Clean Snowmobile Challenge
Fall 2012

Group Members

Burton Fischer

Matt Lewis

Justin Juckem

Neal Eidenschink

Advisors

Dr. Alan Kallmeyer

Dr. Robert Pieri

Andy Blackmore

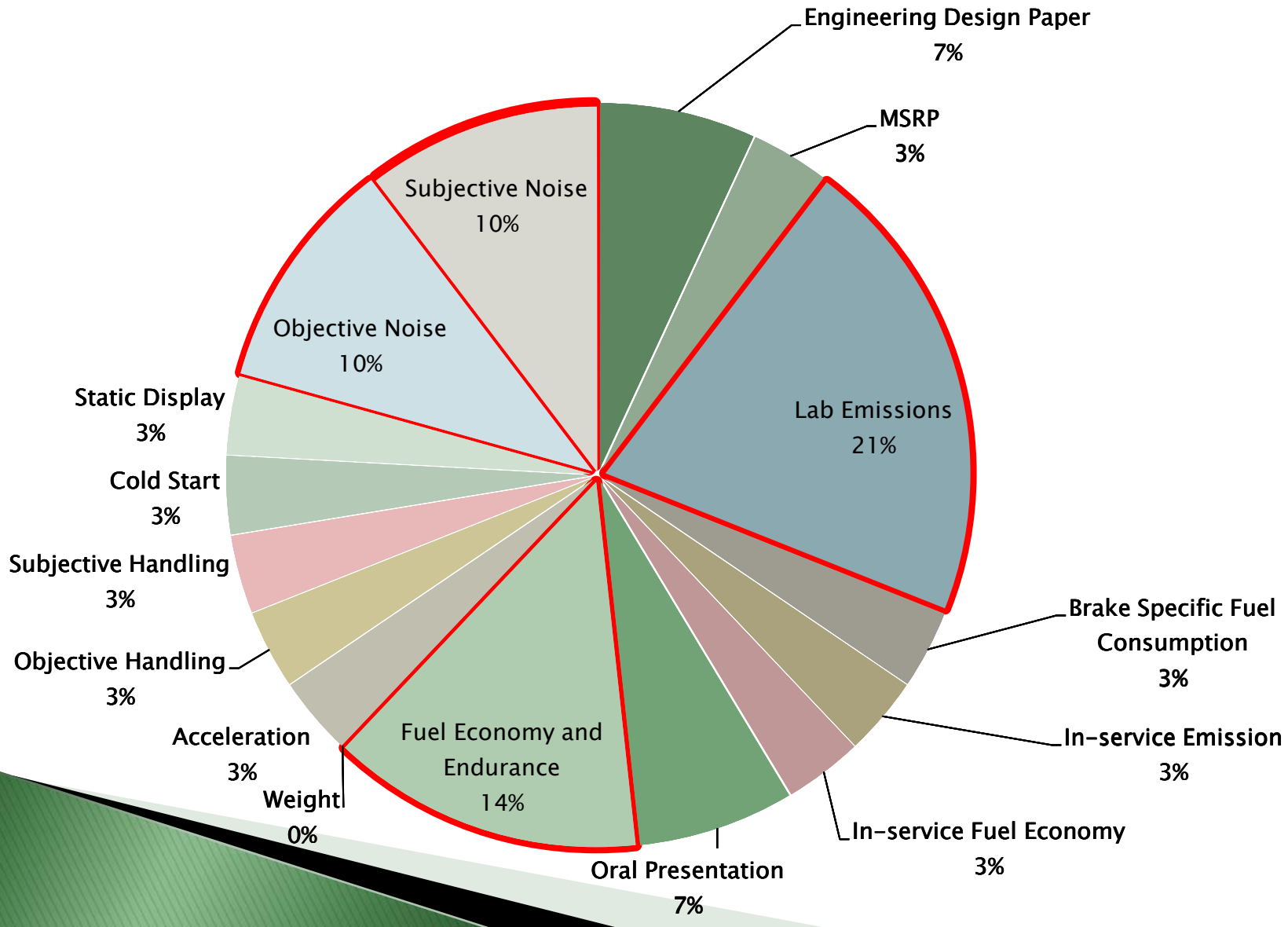
SAE International

NDSU

Outline

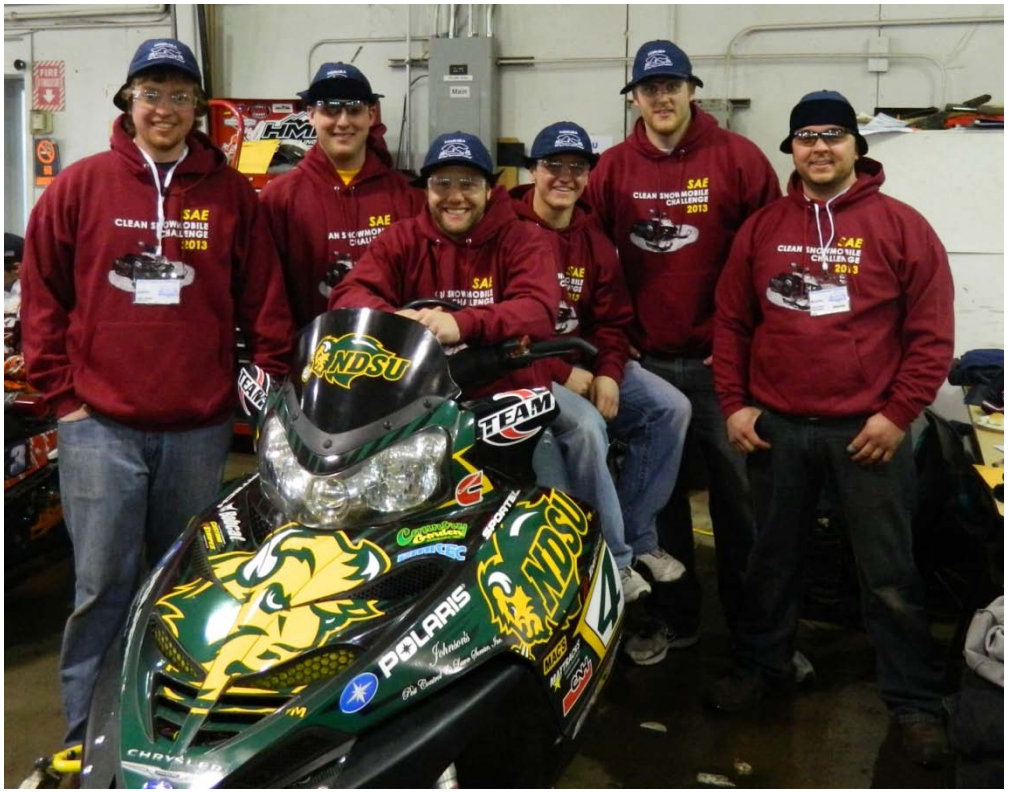
- Objective
- Constraints
- Design
  - Engine Selection
  - Engine Modification
  - Fuel System
  - Forced induction
  - Intercooler
  - Water Methanol
  - Emissions
  - Oil Pan
  - Remote Oil Filter
  - Steering
  - Other Modifications

2013 Competition Point Break Down



Objective

- Reduce Emissions
- Reduce Noise
- Increase Power Output
- Increase Economy
- Improve Handling
- Reduce weight
- Maintain Reliability
- Maintain Safety



SAE International

NDSU

Constraints

- At lease 100 miles to a tank of fuel
- Enough power to accelerate 500ft in 12 sec, but not over 130HP
- Perform at subzero temperature
- Need to keep the chassis in near stock conditions
- Low weight
- Produce less emission that factory engine
- Safety features as priority

Engine Selection

- Kubota D902
  3 cylinder diesel
- Common Rail vs. Mechanical
- Testing
- Final Selection

