



UNIVERSITY OF WATERLOO CLEAN SNOWMOBILE TEAM

**2013 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
 - Aluminum Oil Pan



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
- 12 cell
- Weight: < 2 lbs.
- 300 pulse cranking amps
- 360 cold cranking amps
- Small volume

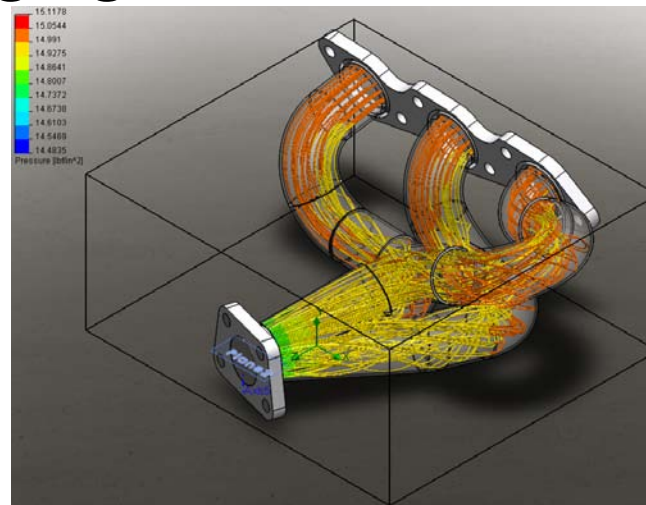
- ✓ Reduces weight (-12 lbs.)
- ✓ Better shelf life (low self discharge)
- ✓ Saleable
- ✓ No maintenance
- ✓ No energy wasted to charge
- ✓ No lead
- ✓ No acid



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

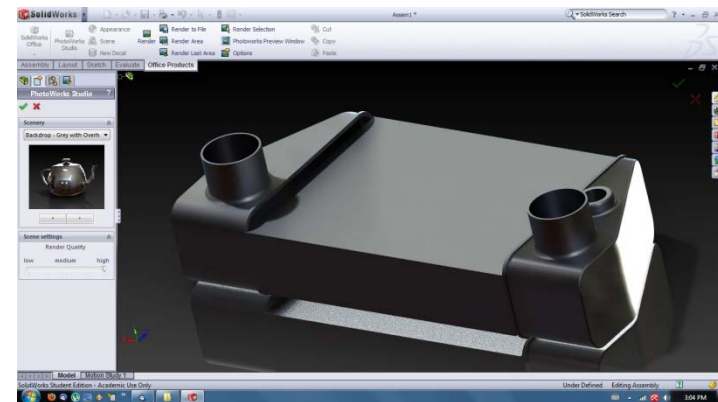
- ☑ Reduced turbo lag
- ☑ More predictable ride
- ☑ Appealing turbo performance



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_x, 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



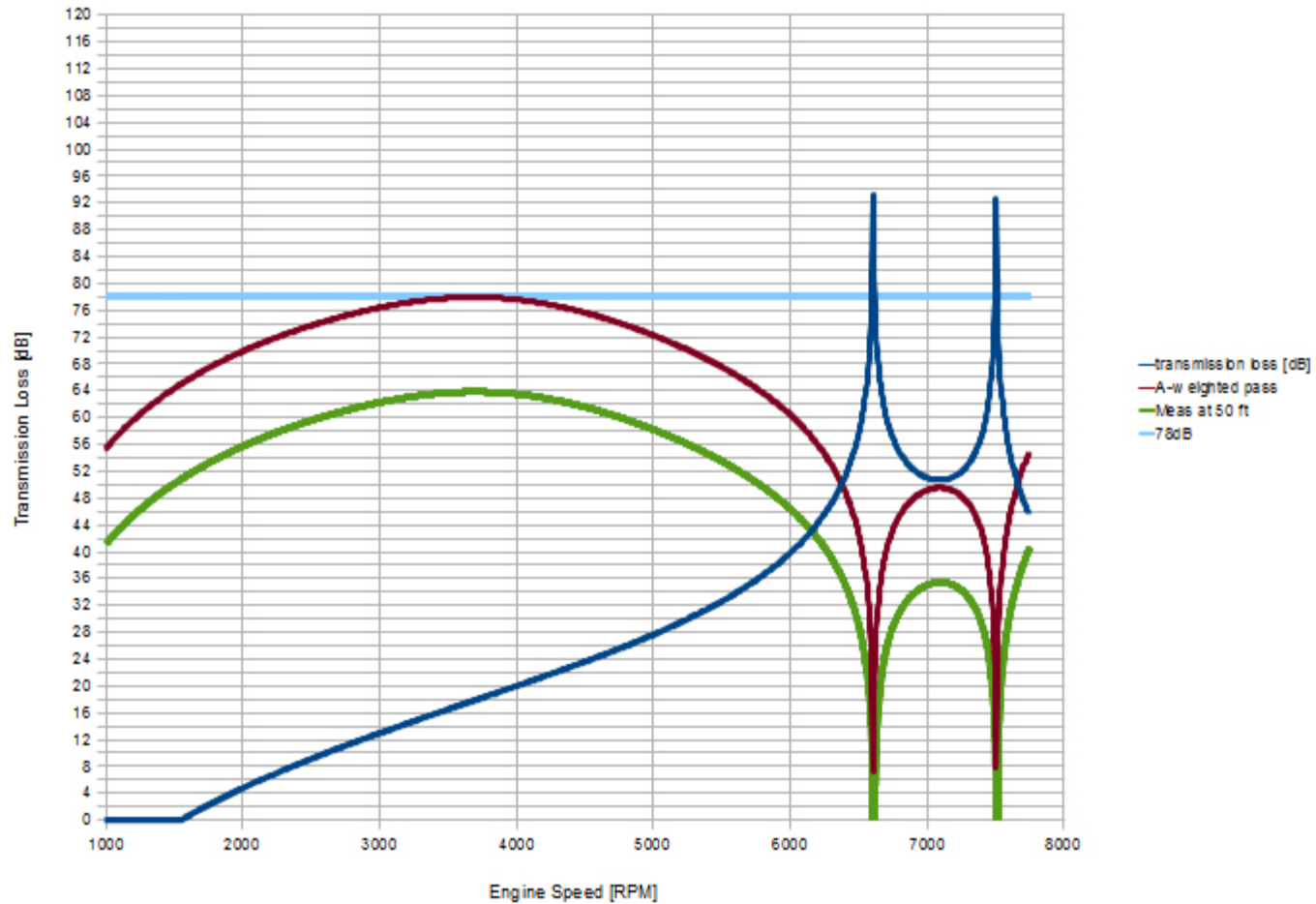
- ✓ Manoeuvrable on trail
- ✓ Quiet for continued running
- ✓ Clearance compared to 2011
- ✓ Easily accessible
- ✓ 76dBA from 50 ft.
- ✓ Recyclable material

Muffler



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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





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Thank you!
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