



**UNIVERSITY OF WATERLOO CLEAN SNOWMOBILE TEAM**

# **2012 SAE CLEAN SNOWMOBILE CHALLENGE**

# Presentation Format

☒ - Operator perspective

☒ - Dealer perspective

☒ - Environmental perspective

# Team Strategy

- Low displacement turbo charged four-stroke
- Light-weight chassis
- Inexpensive weight reductions
  - Lithium-iron phosphate starting battery
  - Aluminum muffler



# Engine Selection

- Arctic Cat T660 Turbo
  - 3-cylinder
  - 660 cc
  - four-stroke
  - turbo charged



- ✓ High power potential
- ✓ Longevity
- ✓ No oil expenditure
- ✓ Electric start
- ✓ Less engine vibration
- ✓ Cost of turbo
- ✓ Power is appealing
- ✓ Behavioural boost maps
- ✓ Four-stroke oil consumption
- ✓ 3-cylinder reduces noise
- ✓ Easier to silence

# Chassis Selection

- 2009 Ski-Doo Renegade
- Long track (137 in.)
- XP platform

- ✓ Ergonomics
- ✓ Aggressive styling
- ✓ Trail stability
- ✓ Cross-over capability

- ✓ Saleable
- ✓ Panel configuration
- ✓ Niche market

- ✓ Low weight
- ✓ Larger trail footprint





# Engine Swap



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# Modifications

# Lithium Iron Phosphate Battery

- Antigravity
- 8 cell
- Weight: < 2 lbs.
- 300 pulse cranking amps
- 220 cold cranking amps
- Small volume

- ✓ Reduces weight ( -12 lbs.)
- ✓ Better shelf life (low self discharge)
- ✓ Saleable
- ✓ No maintenance
- ✓ No energy wasted to charge
- ✓ No lead
- ✓ No acid

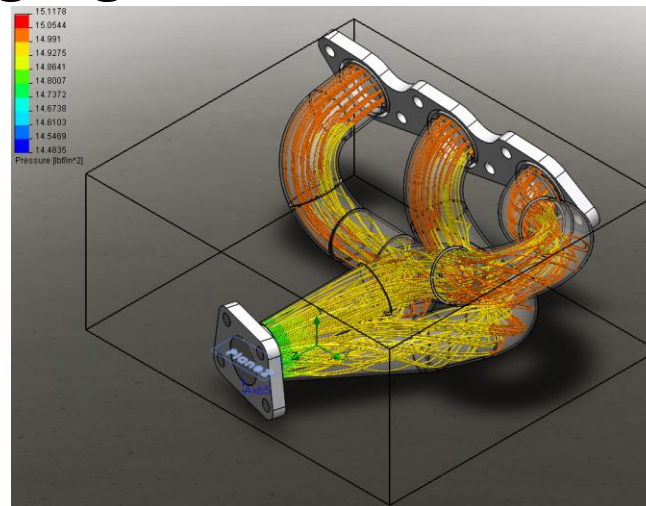




# Equal Length Header

- 3 into 1
- Scavenging effective at 4500 rpm
- Better turbo response
- Principally increases cylinder scavenging
- Principally allows for steadier flow to turbine inlet

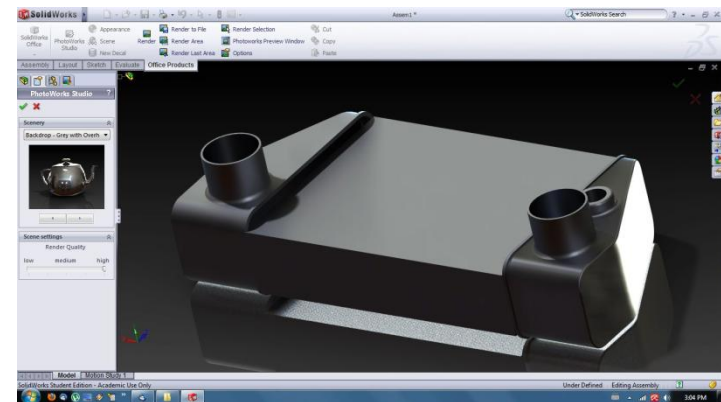
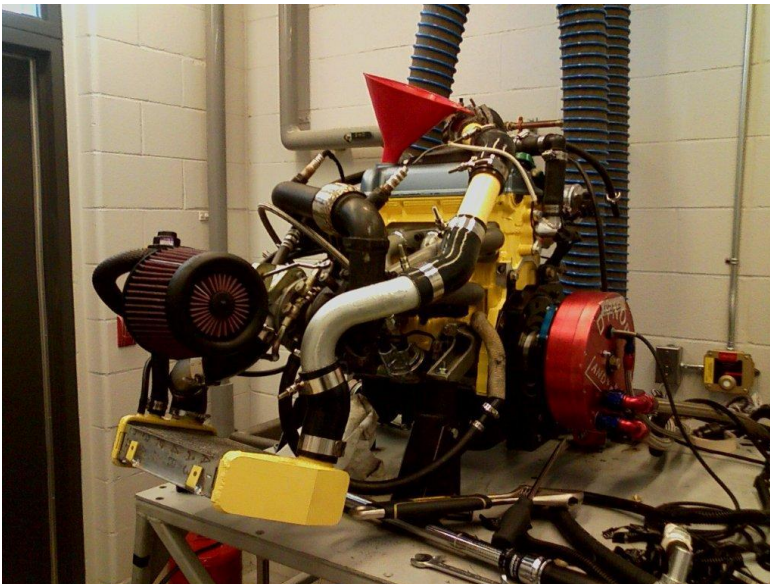
- ✓ Reduced turbo lag
- ✓ More predictable ride
- ✓ Appealing turbo performance



