



Faculty of Engineering
Department of Mechanical Engineering

VERT Project – Electrical Snowmobile

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Overview

- Organization and Information Phases
- Function and Cost Analysis Phases
- Creativity and Evaluation Phases

Organization and Information Phases

Why an electric snowmobile?

Current use:

- Environmental Research
 - Greenland Summit Station

Potential use:

- National Parks patrolling
- Private use

Zero Emission Snowmobile Challenge

Events in the Competition

- Load
- Acceleration
- Distance
- Cold Start
- Noise
- Weight
- Cost [Retail Price]
- Potential in Greenland



Client Objectives

- Primary
 - Maintain or Increase Performance
 - Reduce Cost
 - Reduce Weight

- Secondary
 - Minimize custom parts

Initial Scope Restrictions

- Scope restrictions:
 - Type of Battery
 - Motor

Function and Cost Analysis

Methods

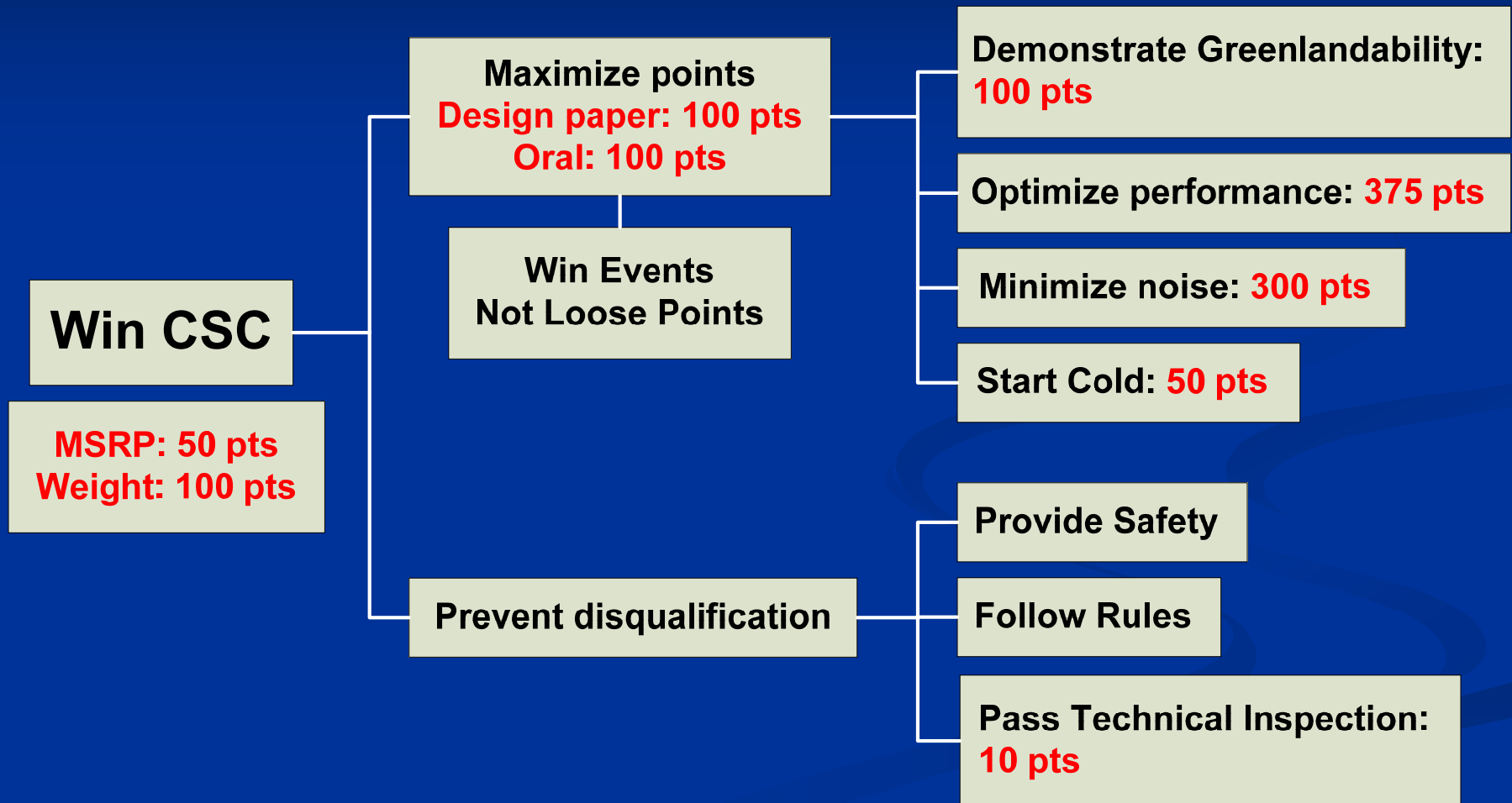
- Environment Analysis
- Rules and Regulations Analysis
- Reference Product Analysis