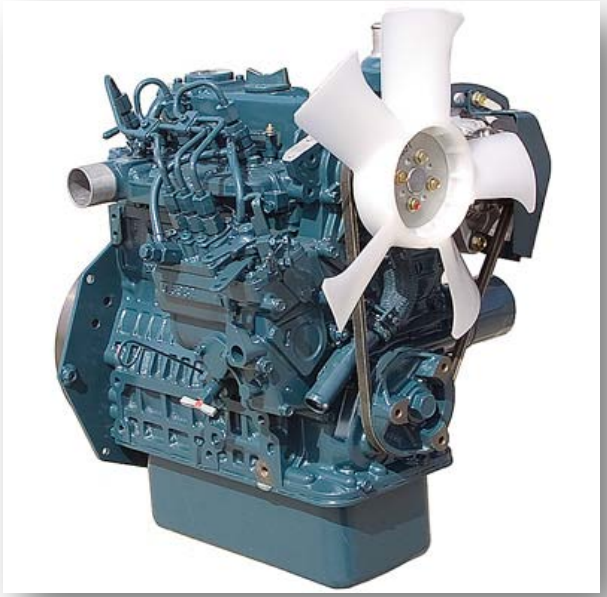


Photo Courtesy of Kubota Engine America

Photo Courtesy of www.commonrail.info

SAE International

NDSU

Fuel System

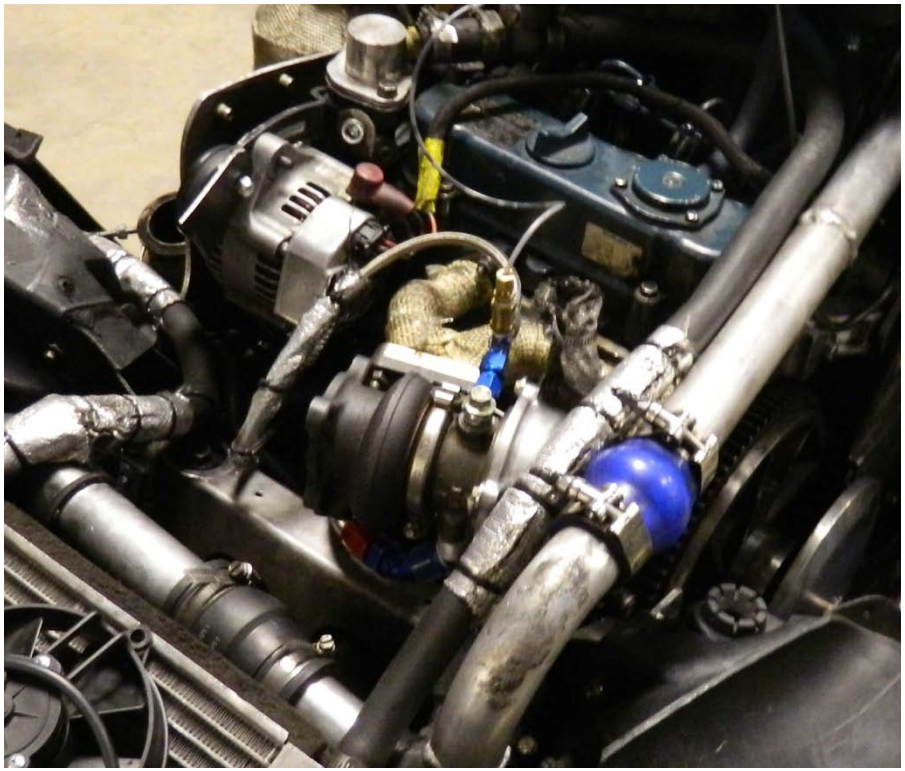
- Mechanical Fuel Injection
- Modify Injection Pump
- Help both team and competition constraints
  - Better Economy
  - Higher Power
- Inline Fuel Pump
  - Simple Operation
  - Effective

SAE International

NDSU

Forced Induction

- Single Turbo Configuration
- Less Turbo Lag
- Increased Economy
- Increased Power
- Helps with team and competition constraints



