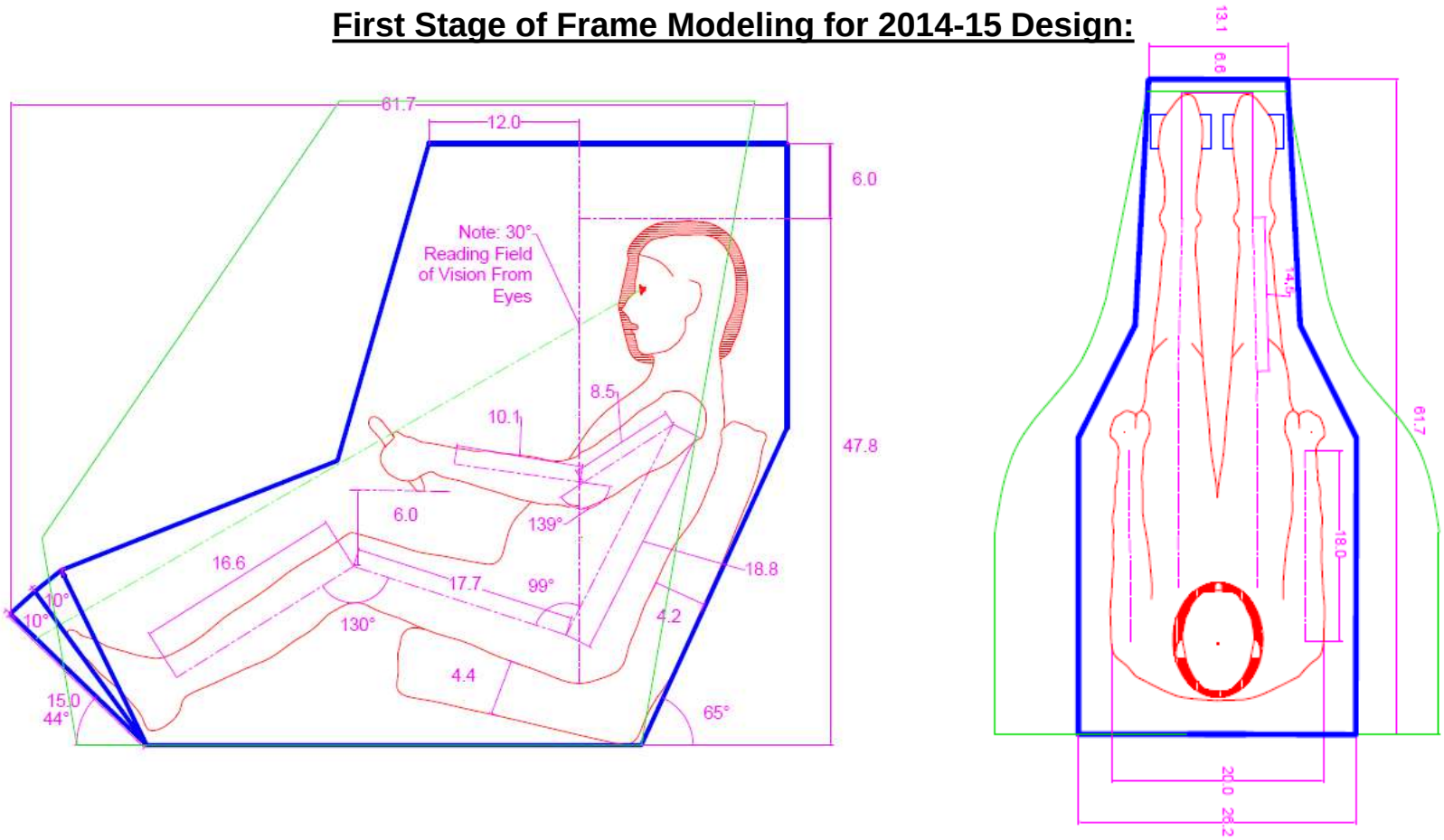
Weight Reduction

- Smaller overall size
- Use of smaller/ lighter secondary members
- Elimination of redundant and unnecessary members
- Fiberglass seat

Baja Frame Comparison		
Vehicle Year	**2013-14**	**2014-15**
Weight [lbs]	~90-100	78
Length [in]	80	79
Width [in]	42	30
Height [in]	50	45
Tubing Length [ft]	~110	93

