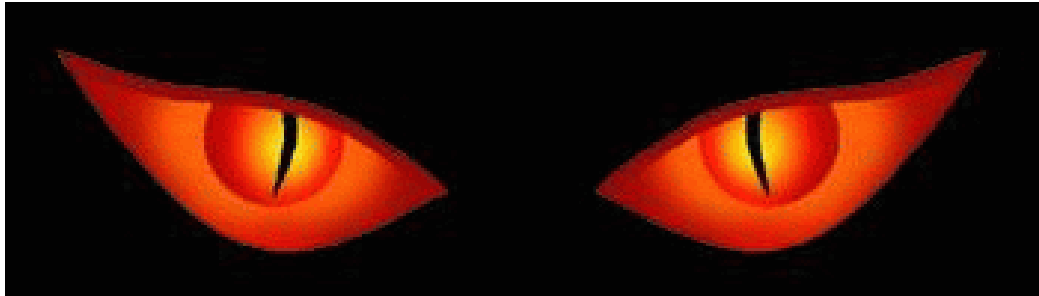


# McGill Electric Snowmobile Team

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“Wendigo”



**Presented by**  
Romain Roux  
Charles Vincent

March 8 th 2012

# Design objectives

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## **Wendigo 2011**

### Strong points:

- Overall Value
- Weight
- Handling

## **Wendigo 2012**

### Improvements:

- Draw bar pull
- Noise attenuation
- Range
- Acceleration

# Design Overview

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**Chassis : BRP Tundra LT 2011**

**Weight = 555 lbs**



Articulated rear suspension



Curtis 1238-6501 Controller  
72V, 550 A



CAN  
communication



LTC Lithium-ion cells 45 Ah  
72 V, 3.24 kWh



AC-15 3Phase induction  
25 HP, 80 N-m



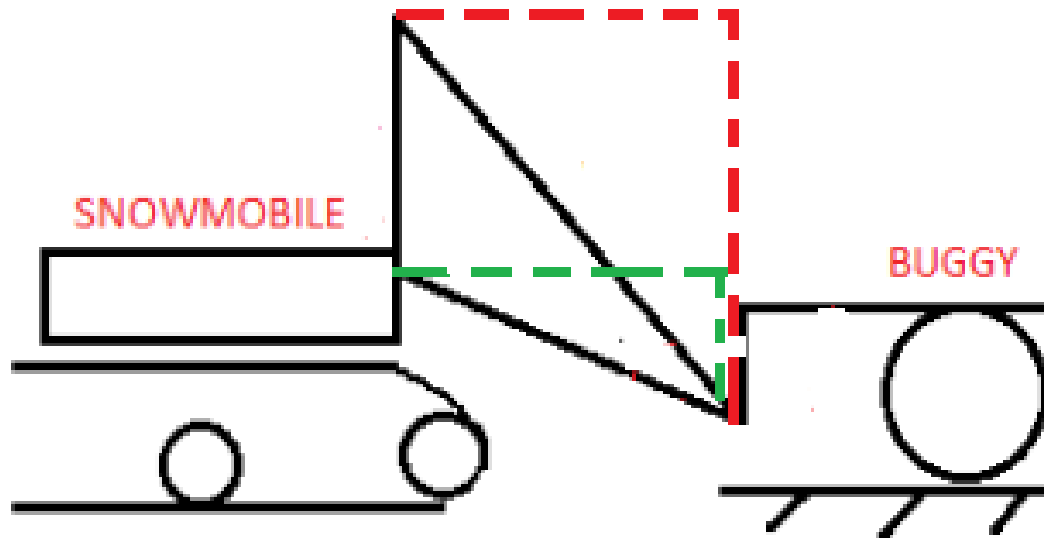
Delta-Q 72V  
Charger and Converter

# Draw bar pull

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- Maximizing pulling capacities of sled
- Engineered elevated rear hitch module

→ Increase traction



# Pulling force to applied weight ratio

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	McGill University			
	Total Mass	Rear Mass	Pull Force	Rear + 60 kg Force ratio
	Kg	Kg	N	N/Kg
<b>AVG</b>	<b>236</b>	<b>114</b>	<b>2054</b>	<b>12</b>

- Potential increase of 12N / kg of weight  
→ Maximize weight at the rear

# Design and development

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**Assembly:**



**Benefits:**

+88 lbs of pulling force (expected)