SAE International

NDSU

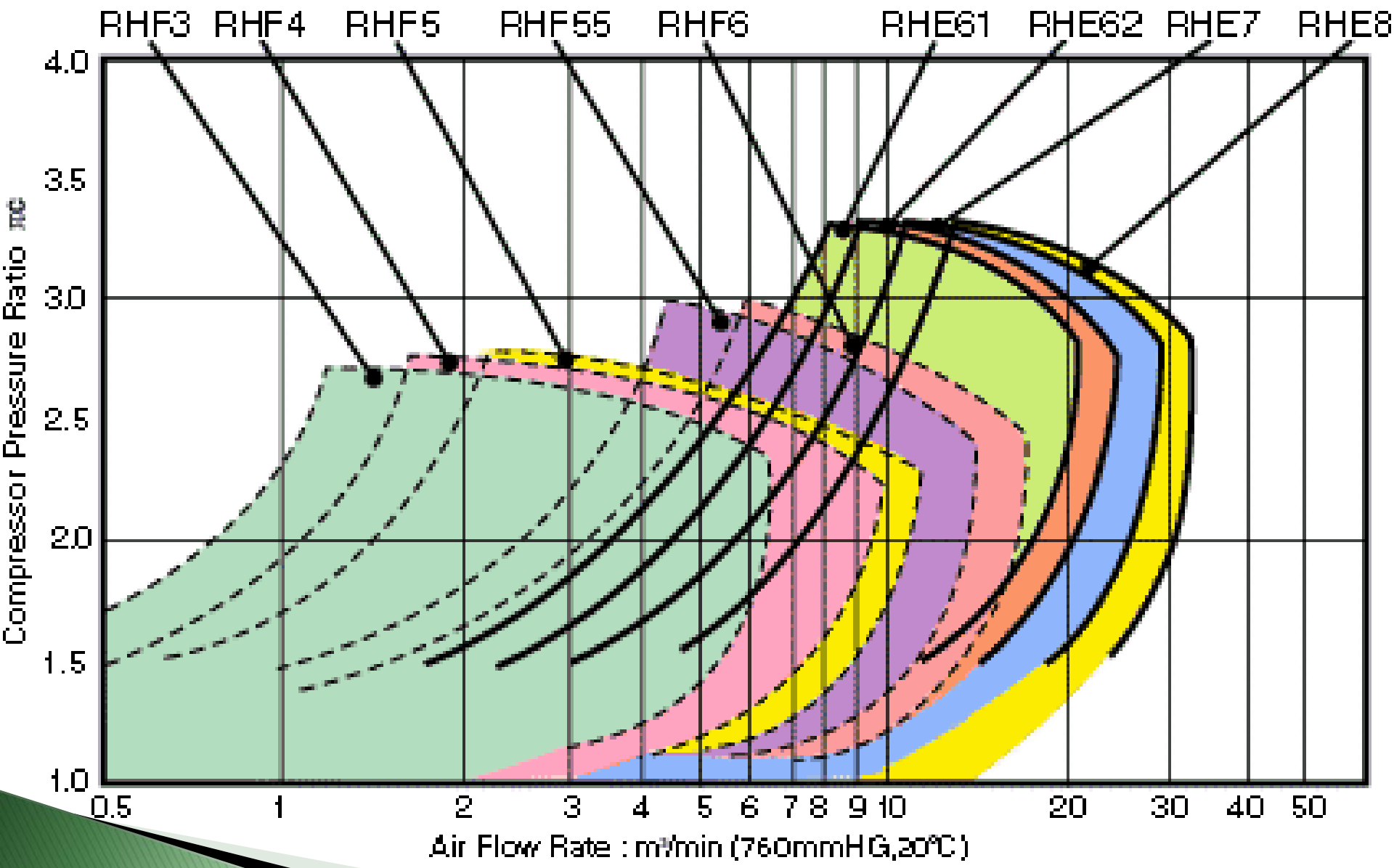
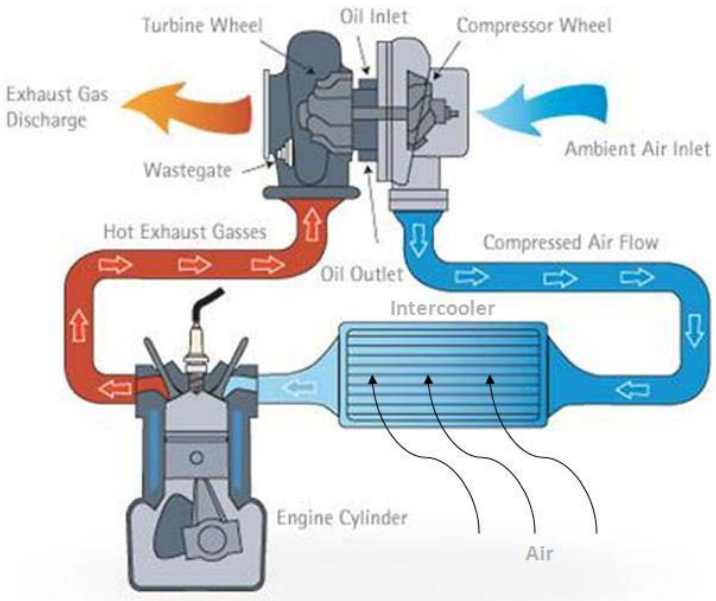