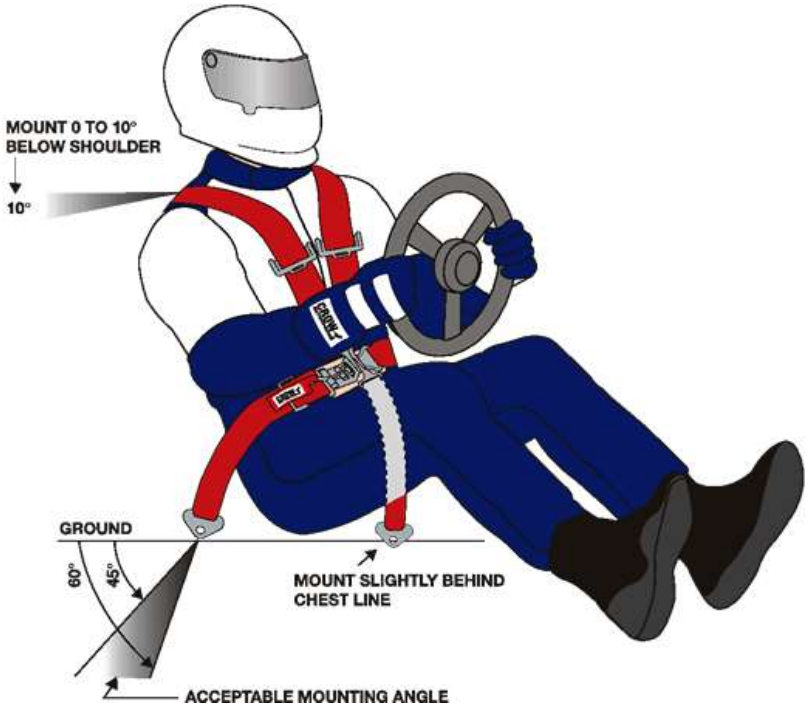
Weight Reduction (cont.)

First Stage of Frame Modeling for 2014-15 Design:



Safety/Rule Compliance

- All design constraints will conform with the 2015 Baja SAE® Series Rules
  - Example: Mounting Tabs shall not visibly deform when a load is applied.
- Cockpit sizing extremely important
  - Helmet must have 6 inches of clearance
  - All other body parts require a 3 inch clearance minimum
- Ergonomics are very important!
  - Proper positioning minimizes driver fatigue
  - Increases situational awareness
  - Improves driver safety
  - **Quicker** reaction times = **Faster** lap times



Source: wescoperformance.stores.yahoo.net

Safety/Rule Compliance (cont.)

Risk Assessment for SAE™ Baja Car Frame

Risk	Risk Factor	Likelihood	Severity	Mitigation
Serious	Injury to Operator from Collision/ Rollover Event	Occasional	Critical	Operator must use all Personal Protective Equipment; All safety system mounting points designed with a factor of safety of at least 4
	Sharp Corners Causing Injury	Probable	Marginal	No sharp edges will be visible; All sharp places properly covered
Medium	Penetration of Foreign Object in Cockpit Area	Remote	Critical	Paneling will be puncture resistant; Side paneling protects cockpit area adequately
	Failure of Primary Frame Member	Improbable	Critical	Each welder will submit test samples to ensure quality fabrication occurs
	Fuel/ Fire Entering Cockpit Area	Remote	Critical	Firewall and fuel containment systems designed to prevent leakages or hazards associated with fire/ hazmat
	Fatigue of Operator	Frequent	Negligible	Cockpit area is ergonomic; All safety equipment will be properly fitted to each operator

Source: http://fsims.faa.gov/WDocs/Notices/N8000-301.htm

Interfacing

- Collaboration between design teams was critical to a successful design
- Examples of Interfacing:
  - Mounting points for:
    - Powertrain components
    - Suspension components
    - Brakes/pedals
  - Enough room provided for:
    - Engine/ Drive Components
    - Steering Assembly

Aesthetics

- 2013-14 design featured the use of poor paneling material
  - Broke easily (sharp edges)
  - Duct Tape/ Zip Ties
- Professional fastening methods and high quality materials
- Inclusion of logos required