# Noise attenuation

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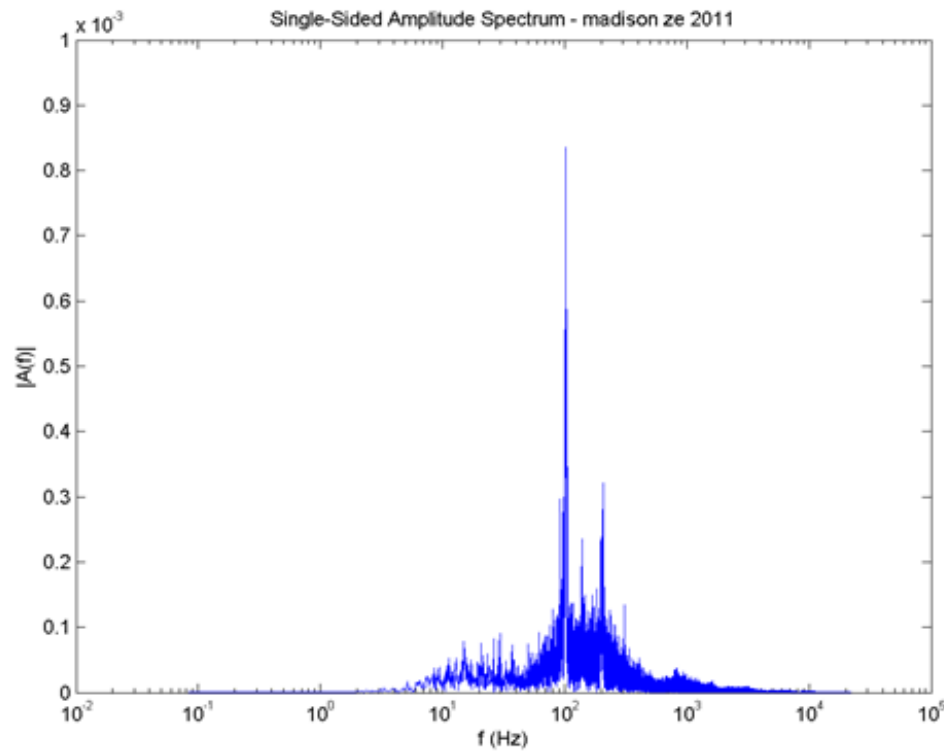
- Significant issue across both IC and ZE platforms
- Reduce vibration propagation



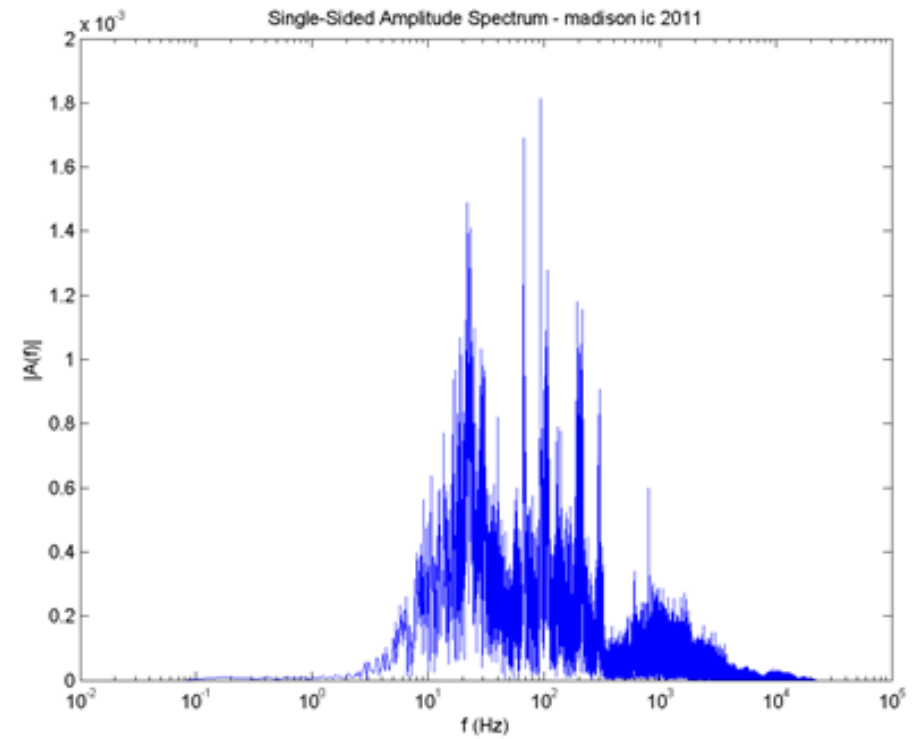
# Spectral Analysis of 2011 CSC

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University of Wisconsin - Madison



**Zero Emission Sled**



**IC sled**



# Noise Testing

## 1) Vibrator Sound Testing

- Gas tank experiment

Modifications	Sound level (dB)
Unmodified	105.7
Viscoelastic gel	103.1
Damping pads	98.0

## 2) Accelerometer and Noise Vibration Tests on Bare Chassis

- Motor imbalance setup
  - Identify vibration hotspots
- ↓ vibration amplitudes by 15%

# Implementation

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- Sound Insulation
- Vibration Isolation
- Vibration Damping



Before

After



# Range

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- **2011 Wendigo performance:**
- 7.81 miles on a 6 year old pack
- 60% of original capacity
- **2012 Wendigo performance:**
- 20 new LTC cells
- Expected mileage: 13.03 (+5.22 miles)

# Range

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Why 72 volts?

