

UNIVERSITY OF WATERLOO TEAM ECO-SNOW

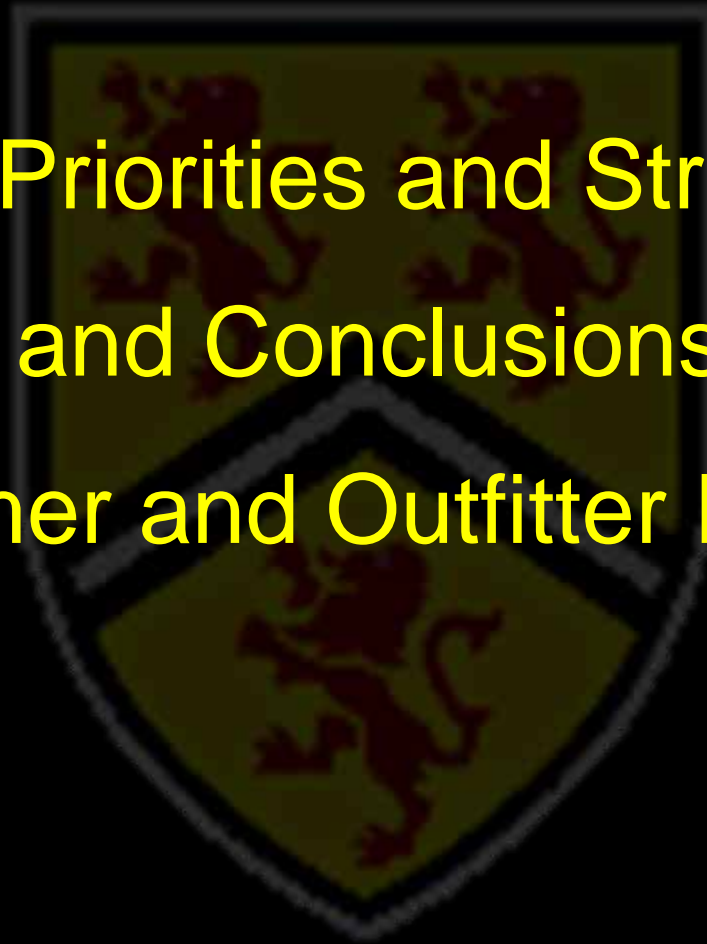


TEAM BACKGROUND

- Team Eco-Snow is a student organization at the University of Waterloo
- The project is managed and administered by students under the direction of the Department of Mechanical Engineering
- The team is funded by industry sponsorship and engineering foundations

PRESENTATION SUMMARY

- Design Priorities and Strategy
- Results and Conclusions
- Consumer and Outfitter Perspective



DESIGN PRIORITIES

Examine feasibility of 2-Stroke vs. 4-Stroke solutions in achieving goals of :

- Reduced Exhaust Emissions
- Reduced Vehicle Noise
- Improved Handling & Engine Performance
- Improved Fuel Economy
- Minimized Technology Implementation Costs

INITIAL COMPARISON

4-Stroke : Better emissions

Lower noise

Lower power to weight ratio

Higher production cost

2-Stroke : High level of UHC emission

Higher noise level

Higher power to weight ratio

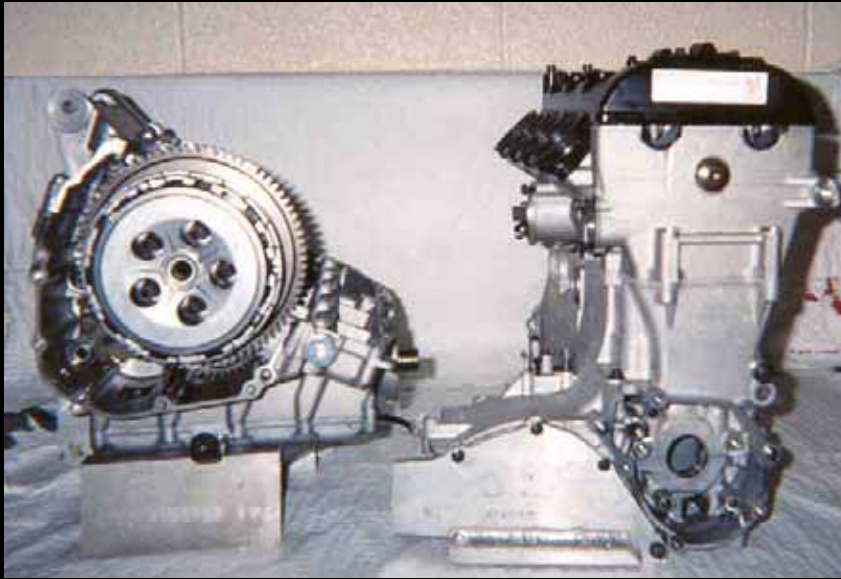
Lower production cost

COMPARISON SYSTEMS

4-Stroke : 1997 Arctic Cat ZRT 800 chassis with a 2000 Suzuki GSX-R750 engine chosen for its stock fuel injection, size, weight, and power