Material Selection

Primary Members

- Meets or exceeds bending stiffness and strength of circular 1018 tubing of 1 in. diameter and 0.120 in. wall thickness.
- Wall thickness must be at least 0.062”
- 1018
  - Strength - 235 N-m
  - Stiffness - 1677 N-m^2
  - Weight – 1.13 lb/ft
- 4130
  - Strength - 280 N-m
  - Stiffness - 1967 N-m^2
  - Weight – 0.83 lb/ft

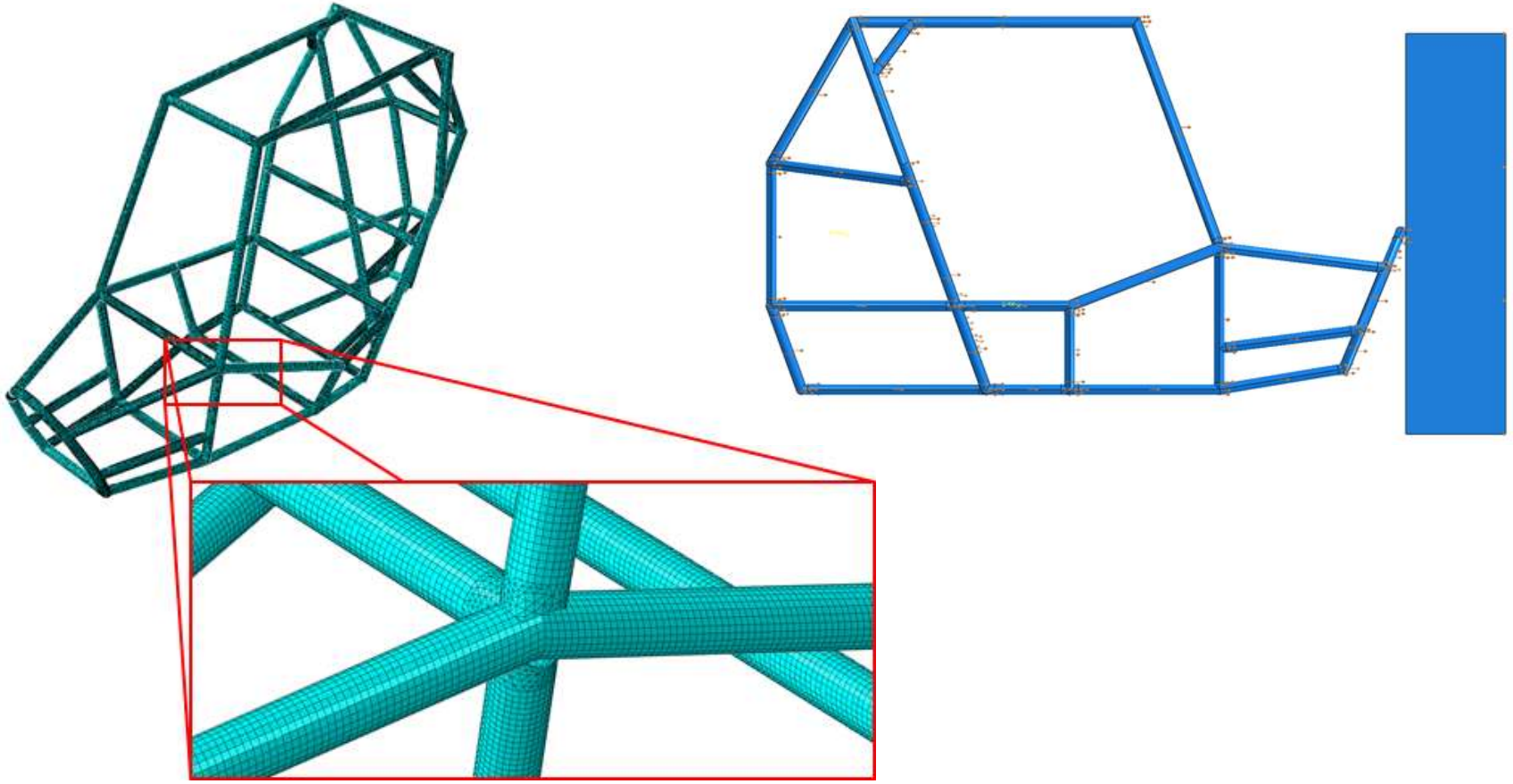
Secondary Members

- Minimum OD of 1”
- Minimum wall thickness of 0.035”

