SAE Mini Baja

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Apr 29, 2016

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SAE INTERNATIONAL

Overview

- Project Introduction
- Objectives and Constraints
- Old designs and Issues
- Design modifications
  - Suspension
  - Transmission
  - Clutch
  - Shifter
- Performance tests of Mini Baja
- Conclusion

Introduction

- Client: SAE Club and Dr. John Tester
- Background: NAU’s SAE club is a club for students interested in automotive and aeronautical career fields

SAE Baja Competition

- Three collegiate competitions held across US
- Uniform Briggs and Stratton 10HP
- Competitions: Endurance, Acceleration, Suspension, Maneuverability, Hill Climb

Project Needs and Goals

- Need Statement: NAU’s SAE club, advised by Dr. Tester, does not have an operational Mini Baja vehicle for the SAE competition
- Goal Statement: To build an operational Mini Baja vehicle through engineering practices and teamwork

Objectives

Objectives	Measurement	Units
Light Weight	Pounds	lb
Quick	Acceleration	ft/s^2
Safety	Factor	ksi/ksi
Endurance	Hours	hr
Ergonomic Cockpit	Feet Cubed	ft^3

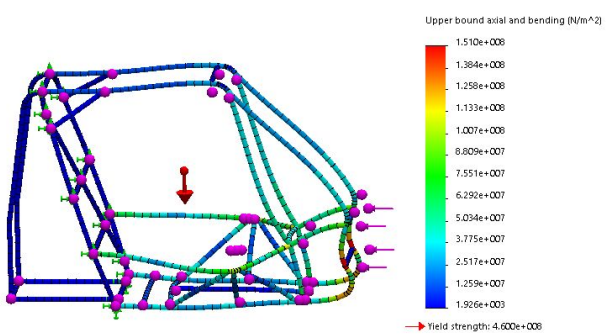
Constraints

- Verify the frame is less than 2 years old
- Must have at minimum 2 forward gears and 1 reverse gear
- Cannot exceed 108” in length or 64” in width
- Weigh less than 800 lb
- Must use a 10 hp Briggs and Stratton engine

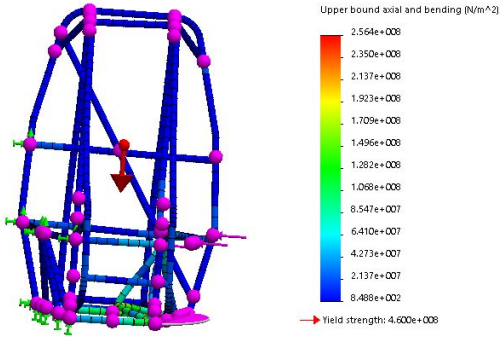
2015 Design and Issues

- Frame: Need to verify the safety of the frame
- Rear Suspension: Allowed for too much deflection
- Transmission: Inconsistent shift fork size
- Shifter: No shifting mechanism was designed for the transmission
- Clutch:
  - Interfered with the travel of the suspension
  - Did not fit within the same area as the shifter
  - Could not be disengaged
  - Designed for constant lubrication