Photo courtesy of IHI Turbo America

Intercooler

- Purpose
  - Cool compressed, heated intake air charge



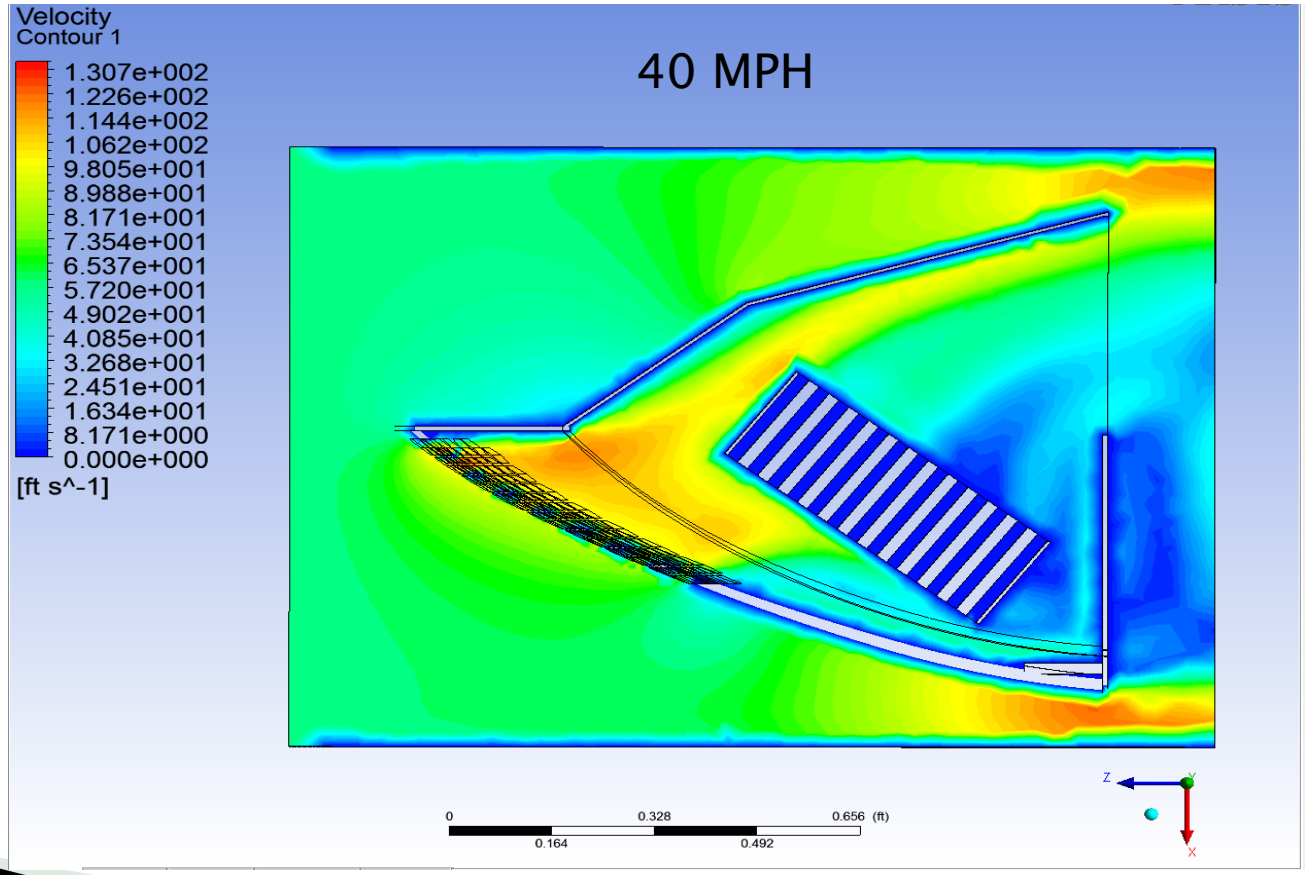
- Reason for Change
  - Smaller Core
  - Insufficient welds
- New design

