

University of Idaho Two-Stroke Direct Injection Snowmobile



Presented By
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Overview

- Competition Goals
- Design goals & target audience
- Design strategy
- Chassis and engine modifications
- Testing strategies
- Testing results
- Summary & conclusions
- Questions

Competition Goals

- Create clean, quiet, and economical snowmobiles while maintaining or improving performance
- Meet EPA exhaust and noise emissions standards
- Provide University students with real world engineering experience



UICSC Design Goals

- Create a National Park certified two-stroke snowmobile
 - E-score >170, J-192 score <74 dBA
- Improve our fuel economy from the 2011 UI competition snowmobile (18mpg on E29)
- Maintain stock power
- Maintain two-stroke riding experience
 - High power density, lightweight
- Deliver original equipment manufacturing level packaging
- Minimize cost by using stock Skidoo components and low cost modifications.

Target Audiences

Dealer/Outfitter

- Low maintenance
 - Less scheduled maintenance means less dealer expenses
- High performance
 - Easy to sell
- Environmentally conscious
 - Meets strictest emissions standards

Rider

- Electronic total loss oil system
 - Comparable to 4-stroke consumption with no oil changes
- Fuel economy
 - 22 mpg means more fun between fill-ups
- Lighter than 4-stroke counterparts
- Power
 - Over 100 hp, a top rider priority

Design Strategy

- Clean & Fuel Efficient
 - E-Tec direct fuel injection
 - Flex fuel E10-E39
 - Electronic oiling
 - Inactive catalyst
- Quiet
 - Low speed 800cc engine
 - Reduce noise through sound insulation
 - Block off or re-route vents
- Rider Friendly
 - Light weight chassis
 - Factory fit and finish
 - Very low maintenance



Chassis and Engine

- Chassis

- 2009 Ski-Doo MXZ REV-XP
 - Performance oriented
 - Proven rider comfort
 - Improved handling

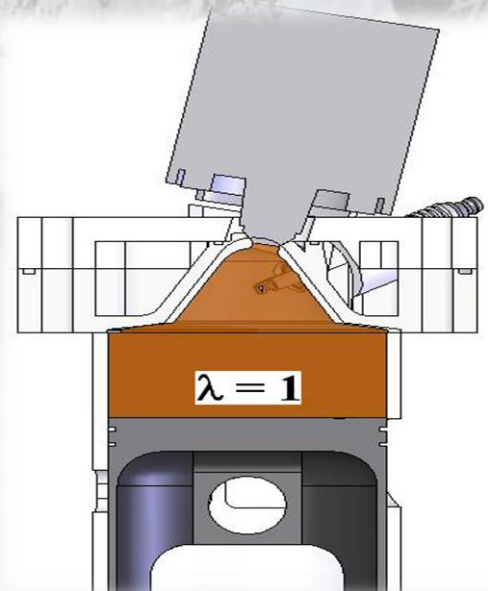


- Engine

- Rotax 799cc H.O. Two-Stroke
 - E-Tec direct injection
 - RAVE 2 variable exhaust with tuned pipe
 - High power-to-weight ratio