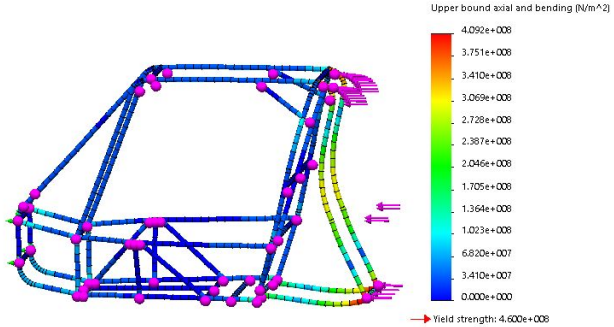
Frame FEA Analysis - Stress



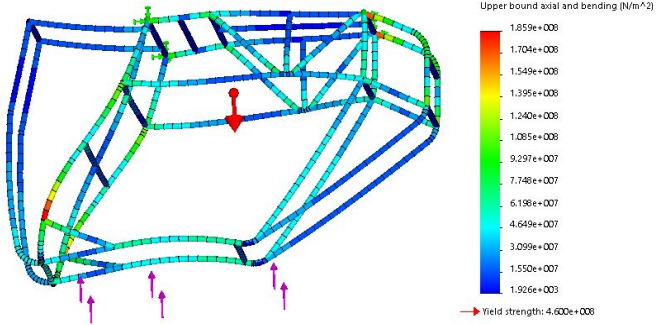
Front Impact



Side Impact



Rear Impact



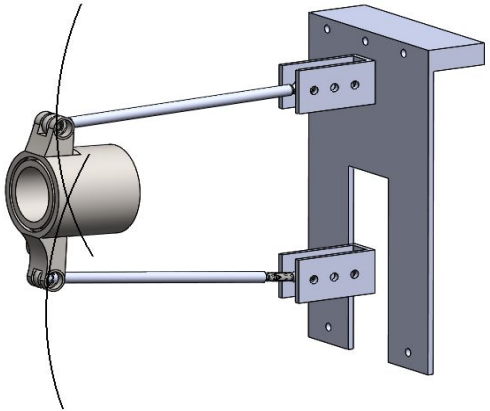
Roll Over

Frame FEA Analysis - Factor of Safety

	Yield Stress $*10^8$ Pa	Maximum Stress $*10^8$ Pa	Factor of Safety	Factor of Safety Requirement
Front impact	4.60	1.55	2.96	1
Side impact	4.60	3.97	1.16	1
Rear impact	4.60	4.09	1.12	1
Roll over	4.60	1.86	2.47	1

Rear Suspension

- Initial design includes dual stacked linked members
- Proof of resistance to horizontal loading
- Proof of range of motion for wheel hub



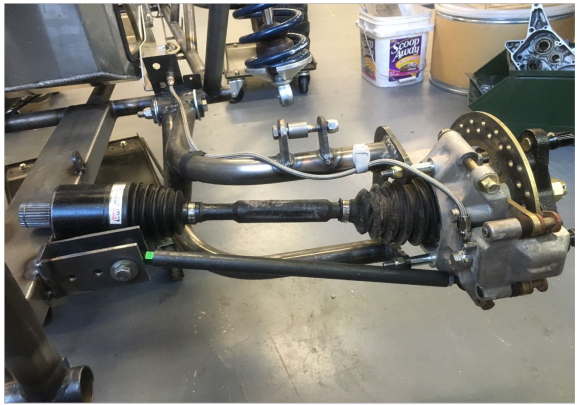
CAD Proof of Concept

Physical Proof of Concept

Rear Suspension

The decision was made to only add one additional link onto the baja and after testing we determined this would fulfill our requirements.

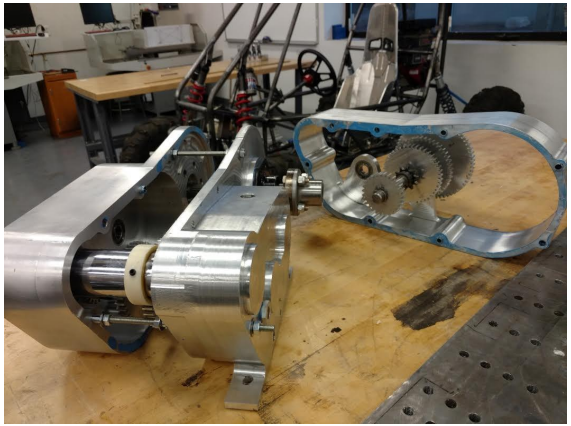
Side View of Linkage



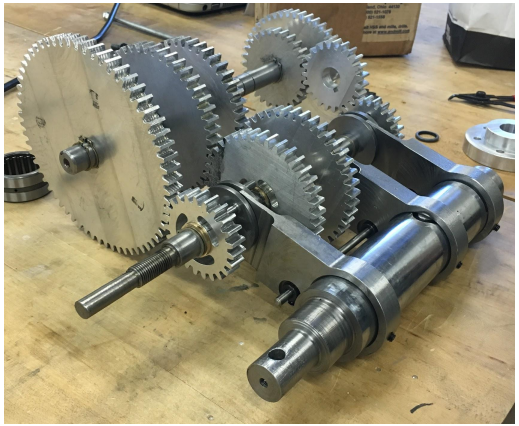
Rear View of Linkage

Transmission

- Sequential transmission 3 forward gears, neutral, and reverse gear
- Transmission does not include synchros