Revised Client Objective

- ~~Maintain or Increase Performance~~
- ~~Reduce Cost~~
- ~~Reduce Weight~~

WIN THE CLEAN
SNOWMOBILE CHALLENGE

Function Diagram



Value Calculation

VE Method: $\text{Value} = \frac{\text{Benefit}}{\text{Cost}}$

Our Situation: $\text{Value} = \text{POINTS}$

Value Calculation

$$\Delta \text{ Value} = \frac{\Delta \text{ Cost}}{\text{Base Cost}} \times \text{Cost Points}$$
$$+ \frac{\Delta \text{ Weight}}{\text{Base Weight}} \times \text{Weight Points}$$
$$+ \sum \Delta\% \text{ Performance} \times \text{Performance Points}$$

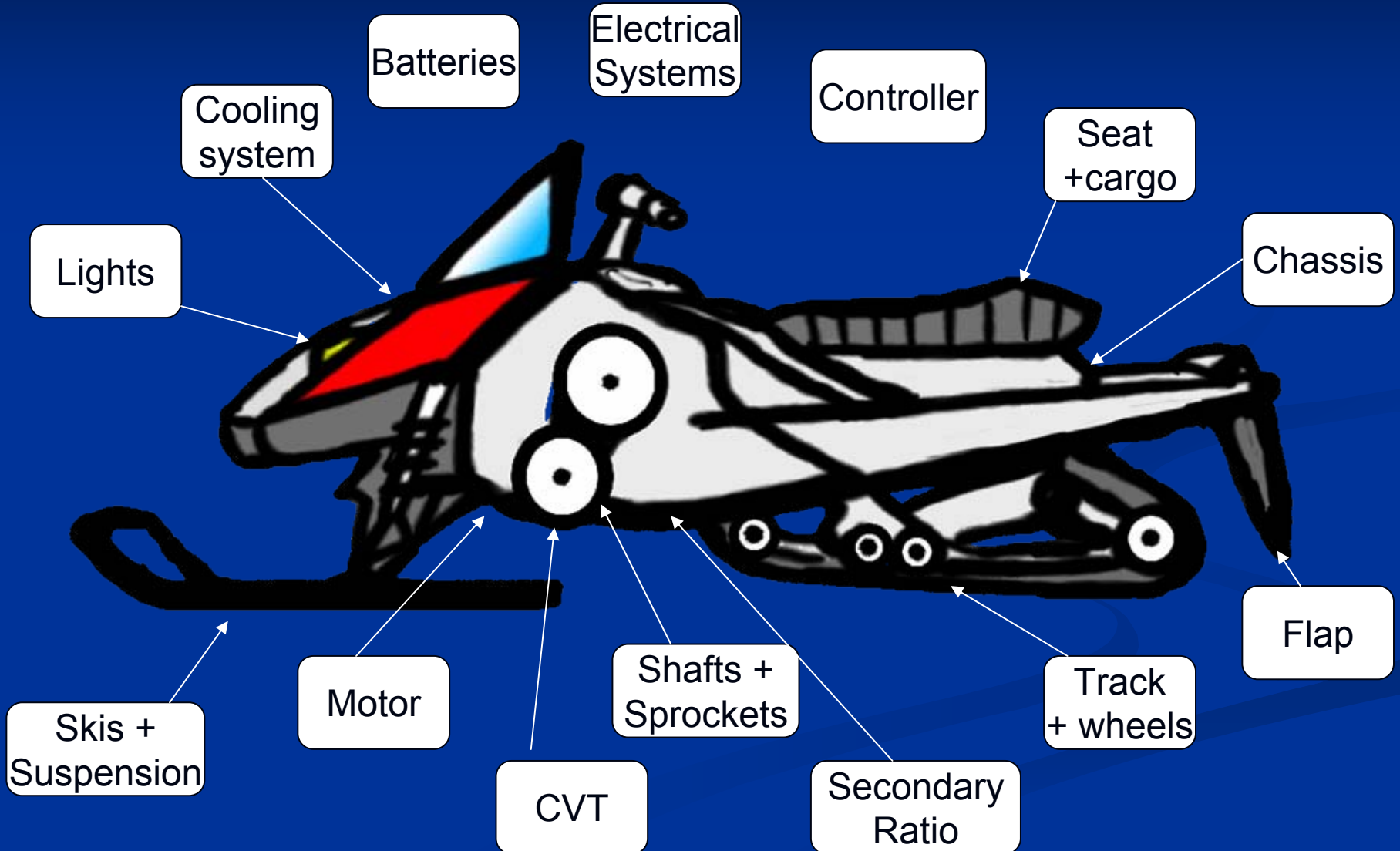
- Value Equation Weighting
 - Competition
 - Consumer