SAE International

NDSU

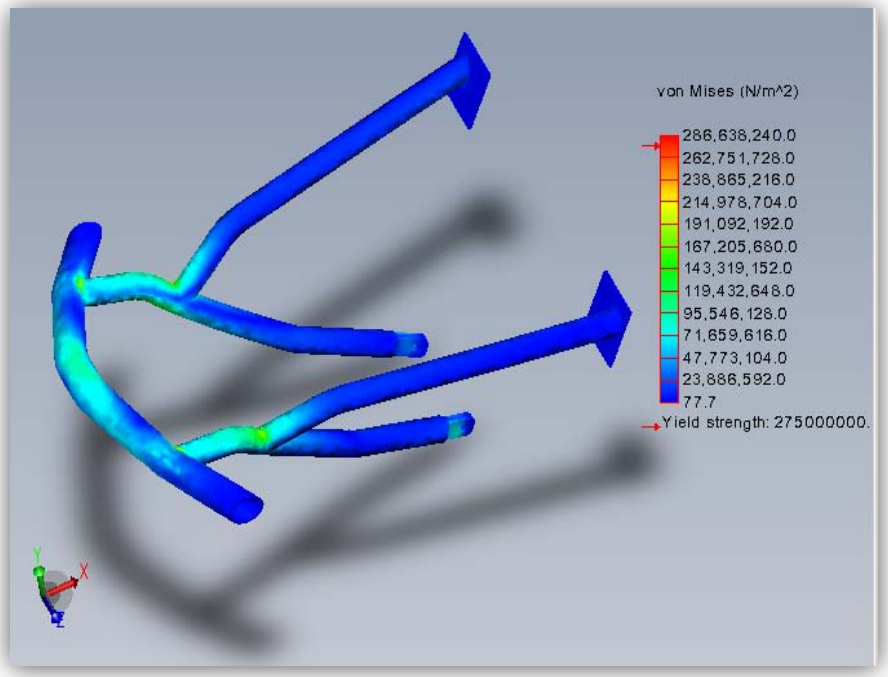
Radiator Placement

- Maximize Air Flow



Front Bumper

- Front bumper was modified
- Vertical force applied
  - 750 lbs
  - FS 1.25



Water Methanol Injection

- Purpose
  - Power
    - increased Hp by 10%
  - Emission
    - Reduces intake temps
    - NOx production
    - Reduces soot production

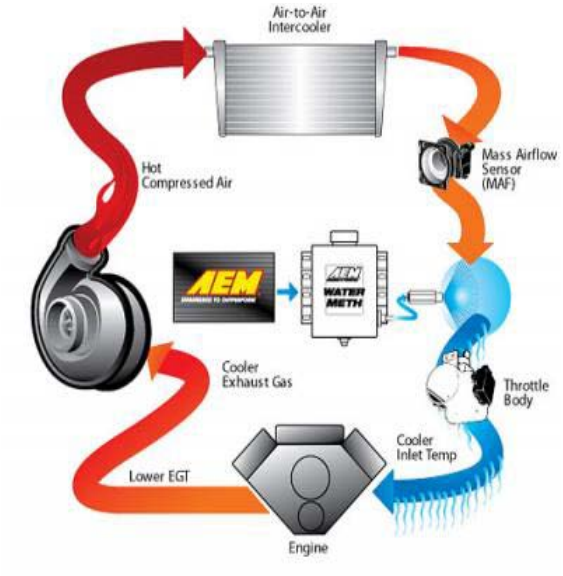
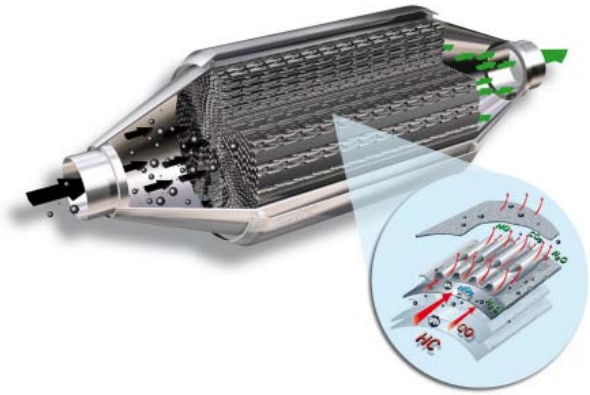