# Intercooler Positioning

- Placed low in the nose
  - To improve air flow
  - Allows for snow cooling

- ✓ Reduced intake heat soak
- ✓ Greater air density
- ✓ Reduce possibility of over heating
- ✓ Reliability
- ✓ Easily accessible
- ✓ Principally, better volumetric and combustion efficiency



# Fuel Injection System



- Higher flow rate injector
  - 375 cc per min.
- Low impedance
  - Idle stability
- Fuel composition sensor
  - GM/Siemens
  - Allows stoichiometric and timing changes for ethanol content
- ☑ Fool proof flex fuel system
- ☑ Existing part
- ☑ Easy to service
- ☑ Limp-home mode possible
- ☑ Allows for use of sustainable fuel

# Catalytic Converter

- 3 way caesium catalytic converter



- ✓ Clear conscience
- ✓ Easy to service
- ✓ Environmental appeal
- ✓ Targets NO<sub>x</sub>, CO, HC emissions



# Muffler

- Single element re-entrant diffuser
- Aluminum construction
- Weight ~ 5 lbs.
- Resonator
  - Weight ~ 5lbs.
- Targets 6500 rpm (hold rpm)
- Under running board
  - Protrudes 3 in below

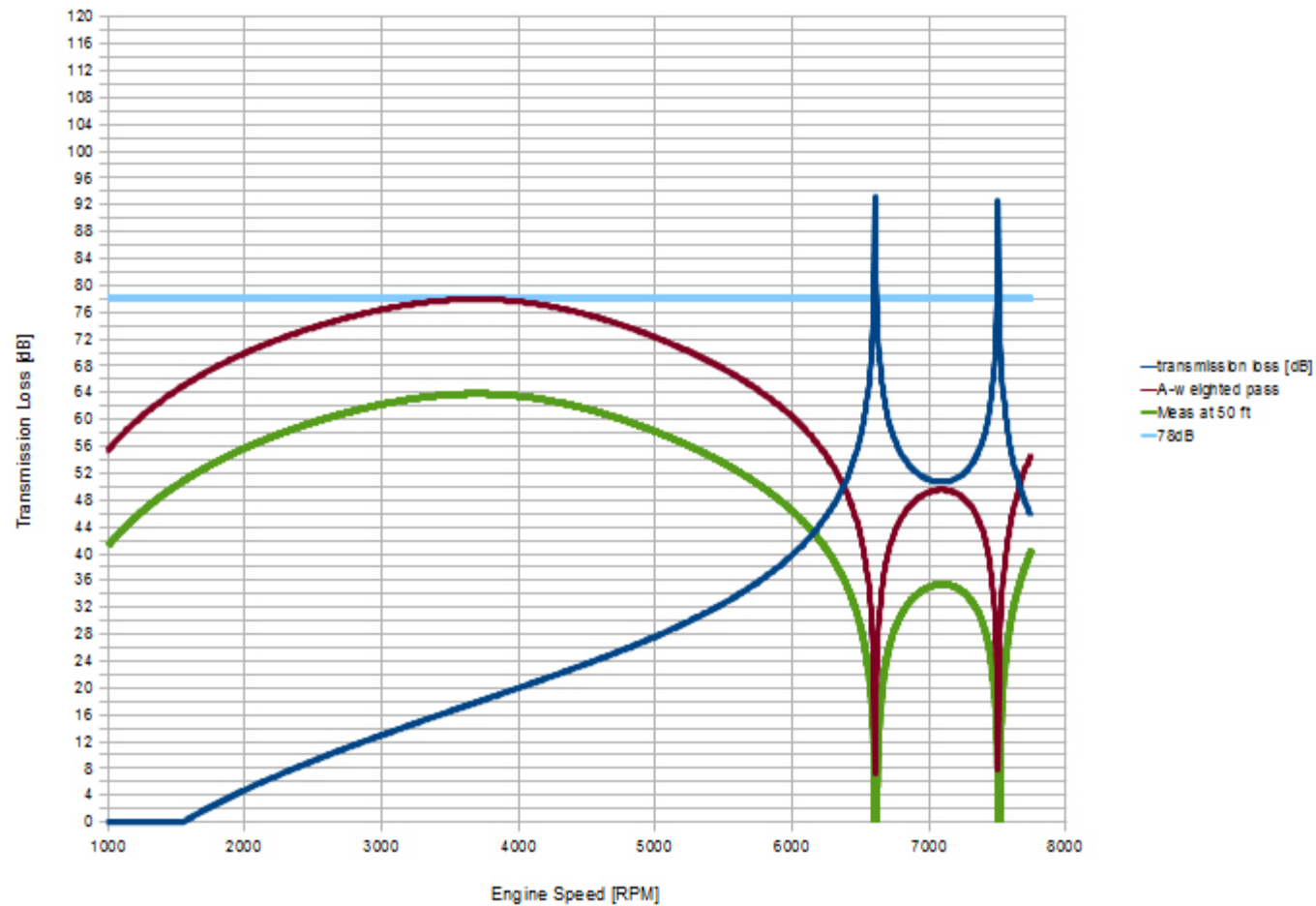


- ✓ Manoeuvrable in trail and cross over environments
- ✓ Quiet for continued running
- ✓ Clearance compared to 2011
- ✓ Easily accessible
- ✓ Promising attenuation curve (unable to test)
- ✓ Recyclable material



# Muffler

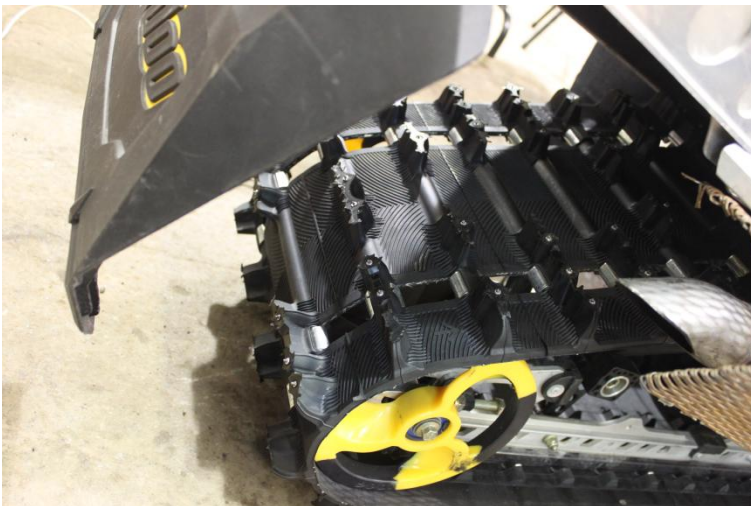
Single Diffuser



# Track

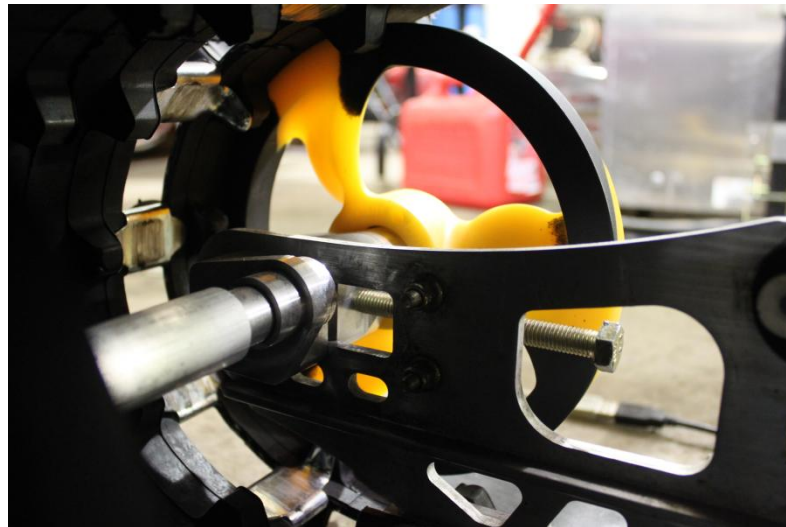
- Camoplast Ice Attak XT
- Pre-studded
- 1.22 in. lug profile
- 42 lbs

- ✓ Positive traction in a range of conditions
- ✓ Better control
- ✓ Safer for novice riders
- ✓ Availability
- ✓ Sales feature
- ✓ Power directly to traction



# 8 in. Rear Wheels

- Larger rear wheels
  - Offset axle
  - Less dynamic track deformation
  - Lower bearing speed
- ✓ More available power
  - ✓ Popular aftermarket conversion
  - ✓ Selling feature
  - ✓ Less fuel wasted to friction



Thank you!  
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