# Range

---

	72 volts (20 cells)	93.6 volts (26cells)
Range	13.03 miles	16.94 miles
Weight(kg)	30	39
Cells Cost	\$6000	\$7800
Energy	3240 Wh	4214 Wh

**Table 1** - Battery pack comparison

# Range

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Loaded Acceleration		
Drive Ratio	72V	93.6V
2	22.55 s	21.71 s
3	19.7 s	17.85 s
4	19.13 s	17.48 s
5	19.02 s	17.72 s
6	19.27 s	17.95 s
7	19.84 s	18.69 s

**Table 2** – Loaded acceleration time simulations

# Range

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## **Sled usage in Greenland:**

- Average trips, loaded sled: 3.7 miles a day
- Effective average trips, unloaded sled: 11.1 miles a day

# Range

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	<b>72 volts (20 cells)</b>	<b>93.6 volts (26cells)</b>
<b>Range</b>	<b>13.03 miles</b>	<b>16.94 miles</b>
<b>Weight(kg)</b>	<b>30</b>	<b>39</b>
<b>Cells Cost</b>	<b>\$6000</b>	<b>\$7800</b>
<b>Energy</b>	<b>3240 Wh</b>	<b>4214 Wh</b>

The extra benefit to cost is hard to justify



# Range

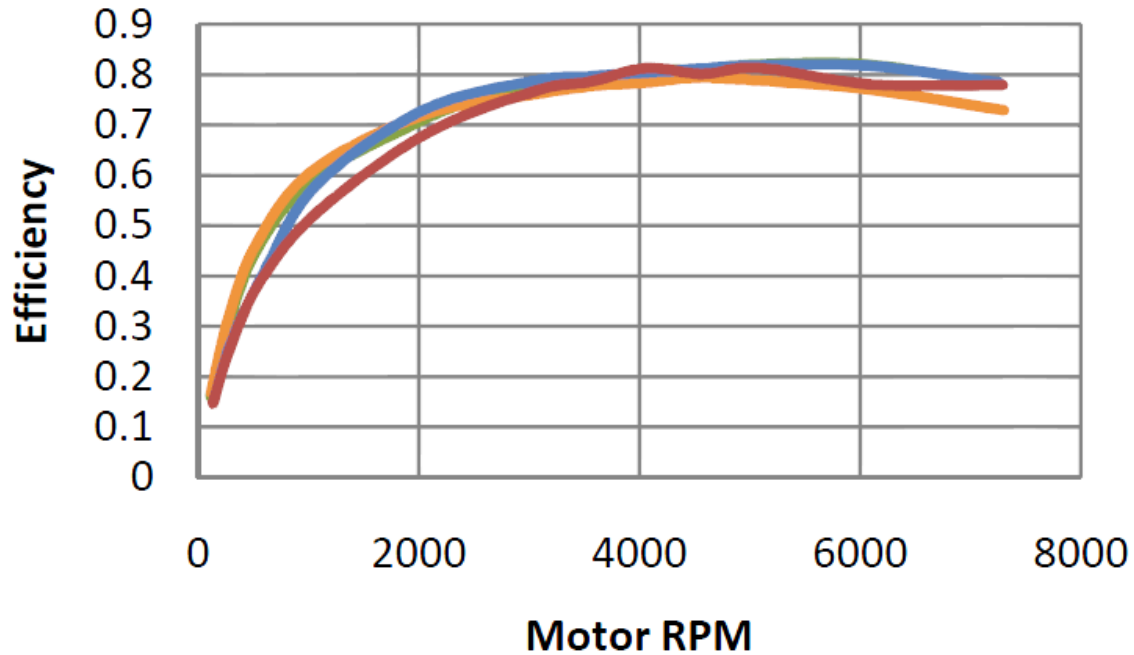
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## Powertrain:

- Extensive dynamometer testing
  - Acquired maps for current, torque, efficiency, slip gain, power, and other parameters.

# Range

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- 1236- 180A Limit
- 1236- Max Power (=300A)
- 1238- 180A Limit
- 1238- 300A Limit

Highest motor efficiency at 3000 RMP of more

**Graph 1 – Motor efficiency versus RPM**

# Range

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## Drivetrain

- Fixed gear ratio of 3 to 1 :
  - Translates to 20mph at 3000 RPM
  - Simpler packaging (stock chain case)
  - Ease of maintenance
  - High reliability
  - Good acceleration

# Loaded acceleration

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## **PSAT simulations taking into account:**

- Snow friction
- Aerodynamic drag
- Traction limits
- 800 lbs trailer load over 500 ft

# Loaded acceleration

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Loaded Acceleration	
Drive Ratio	72V
2	22.55 s
<b>3</b>	<b>19.7 s</b>
4	19.13 s
<b>5</b>	<b>19.02 s</b>
6	19.27 s
7	19.84 s

**Table 2** – Loaded acceleration time simulations

# Conclusion

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Improvement	Solutions
<ul style="list-style-type: none"><li>• Draw bar pull</li></ul>	Elevated rear hitch design
<ul style="list-style-type: none"><li>• Noise attenuation</li></ul>	Damping pads
<ul style="list-style-type: none"><li>• Range &amp; Acceleration</li></ul>	Improved utility and performances

Perfect for the Arctic !

# Thank you!

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