2-Stroke : CSC2000 Second place sled, a 1998 Polaris Indy Trail chassis with a modified 2000 Polaris 500 XCSP carbureted engine chosen for its proven performance, reliability, and availability

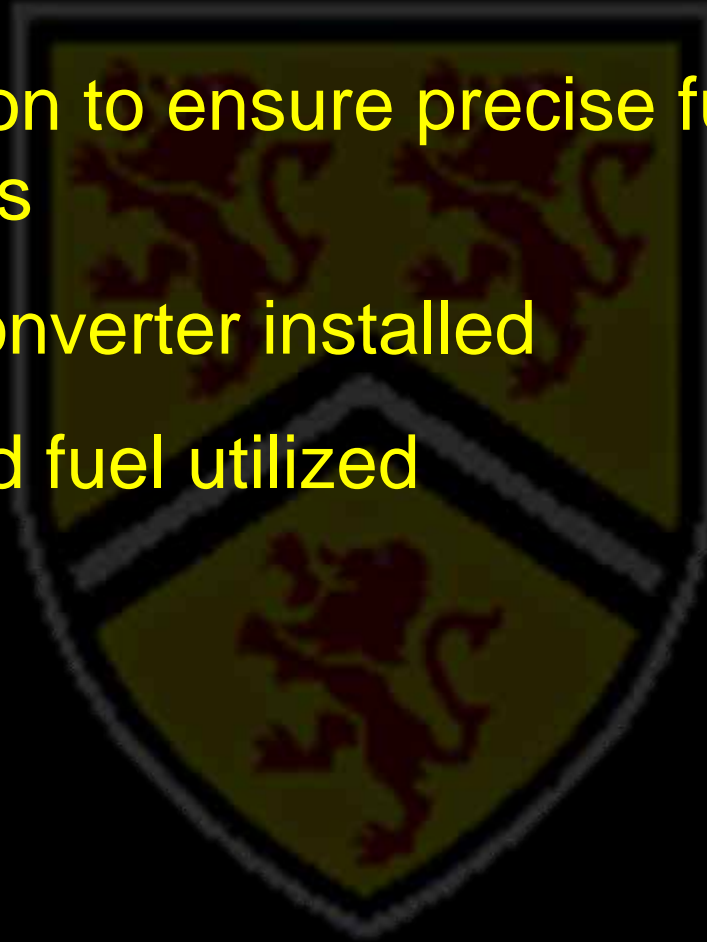
4-STROKE IMPLEMENTATION



- Transmission removed to reduce weight & size
- Dry sump system implemented to reduce engine height and replace stock components
- Secondary shaft used to transfer power from crankshaft to clutch and accessory pumps

4-STROKE : EMISSION REDUCTION

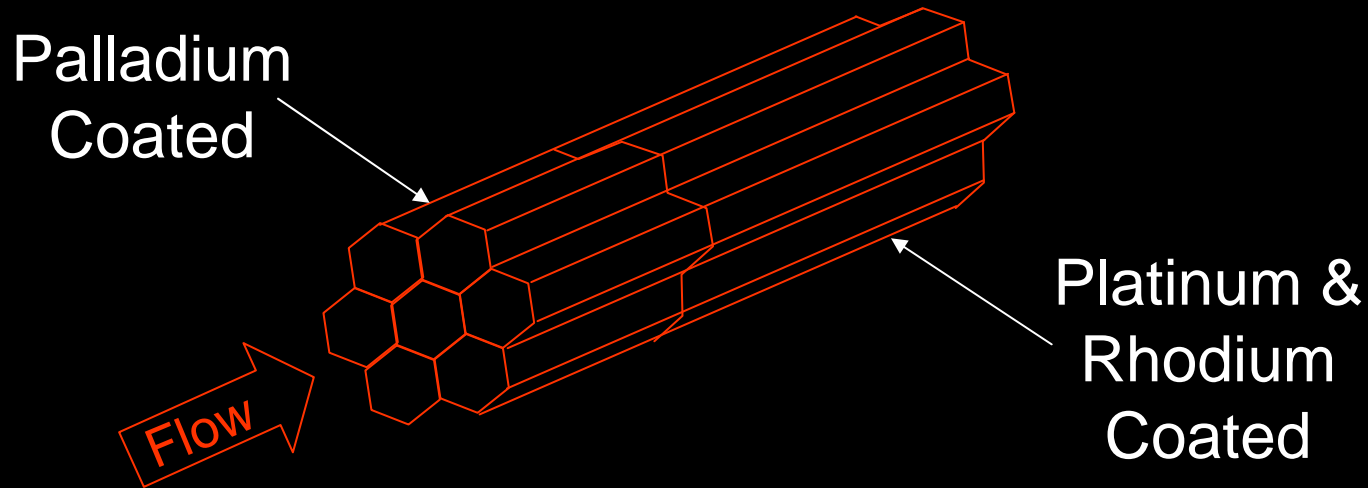
- Fuel injection to ensure precise fuel control in all situations
- Catalytic converter installed
- Oxygenated fuel utilized