Transmission Case



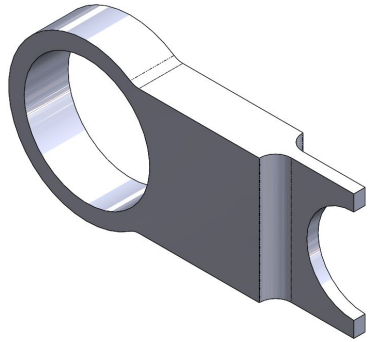
Transmission Internals

Transmission Assembly

Transmission: Shift Forks

- Concept of Transmission was selected last year, however design changes were required
- The main design modification was to the shifting forks

Old Shift Forks

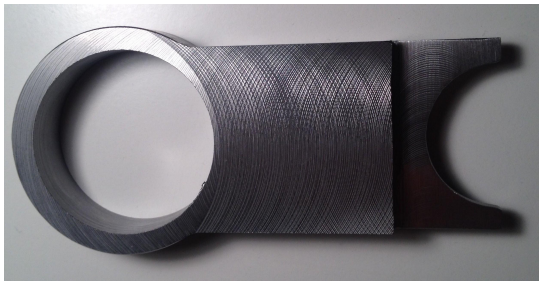


Design Modification

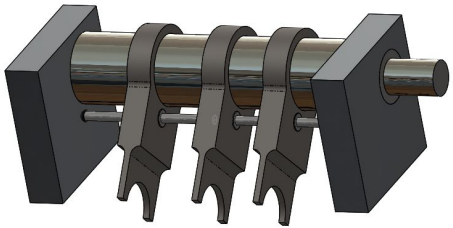
Transmission: Shift Forks

- Initial prototype binded on shift shaft due to twisting motion
- A guide rod was added to the series of shift forks

3D Printed Fork



First Steel Fork



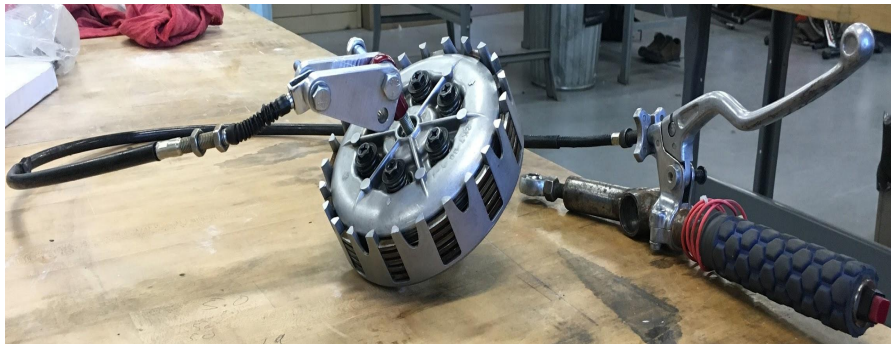
Design Modification

Clutch

- Criteria: Durability, maintenance/repair, starting torque, user friendly, and cost
- Concepts: Dry-basket clutch and centrifugal clutch
- Concept Initially Selected: Centrifugal clutch
- Final Concept Selected: Dry-basket clutch through wet clutch modification

Initial Design: Clutch

- Initial Proposed Clutch: Centrifugal Clutch
- Final Proposed Clutch: Wet Clutch from Yamaha YZ250