Photo courtesy of AEM Electronics

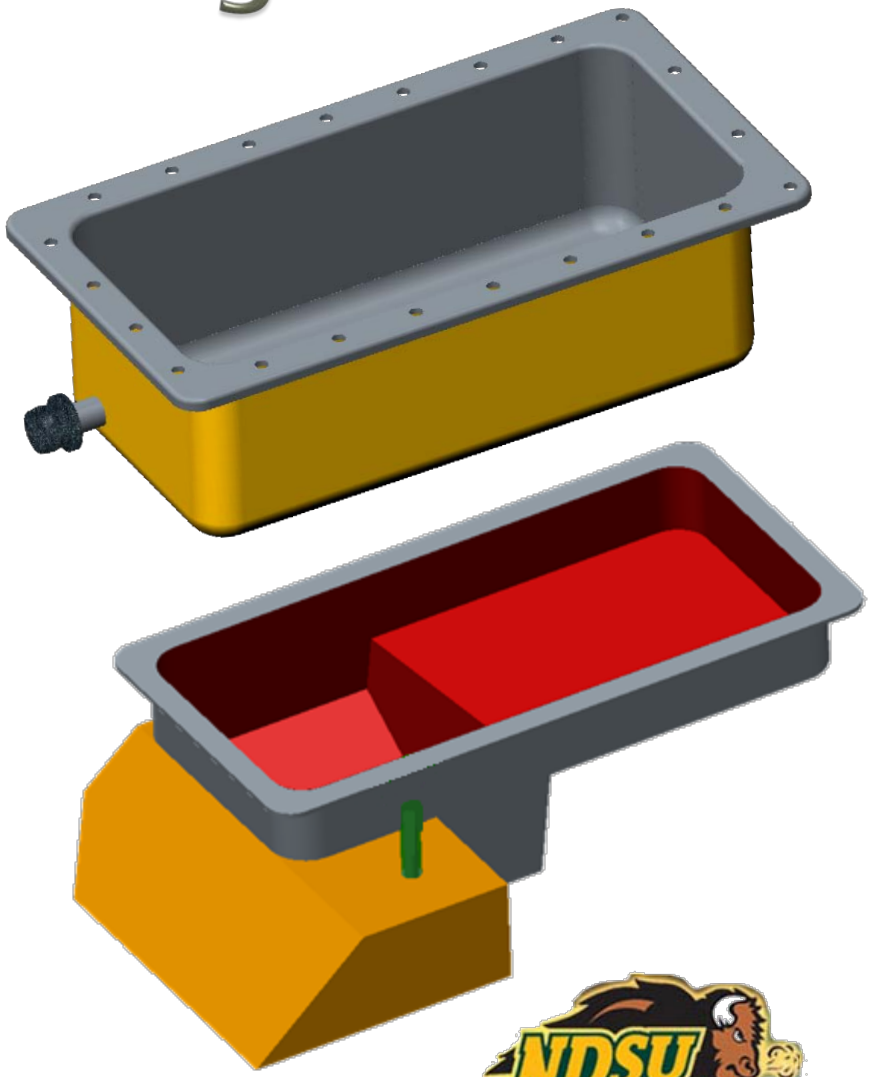
Emissions Equipment

- 3 types of Emission Control
  - Filtration
  - Reaction
  - Prevention
- Filtration method Selected
  - All emission methods require a DOC and DPF
  - Effectiveness
    - High hydrocarbon, carbon oxides, nitrous oxides and particle matter filtration
    - Low backpressure