2-STROKE : EMISSION REDUCTION

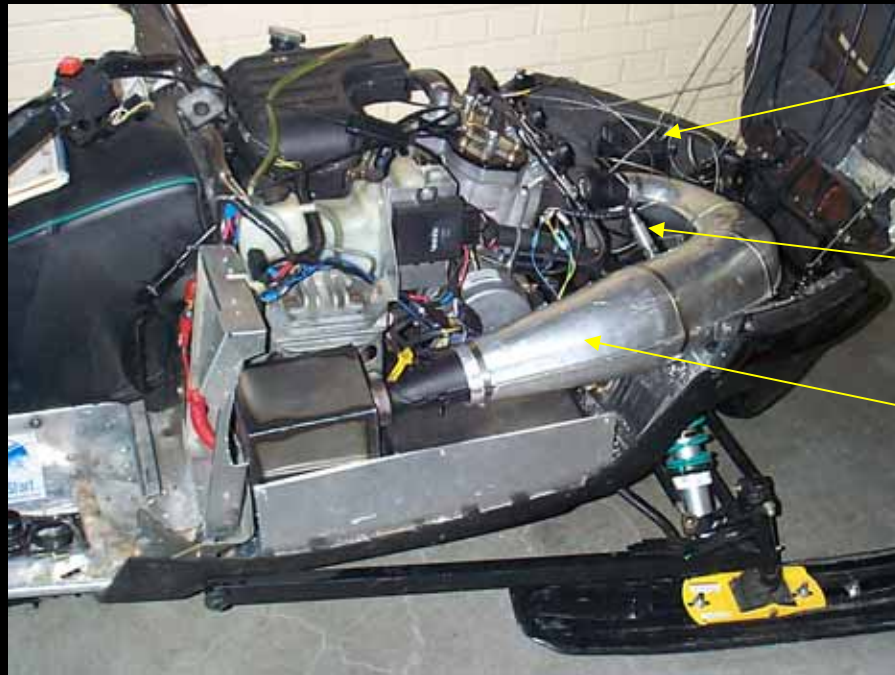
- Engine modifications were completed to improve the combustion process
- Catalytic converter installed
- Secondary air injection
- Oxygenated fuel utilized
- Biodegradable synthetic lubricant
- Precision carburettor tuning for conditions

CATALYTIC CONVERTER



- 3 way, dual bed, catalytic converter
- Combats all negative emissions scenarios, except particulates, including poor air/fuel ratio, short circuiting, and overheating

AIR INJECTION REACTION (AIR)



Secondary air injection blower

O₂ Sensor

Expansion chamber with catalytic converter

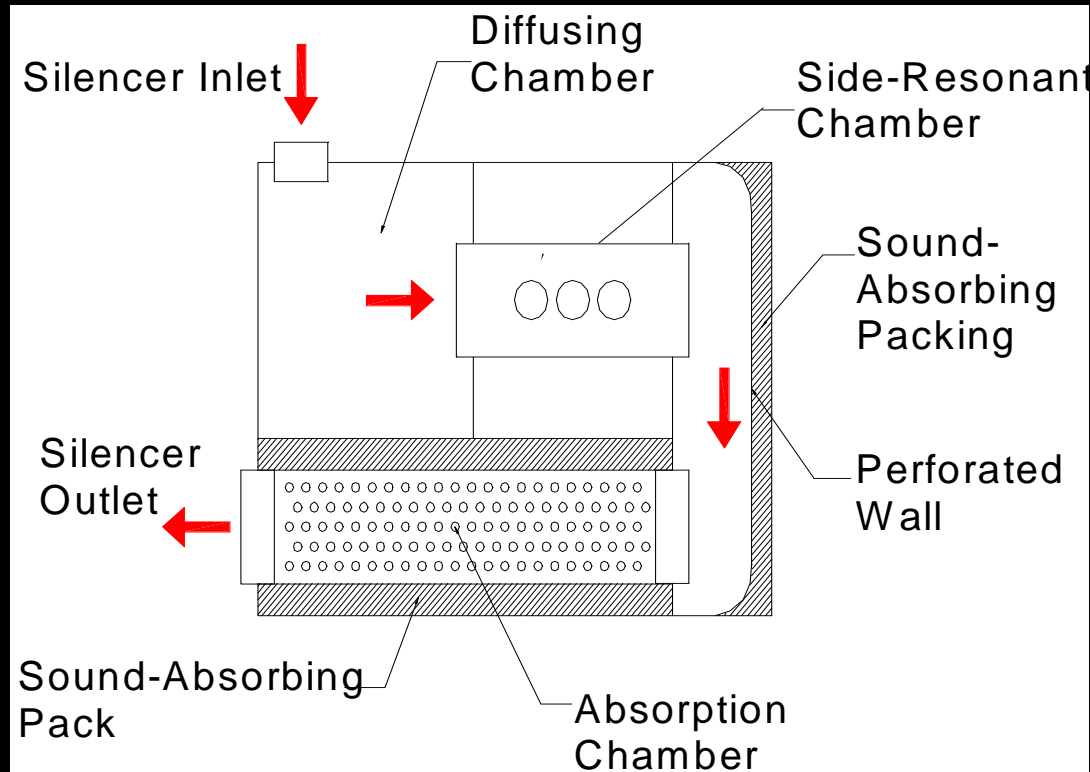
Air injection was implemented to assist in the conversion of unburned hydrocarbons (UHC) and carbon monoxide (CO) through the addition of oxygen