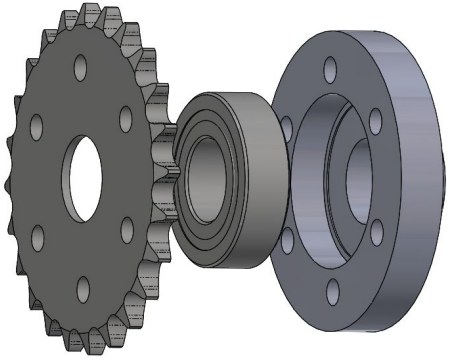
Yamaha YZ250 Wet Clutch

Centrifugal Clutch

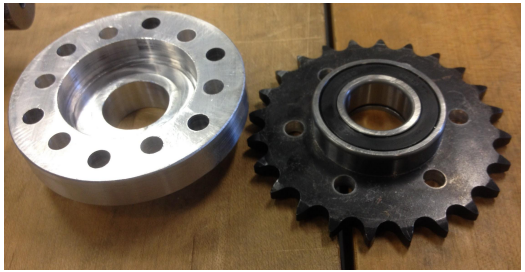
Clutch Design Modification: Clutch

- After further consideration, the team chose to use a dry basket clutch
- Modification of the current clutch was required since it required lubrication
- Design modification includes custom fabricated parts and a bearing

Yamaha YZ250 Wet Clutch



Dry Clutch Conversion Design



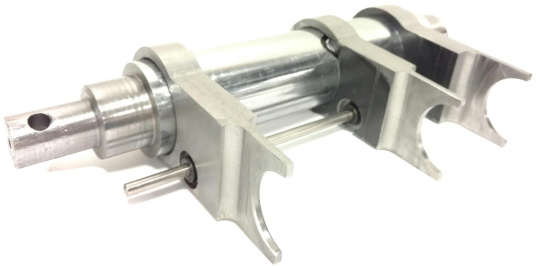
Dry Clutch Assembly

Shifter

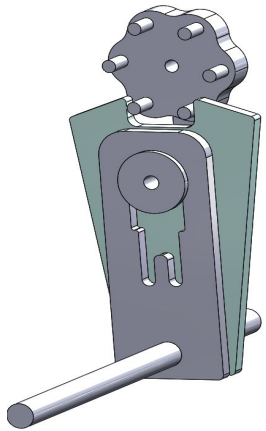
- Criteria: Degrees of throw, shifting speed, simplicity
- Concepts: Ratcheting sequential shifter and gate shifter
- Concept Initially Selected: Gate shifter
- Final Concept Selected: Sequential shifter

Shifter

- Solidworks model and motion analysis
- 3D print of shifter
- Proof of geometric fitment



Shift Shaft



Solidworks Model

3D Print

Shifter

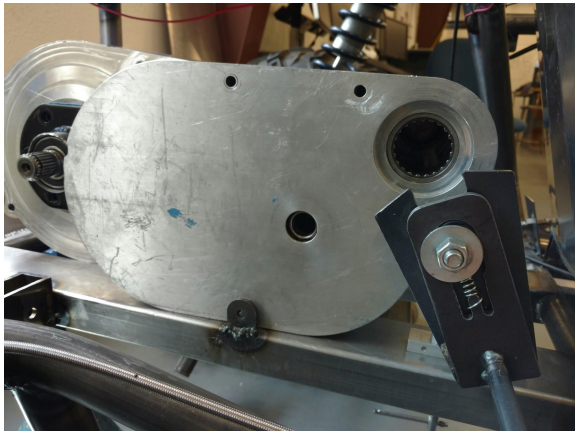
- Machined slides for shifter
- Machined shifting flower

