McGill University
Clean Snowmobile Challenge 2009 Design Presentation:

Electric Snowmobile Design for the "Real World"

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Content

- Why build an electric snowmobile?
- Electric snowmobile design challenge
- Snowmobile modeling and simulation
- Canadian Snowmobile Adventures case study

Why Build an Electric Snowmobile?

- Suit the needs of:
  - Canadian Snowmobile Adventures
  - Vancouver 2010 Olympic Committee
  - Mont Saint-Sauveur International
  - FIS 2009 World Alpine Ski Championships (Val d'Isere, France)
  - Les Trois Vallees
  - NSF
  - …

Why Build an Electric Snowmobile?

Environmental Perspective

•With over 90% of British Columbia's electricity produced by hydro power, an electric snowmobile when used in Whistler can be considered an extremely clean vehicle when it comes to air pollution.

•An ANL GREET Model simulation analysis of fuel cycle emissions using the entire Canadian electrical production mix as an electricity source yields the following comparative results between an electric snowmobile and a gasoline snowmobile.

Why Build an Electric Snowmobile?

Environmental Perspective

	GAS Snowmobile			Electric Snowmobile			Relative Energy Use and Emissions		
	Wh/km or grams/km			Wh/km or grams/km			(Electric snowmobile relative to gasoline snowmobile)		
Item	Well to pump	Vehicle Operation	Total	Well to pump	Vehicle Operation	Total	Well to pump	Vehicle Operation	Total
TOTAL ENERGY									41%
CO_2									29%
VOC									1%
CO									0%
NOx									5%
PM									219%

Based on Canadian Electric Power Generation Data from the International Energy Agency

Why Build an Electric Snowmobile?

Environmental Perspective

What about sound?

Mont Saint-Sauveur

FIS 2009 World Alpine Ski Championships

Summit Station, Greenland

Electric Snowmobile Design Challenge

BRP Tundra 300F Gasoline
Light Duty Utility Snowmobile
Fuel on-board: **34l of gasoline**
Vehicle weight (full capacity): **~440lbs**

BRP Tundra Electric
Light Duty Utility Snowmobile
Fuel on-board: **equiv. to 0.33l of gasoline**
Vehicle weight (full capacity): **498lbs**

Electric Snowmobile Design Challenge

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Q: Can one overcome such an obstacle and create an electric snowmobile capable of satisfying the needs and desires of **all** light duty utility snowmobile users and outfitters?

A: Probably not

Q: Can one overcome such an obstacle and create an electric snowmobile capable of satisfying the needs and desires of **some** light duty utility snowmobile users and outfitters?

A: It is not easy but we think it can be done

Electric Snowmobile Design Challenge

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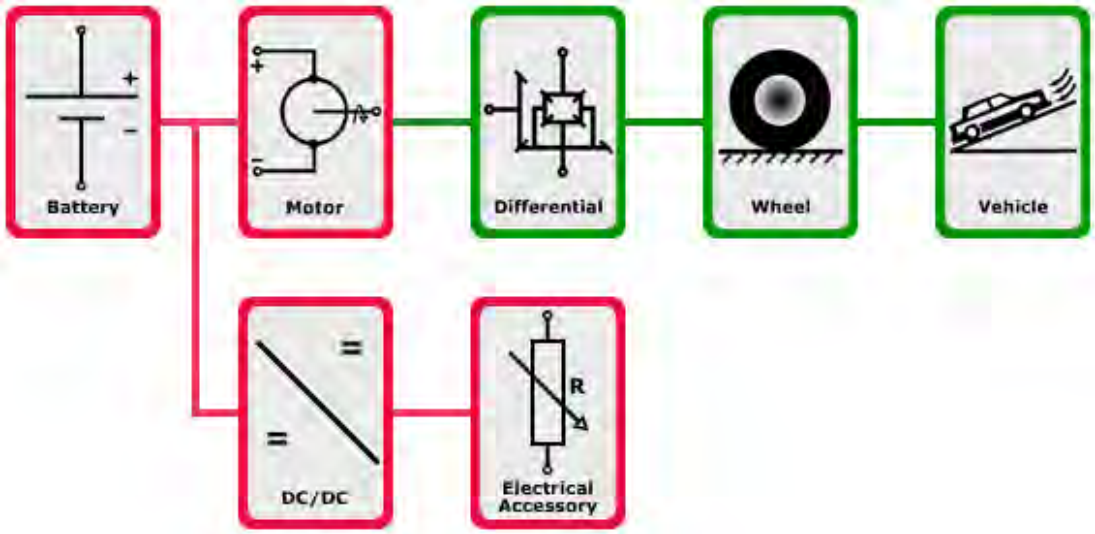
Q: How can this be accomplished?