Creativity and Evaluation Phases

Methods

- Brainstorming
- Research options
- Eliminate ideas that are not feasible
- Group remaining ideas in families
- Vote on proposals as a team

Key Issues & Interests



Proposals – Stock Chassis

- Chassis change:
 - Tundra → Freestyle
- Cargo rack and other options not necessary for our snowmobile
- Freestyle saves \$420 and 20 lbs



$$\begin{aligned}\Delta\text{Value} &= 3.5 \% \times 50 \text{ pts} \\ &+ 4.0 \% \times 100 \text{ pts} \\ \hline &= 5.75 \quad \uparrow\end{aligned}$$

[Cost]

[Weight]

Proposals – Drive Train

- Altering Secondary Ratio
 - Increases torque and acceleration
 - Return to stock configuration
 - Lowers cost by \$1200



$$\begin{aligned}\Delta\text{Value} = & 7.7 \% \times 50 \text{ pts} \\ & + 0.4 \% \times 100 \text{ pts} \\ & + 2.5 \% \times 50 \text{ pts} \\ \hline = & 6.74 \uparrow\end{aligned}$$

[Cost]

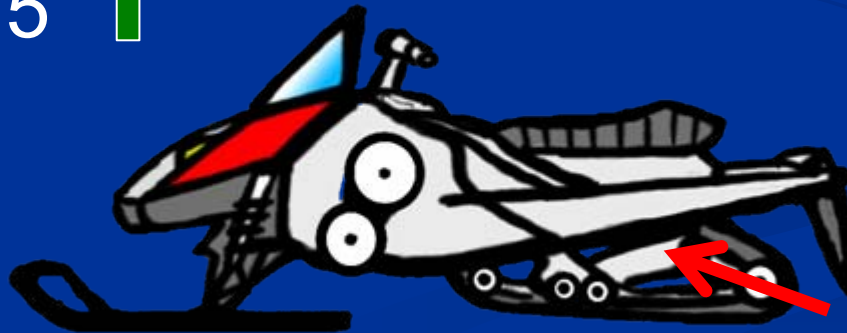
[Weight]

[Performance]

Proposals – Drive Train

- New rear suspension and track
 - Improves handling
 - Improves acceleration
 - Saves 10 lbs

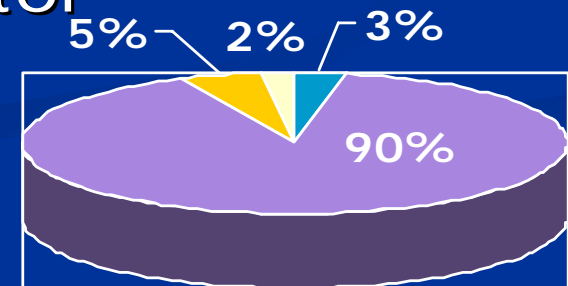
$$\begin{array}{r} \Delta\text{Value} = \quad 2 \% \times 100 \text{ pts} \qquad \qquad \qquad [\text{Weight}] \\ \quad \quad \quad + 9 \% \times 125 \text{ pts} \qquad \qquad \qquad [\text{Performance}] \\ \hline = 13.5 \quad \uparrow \end{array}$$



Proposals – Noise Reduction



- Track is the major contributor of noise (66dB)
- Currently nothing is being done to reduce noise
- Focus efforts on insulation of track
 - Addition of 'Skirt'
 - Produce a 'less noisy' track



Proposals – Noise Reduction

Addition of skirt

■ Material Consideration

- Light-weight
- Cheap
- Rigid



Foam

Rubber

Proposals – Noise Reduction





- Foam

Weight: 0.99 lbs

Cost: \$27

Noise Reduction: 10% at 66 dB

Δ Value: 29.69

$\Delta \text{Value} = -0.2\% \times 50 \text{ pts}$		[Cost]
$-0.2\% \times 100 \text{ pts}$		[Weight]
$+10\% \times 300 \text{ pts}$		[Noise]
<hr/>		
$= 29.69$		

Proposals – Battery Pack



- Increasing range and acceleration
 - Adding 6 battery cells will:
 - ↓ ■ Add \$2400 in Cost, or 14.7%
 - ↓ ■ Add 20.4 lbs in weight, or 4%
 - ↑ ■ Boost range by 30%
 - ↑ ■ Boost acceleration by 26%