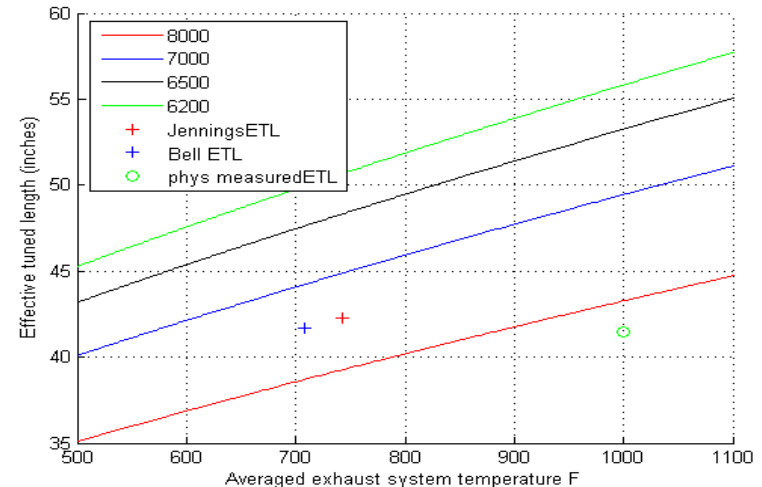
Engine Modifications

- Low Speed
 - Reduced engine RPM to lower noise levels, increase fuel efficiency, and reduce emissions
- Aristo inactive catalytic converter
 - Creates secondary combustion event



Modified Tuned Pipe

- Increased length of pipe to lower the tuned RPM
 - Changes return pulse from pipe to lower RPM
 - Maintain 100 horse power while increasing torque

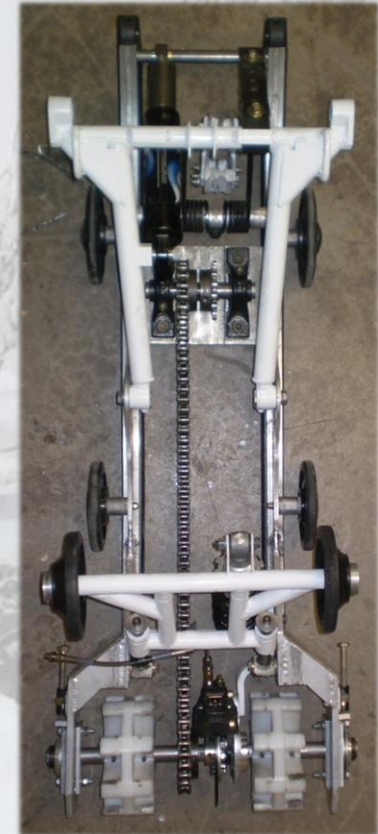
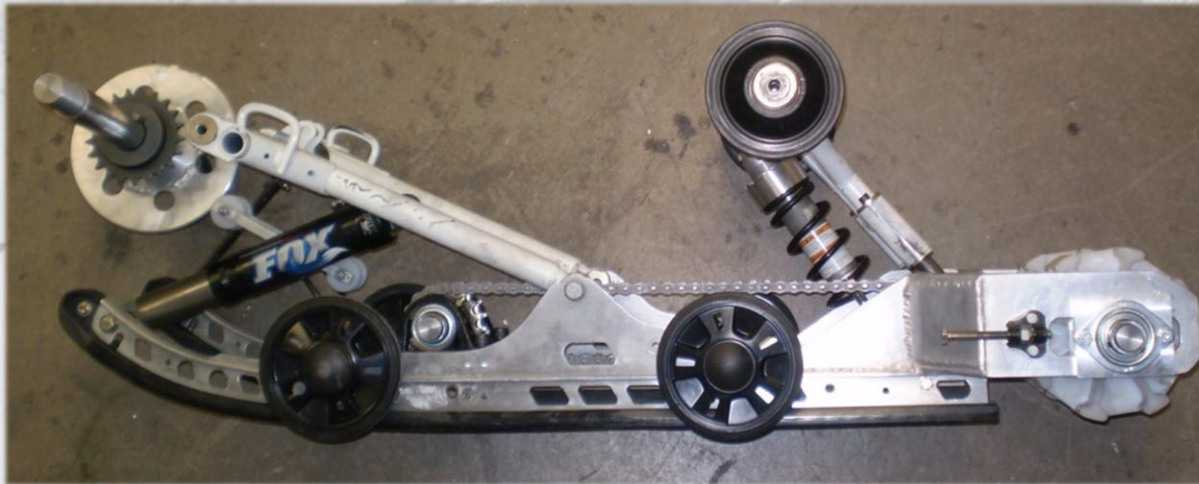