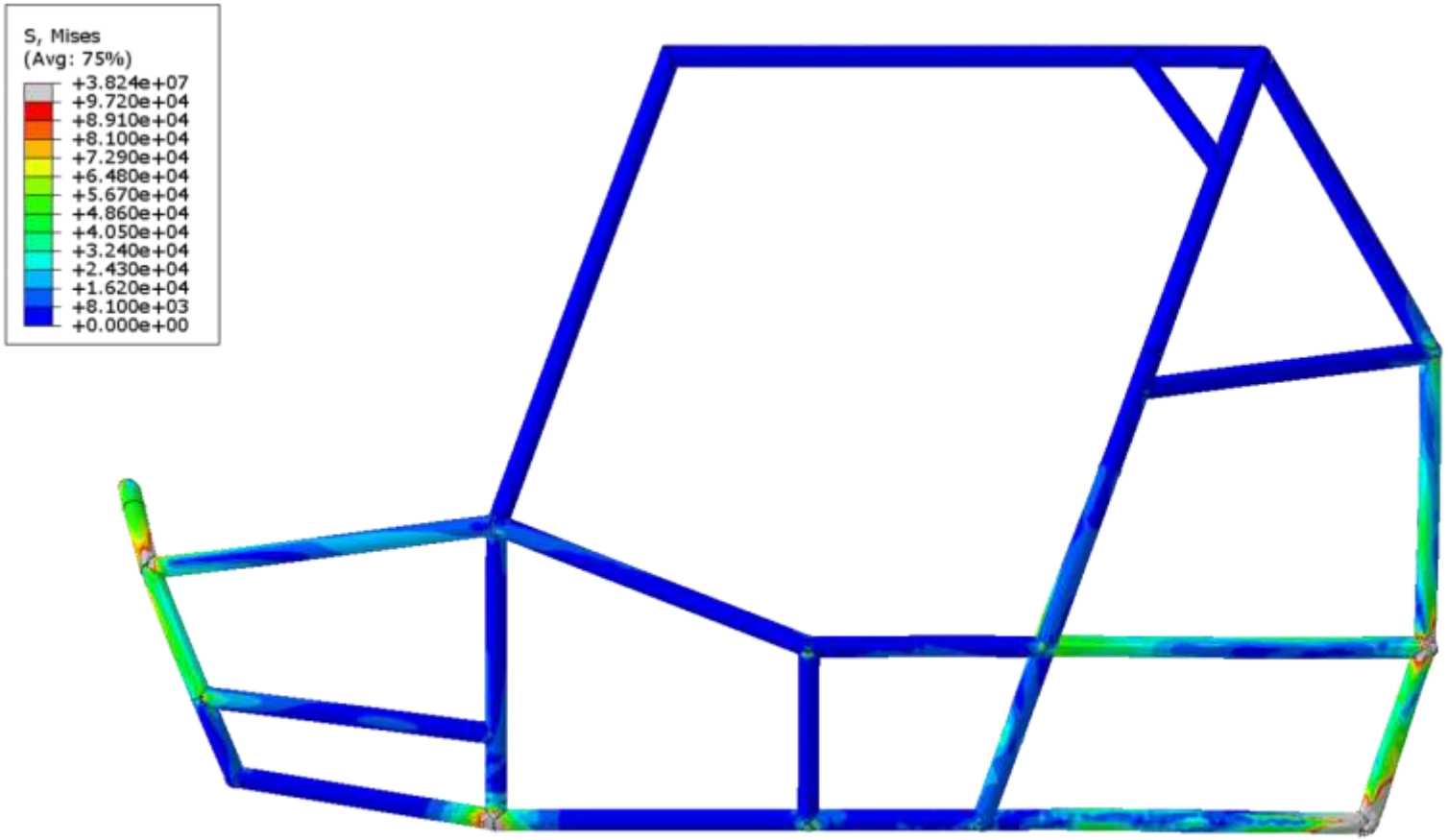
Paneling

- High strength, high toughness, low weight material desirable
- Materials compared on basis of strength, stiffness, toughness, and density
  - Kydex
  - Fiberglass
  - Acetal (Delrin)
  - Polycarbonate (Lexan)
  - UHMW-PE
  - 6061-T6 Al
- UHMW chosen as best balance of required traits with additional benefits
  - Low friction
  - Excellent impact resistance
  - Thermoformable

Theoretical Testing



Theoretical Testing (cont.)