A: Via custom design of electric snowmobiles for specific applications by using advanced powertrain computer modeling and simulation



Snowmobile Modeling and Simulation

Q: What is advanced powertrain modeling and simulation?

Snowmobile

Terrain & Application

Matlab

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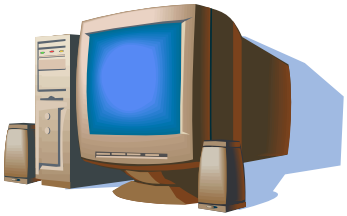
ANL PSAT



Performance Results

Snowmobile Modeling and Simulation

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Q: How does computer modeling and simulation help suit the needs and desires of snowmobile outfitters and users?

A: Ensure basic performance requirements are being met at the lowest possible cost.

“Real-life” example: Canadian Snowmobile Adventures



Canadian Snowmobile Adventures Case Study

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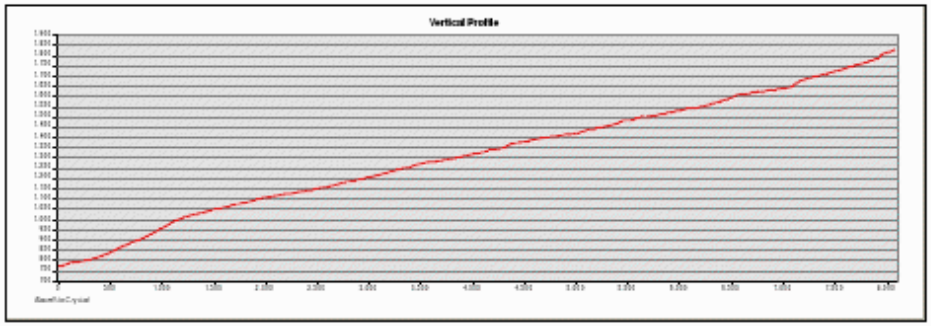
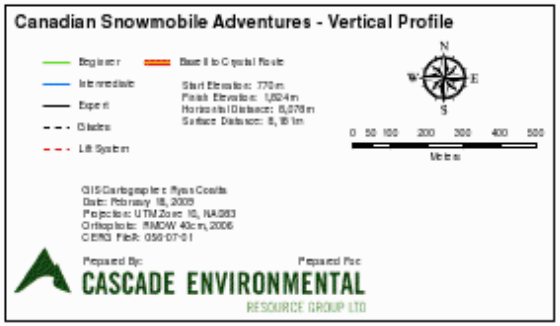
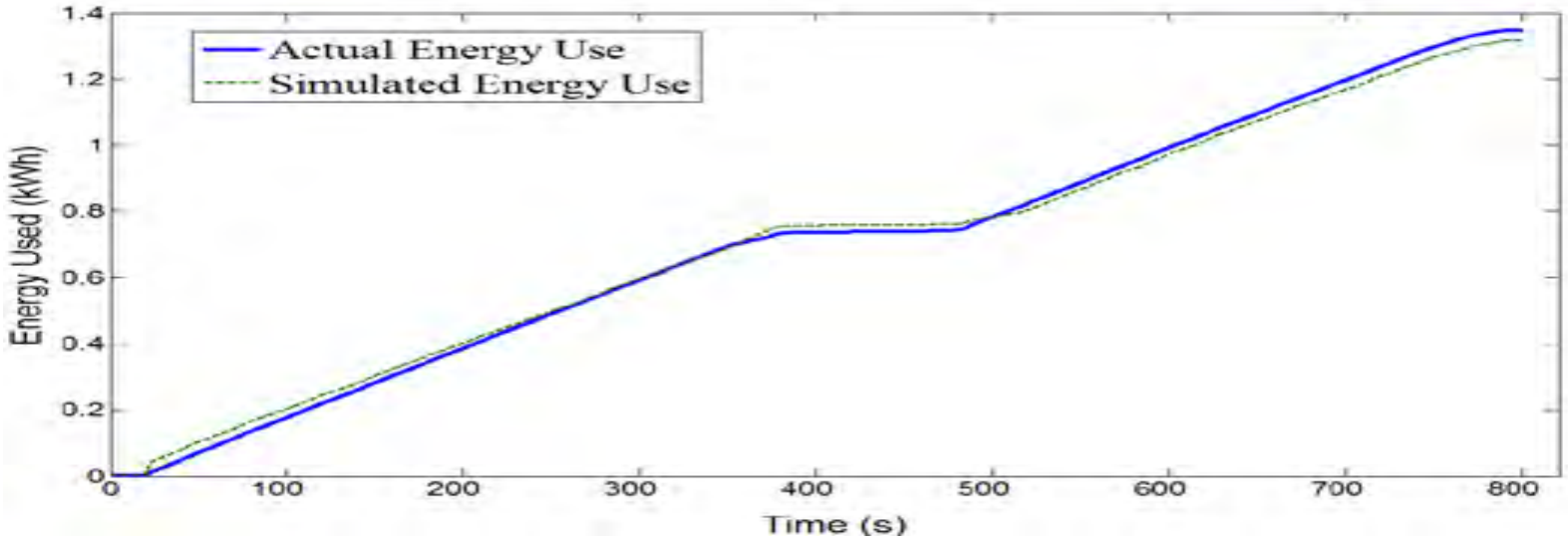
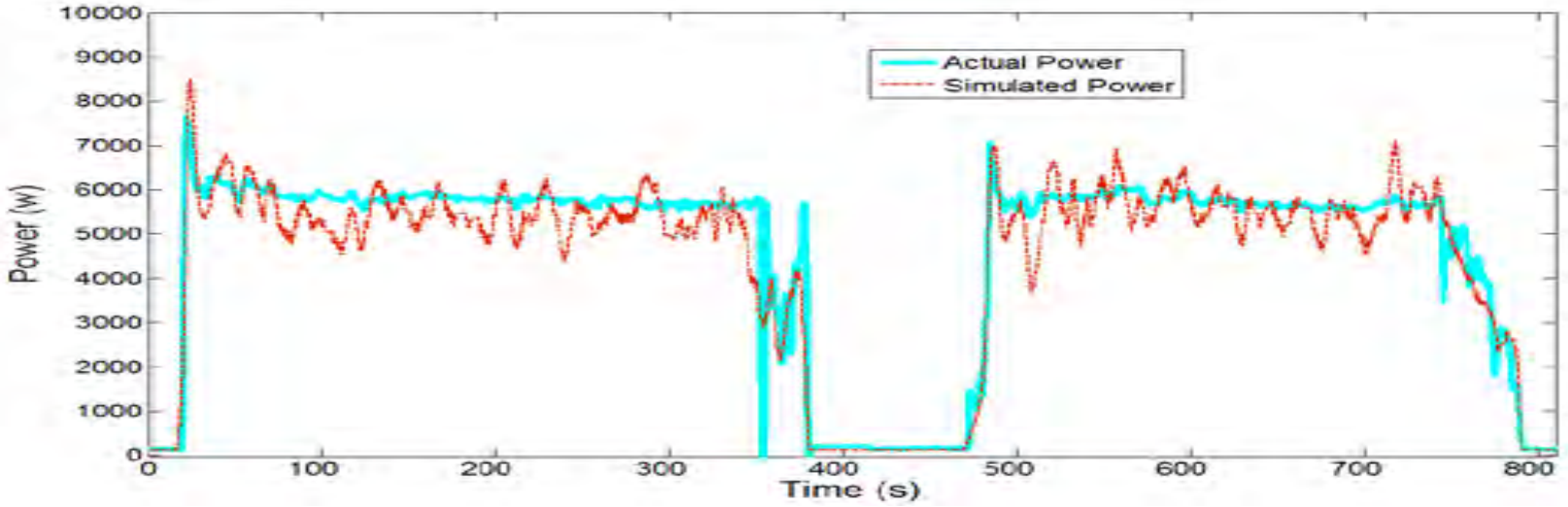
Design Process: Modeling and Simulation





Canadian Snowmobile Adventures Case Study





Canadian Snowmobile Adventures Case Study

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Design Process: component selection

Snowmobile life: 12,000km
Pack changes during life: 0
Cost of energy during life: ~$120 US (i.e. approx $0.01 /km)

- Handling and performance
  - Pre-studded track (136in.)
  - Extremely low center of gravity
  - CVT tuning can yield performances similar to original Tundra 300F
  - Low weight
  - Wide ski stance and adjustable shocks (can be adjusted for different clients)

- Ease of use/service and ergonomics
  - Intuitive on-board charging from any regular North American household outlet
  - Same driver position and driver main controls as original vehicle
  - Minimal custom made parts
  - Charge and drive status indication lights

Canadian Snowmobile Adventures Case Study

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Design Process: End result

A $15,000 electric snowmobile capable of suiting the needs of Canadian Snowmobile Adventures “beginner” tour along Fitzsimmons Creek .

Furthermore, the snowmobile has proven its ease of use by novice users when it was used for 2 weeks in Val d’Isere France, towing a trailer through a crowd of 200,000 spectators, by people who had never touched a snowmobile before.

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Questions