Chassis Modifications

- Larger XR (4-stroke Skidoo) body panels
- Sound deadening material
 - In body panels
 - On tunnel
- Hood scoops to force cooling

Rear Drive System

- Improves handling and fuel efficiency
- Bolt in replacement

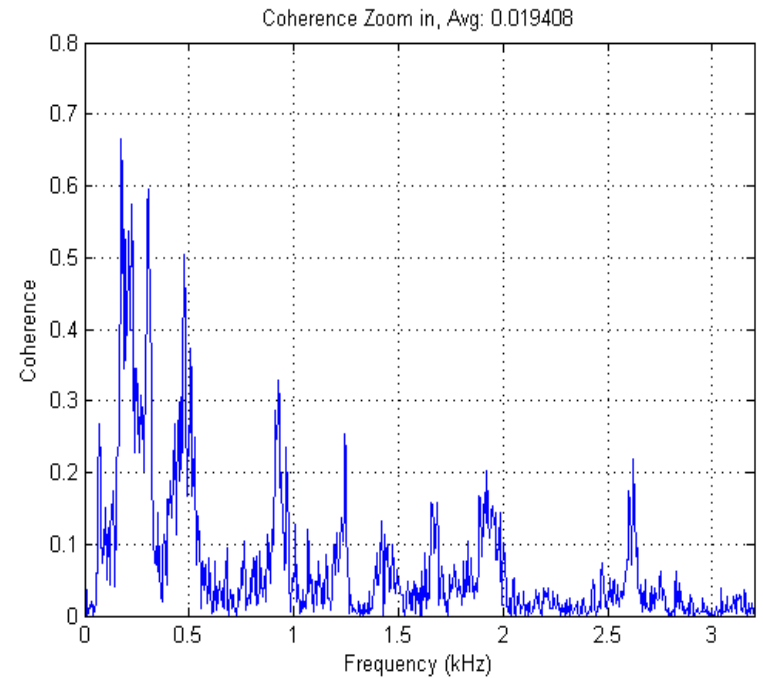
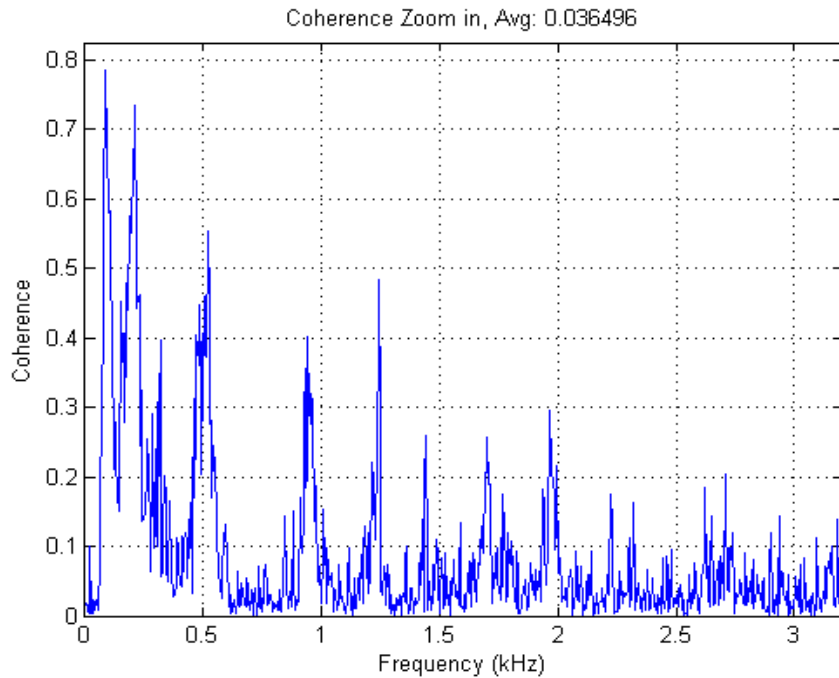


Coherence Testing

- Percentage of a local contribution to the overall sound measurement.
- Used to test sound insulation materials and modifications.