Real World Testing

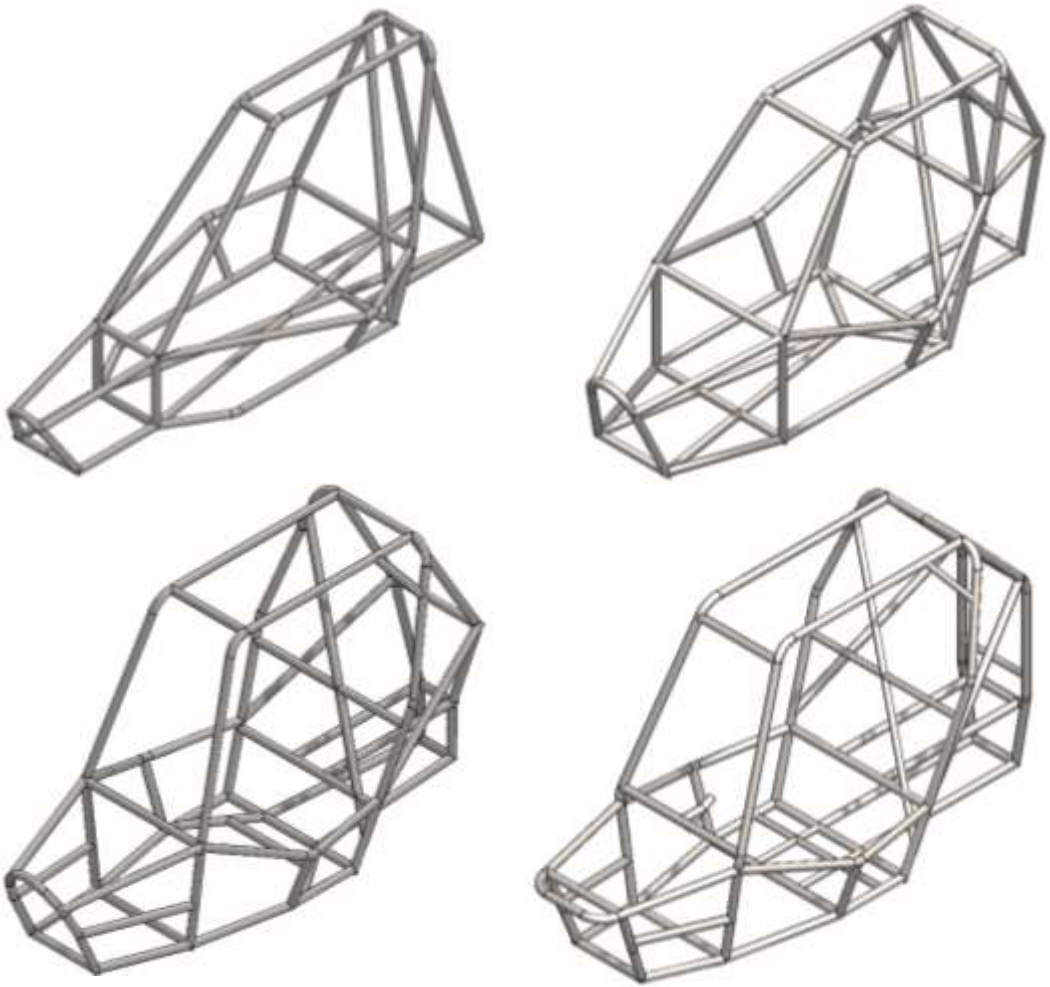
- Testing of welding samples
- Weighing the frame
- Test driving at airport (upon completion)

Design Validation

- Along each phase of design/building process tested driver compatibility
- Provided a more accurate depiction of design feasibility
- Better estimate of materials needed/ interface with components

Fabrication

Iterative Design Process



Conclusions

- Design and fabrication offered various challenges
  - Chassis construction
  - Interfacing
- Overall high quality construction
- Current frame offers substantial improvements over the previous design

Acknowledgements

- Dr. Erikson – Sponsor and advisor
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