NOISE REDUCTION

- Exhaust silencing
- Sound deadening insulation
- Other areas



EXHAUST SILENCING



Silencer developed using diffusing, side resonant, and absorption type silencer designs and all available space

OTHER NOISE CONSIDERATIONS

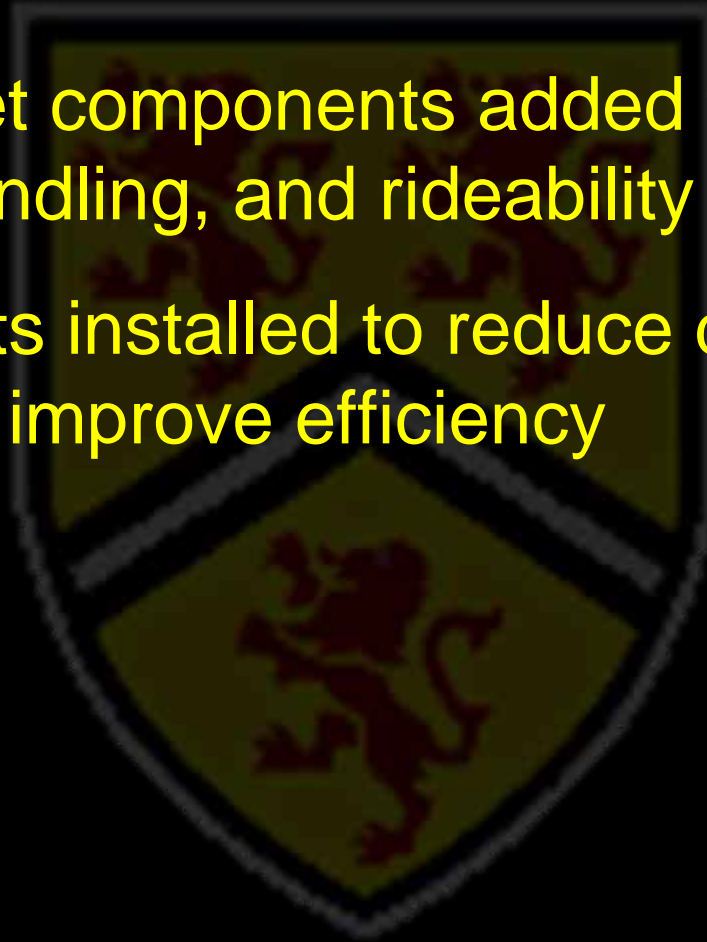


Track
“Curtains”

The impact of track noise on total vehicle noise was examined and solutions investigated

OTHER IMPROVEMENTS

- After market components added to improve traction, handling, and rideability
- Components installed to reduce drive train friction and improve efficiency



COMPARISON RESULTS

- 4-Stroke emitted slightly lower noise levels
- 4-Stroke exhibited lower emission levels
- 2-Stroke weighs less providing better handling
- Engine performance is comparable
- 2-Stroke offers superior reliability

DESIGN CONCLUSIONS

- Similar exhaust after treatment, noise reduction, handling, driveability, and efficiency improvements can be implemented on both 4-Stroke and 2-Stroke solutions
- Each solution provides improved emissions and noise
- Refinement of 4-stroke alternative will improve reliability and simplicity
- 2-Stroke solution best meets the goals of Team Eco-Snow

CONSUMER AND OUTFITTER PERSPECTIVE

- Implementation costs of each solution are less than \$1000 US, \$1570 Can
- 2-Stroke alternative combines reduced emissions and noise with increased power and performance in a simple, economical package
- 4-Stroke alternative provides increased emissions and noise reductions for sensitive areas
- Both options can be easily incorporated into existing snowmobile designs



QUESTIONS?