Coherence Testing Graphs



Un-damped Plastic Sample Sheet

Multi-layered foam on plastic sheet



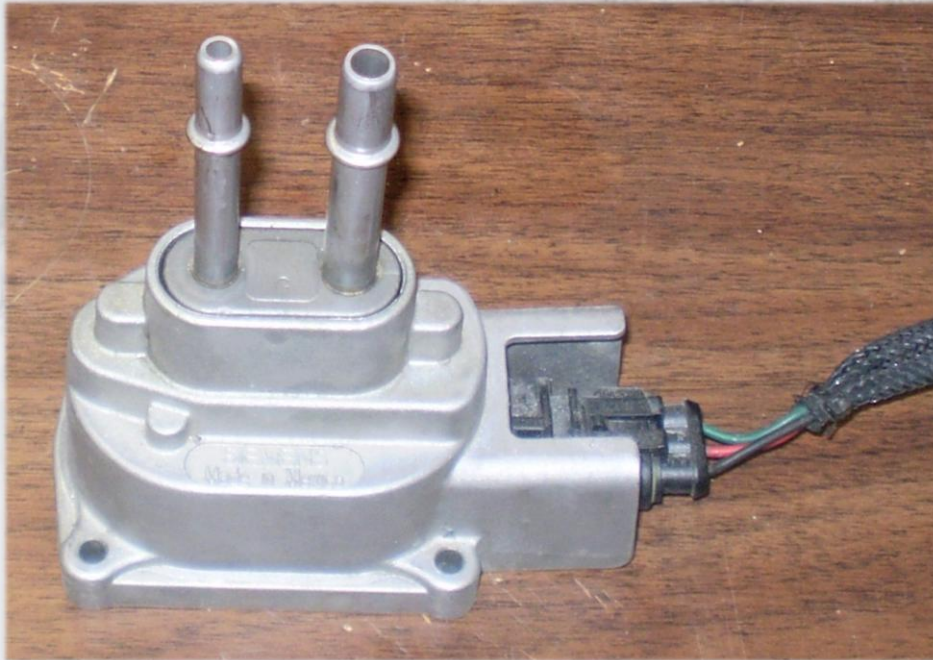
Engine Tuning and Calibration

Borghgi & Saveri Eddy Current Dyno with Superflow Controller

- Survivability
- Ridability
- Fuel Economy
- Power
- Emissions

Flex Fuel

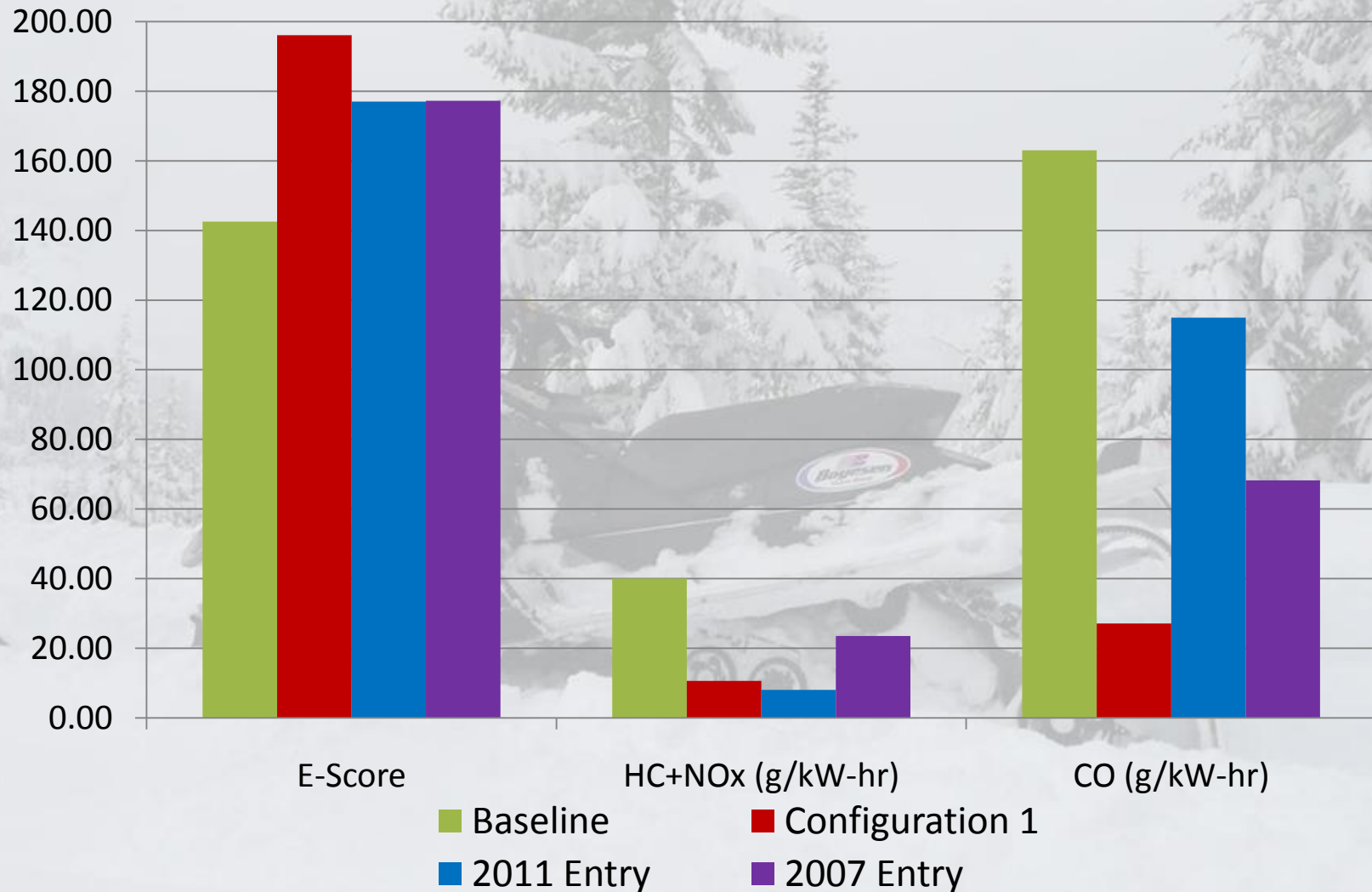
- Used a GM flex fuel sensor
- Tuned for E10, E20, E30, E40



Engine Calibration Strategy

- Started with existing calibration for E10
- Overall fuel correction was calculated based on energy content of ethanol
- Tuned for E10, E20, E30, E40
- Tuned for catalyst back pressure
- Finetuned mode points and cruise

Emissions Results



Engine Results

- E-Score of 196 on E10, 193 on E20
 - Goal of 170 (National Park Standard) met
 - Meets requirements for CO and HC+NO_x
- Achieved an average 105 horsepower during mode 1 emissions



MSRP Breakdown

- Base sled price \$12099
- UICSC sled price ~\$14632
- Major contributors
 - Ice ripper track $\$550 * 1.5 = \850
 - Stock track \$488
 - Skis $\$244 * 1.5 = \366
 - Stock skis \$125
 - Rear Drive $\$560 * 1.5 = \840

Summary

- Goals met:
 - Meets NPS exhaust emissions standards
 - Wet weight ~600 lbs
 - Increased fuel economy from 18 mpg (E29) to 22 mpg (E10)
- Goals not met:
 - NPS sound emissions
 - EPA standard of 78dBA met
- Consumers want a powerful, agile, and fuel efficient snowmobile and the UICSC sled is an economical response to this demand

Thank You



Questions?

Two Stroke Verses Four Stroke