Oil Pan Design

- Clearance issues
- Wet sump vs. Dry sump
- Increased volume
- Maintenance



SAE International

NDSU

Oil System Additions

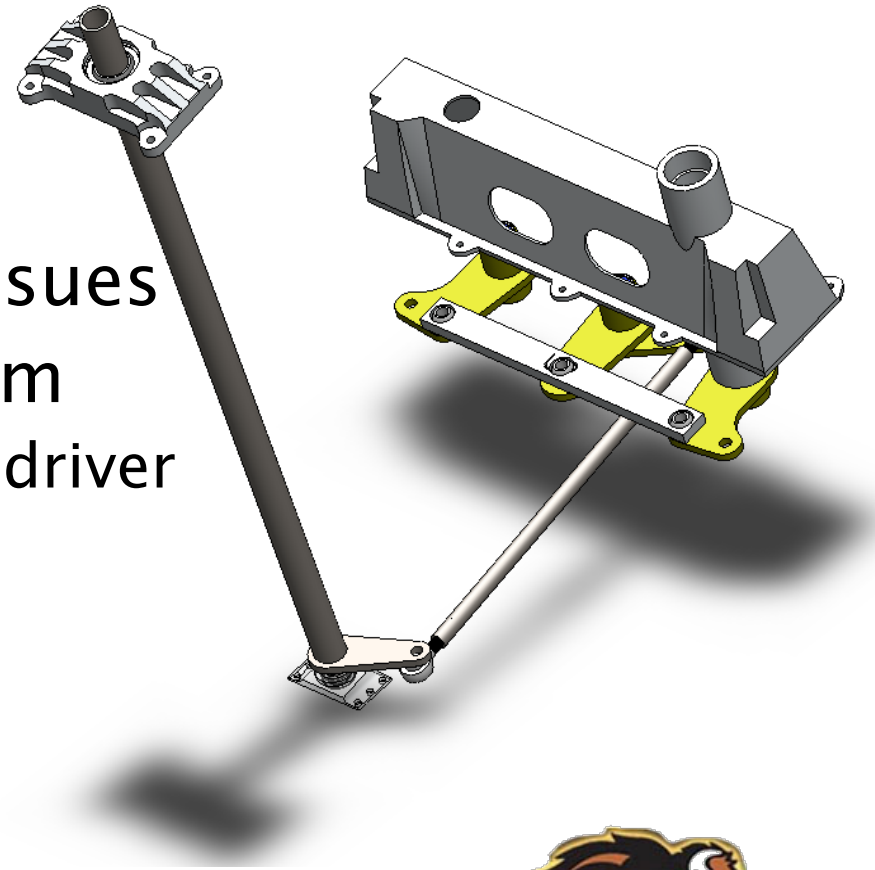
Remote Oil Filter

- Improved maintenance
- Greater accessibility

Courtesy of westerbeke.com

Steering

- Steering used last year
  - Mechanical steering shaft
  - Under engine without modifying original chassis
- Experienced clearance issues
- Explored hydraulic system
  - Hydraulic actuator as fluid driver
  - Hydraulic cylinder options
- Revert to original design



Other Modifications

- Lizard Skin rubber coat on chassis
- Foam engine compartment
- Exhaust exit in tunnel
- Lightweight track
- Lightweight and better handling suspension
- Pro-steer Skis

Questions?

SAE International

NDSU

References

- Mike Ruth of Cummins INC.
- http://www.aemelectronics.com/
- http://www.kubotaengine.com/index.html
- http://www.emitec.com/
- victorylibrary.com
- westerbeke.com

Points Breakdown

2013 Points Break-Down	Points
Engineering Design Paper	100
MSRP	50
Lab Emissions	300
Brake Specific Fuel Consumption	50
In-service Emission	50
In-service Fuel Economy	50
Oral Presentation	100
Fuel Economy and Endurance	200
Weight	0
Acceleration	50
Objective Handling	50
Subjective Handling	50
Cold Start	50
Static Display	50
Objective Noise	150
Subjective Noise	150

Turbo Calculations

A/F	Intake O2	Vol Eff	RPM	Disp	IMT	Mdot fuel	Mdot air	O2 stack	Mdot EGR	Mdot Stack	Mdot charge	EGR	Pint
[none]	[%]	[none]	[rpm]	[L]	[deg F]	[lb/hr]	[lb/min]	[%]	[lb/min]	[lb/min]	[lb/min]	[%]	[bar abs]
24	20.79	0.9	3000	0.98	50	22	8.80	8.23	0.00	9.17	8.80	0.00	2.45
24	20.79	0.88	3000	0.98	50	22	8.80	8.23	0.00	9.17	8.80	0.00	2.51
24	20.79	0.87	3000	0.98	50	22	8.80	8.23	0.00	9.17	8.80	0.00	2.54
24	20.79	0.86	3000	0.98	50	22	8.80	8.23	0.00	9.17	8.80	0.00	2.57
24	20.79	0.85	3000	0.98	50	22	8.80	8.23	0.00	9.17	8.80	0.00	2.60
24	20.79	0.84	3000	0.98	50	22	8.80	8.23	0.00	9.17	8.80	0.00	2.63
24	20.79	0.83	3000	0.98	50	22	8.80	8.23	0.00	9.17	8.80	0.00	2.66
24	20.79	0.82	3000	0.98	50	22	8.80	8.23	0.00	9.17	8.80	0.00	2.69
24	20.79	0.81	3000	0.98	50	22	8.80	8.23	0.00	9.17	8.80	0.00	2.73
24	20.79	0.8	3000	0.98	50	22	8.80	8.23	0.00	9.17	8.80	0.00	2.76
24	20.79	0.79	3000	0.98	50	22	8.80	8.23	0.00	9.17	8.80	0.00	2.80