Proposals - Battery Pack

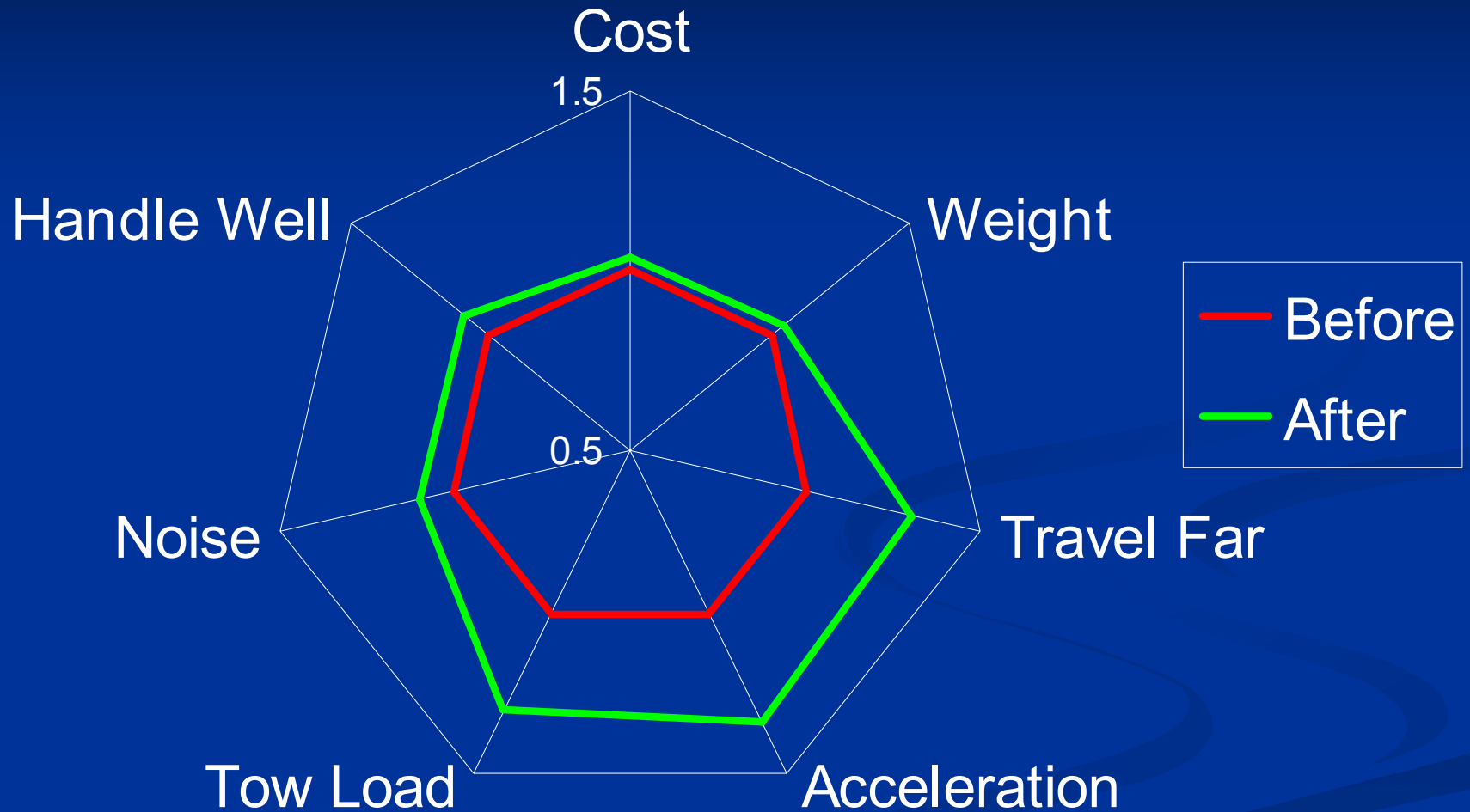
Δ Value = - 14.7 % x 50 pts	↓	[Cost]
- 4 % x 100 pts	↓	[Weight]
+ 30 % x 100 pts	↑	[Range]
+ 26 % x 100 pts	↑	[Accel.]
<hr/>		
= 31.56	↑	

Proposals - Removing onboard Charger

- Remove the onboard battery charger
 - Reduces cost by \$630
 - Reduces weight by 13 lbs
 - Increases acceleration by 2.6%

$$\begin{array}{r} \Delta \text{ Value} = 3.9 \% \times 50 \text{ pts} \quad \uparrow \quad [\text{Cost}] \\ + 2.6 \% \times 100 \text{ pts} \quad \uparrow \quad [\text{Weight}] \\ + 2.6 \% \times 100 \text{ pts} \quad \uparrow \quad [\text{Accel.}] \\ \hline = 6.13 \quad \uparrow \end{array}$$

Value Distribution



Conclusion

- Total Cost Savings: \$568 (~3.5%)
- Total Weight Savings: 25 lbs (~5%)
- Total Performance Increase: 90 pts (~13%)
 - Range increased by 5 km to 21 km
 - Top speed increased by 10 km/h to 60 km/h
 - Total noise reduced by 7 dB (~10%)
- Total Value Increase: 97 pts (~8%)

Our successful approach even prompted the client to re-scope the project to include more breadth!



Questions / Thank You