Shifting Slide

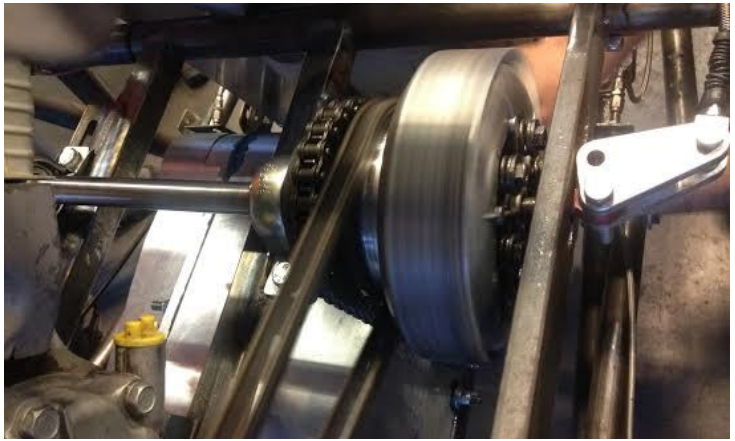
Shifting Flower

Shifter

- Clearance issues with suspension and clutch chain
- Shifting mechanism moved to transmission mount
- Clutch relocated to an idler shaft



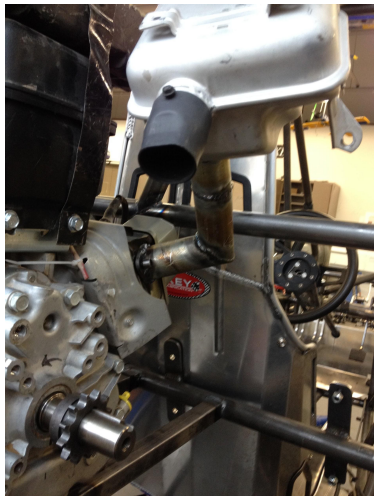
Shifter Location



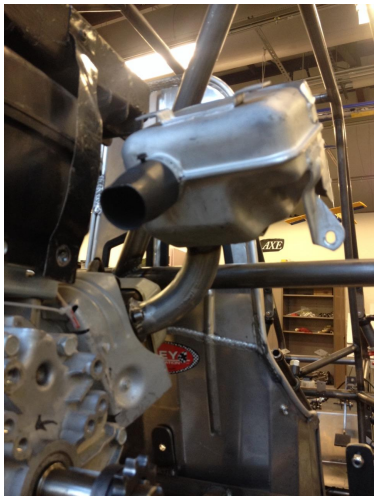
Clutch Location

Design Modification: Muffler

- Old Muffler did not meet the SAE requirements.
- The main design modification was to meet the SAE requirements.



Old Muffler

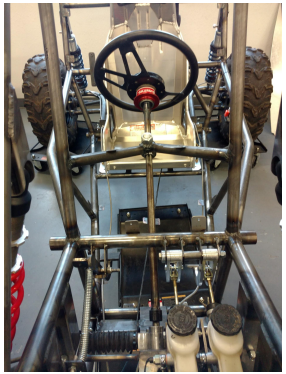


Design Modification

Miscellaneous Design Modifications

- Steering shaft broke at the weld
- New shaft was fabricated
- Throttle cable mount welds broke
- Mount was moved and welded back on

Broken Steering Shaft



New Steering Shaft

Throttle Cable Mount

Performance Testing

Suspension Travel Demonstration

Clutch Demonstration

Mini Baja Test

Results

- Clutch successfully engages and disengages power from engine
- Suspension cycles without interference or deflection
- Chain sprocket broke during test

First Broken Chain Sprocket

Second Broken Chain Sprocket

Bent Engagement Pins

Conclusions

- The NAU SAE Club needed an operational Mini Baja vehicle to compete with
- Verified the structural integrity of the frame
- Concept generation and development of the suspension
- Design modifications were made for shift forks
- Concept generation, relocation, and development of clutch
- Concept generation and development of shifting mechanism
- Other design modifications: fixed steering shaft and throttle cable mount

Acknowledgements

- NAU SAE Chapter
  - Dr. John Tester, Advisor
  - Club Members
- NAU Machine Shop
  - Derrick Lemons
  - Zach Rischar
  - Tom Cothrun
  - Derek Pacheco
- NAU HVAC

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Questions?