

# The SAE Clean Snowmobile Challenge 2000

## *Summary and Results*

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Lori M. Fussell

*September 11, 2000*

SAE International  
Off-Highway and Powerplant  
Congress and Exposition

# Overview of Presentation

- ◆ Video Introduction
- ◆ Competition Overview
- ◆ Description of Entries
- ◆ Event Descriptions and Results
- ◆ Conclusion
- ◆ Video Conclusion
- ◆ Acknowledgments



# Video Introduction

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to the television screen.*

# Competition Overview - History

- ◆ Competition founded in Jackson Hole, WY
- ◆ Organized jointly by:
  - Society of Automotive Engineers
  - Teton County Commissioner Bill Paddleford
  - & Environmental Engineer Dr. Lori Fussell





# Competition Overview - Purpose

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*To challenge engineering students to design a snowmobile with improved emission and noise characteristics that does not sacrifice performance and remains cost effective.*

# Overview - General Rules

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- ◆ Modify used, 488cc fan-cooled snowmobile
- ◆ Maintain stock tunnel
- ◆ 4-strokes and 2-strokes permitted  
(800cc and 500cc limit, respectively)
- ◆ Gasoline, 10% ethanol, and/or electricity
- ◆ Track driven and ski-steered
- ◆ Variable ratio belt transmission
- ◆ No turbochargers, traction control devices

# Overview - Events & Scoring

<b>Event</b>	<b>Penalty for Failing</b>	<b>Points Available for Relative Performance</b>
Emissions	-200	250
Fuel Economy/Range	-100	100
Noise	-100	150
Acceleration		100
Handling		50
Cold Start	-100	0
Hill Climb		100
Engineering Design		100
Oral Presentation		100
Static Display		50
<b>Total Points</b>	<b>-500</b>	<b>1000</b>

# Entries - Participants

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- ◆ Colorado State University (CSU)
- ◆ Ecole de Technologie Superieure (ETS)
- ◆ Colorado School of Mines (CSM)
- ◆ Michigan Technological University (MTU)
- ◆ University of Waterloo (UW)
- ◆ Minnesota State University, Mankato (MSU)
- ◆ University at Buffalo, SUNY (UB)

# Entries - Technical Description

Engine Cycle	One 4-stroke, Six 2-strokes
Fuel Delivery	Three EFI, Four carburetor
Cooling	Six liquid, One air
Fuel	Six 10% ethanol, One gasoline
Emission Control	One lean, One lean+catalyst Two catalyst Two catalyst and air inj. One catalyst and ESP
Noise Control	All added foam, some modified exhaust and muffler/silencers

# Events Description and Results

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- ◆ Emission Tests
- ◆ Fuel Economy/Range Test
- ◆ Acceleration/Noise Test
- ◆ Handling, Cold Start, & Hill Climb Event
- ◆ Engineering Design & Oral Presentation

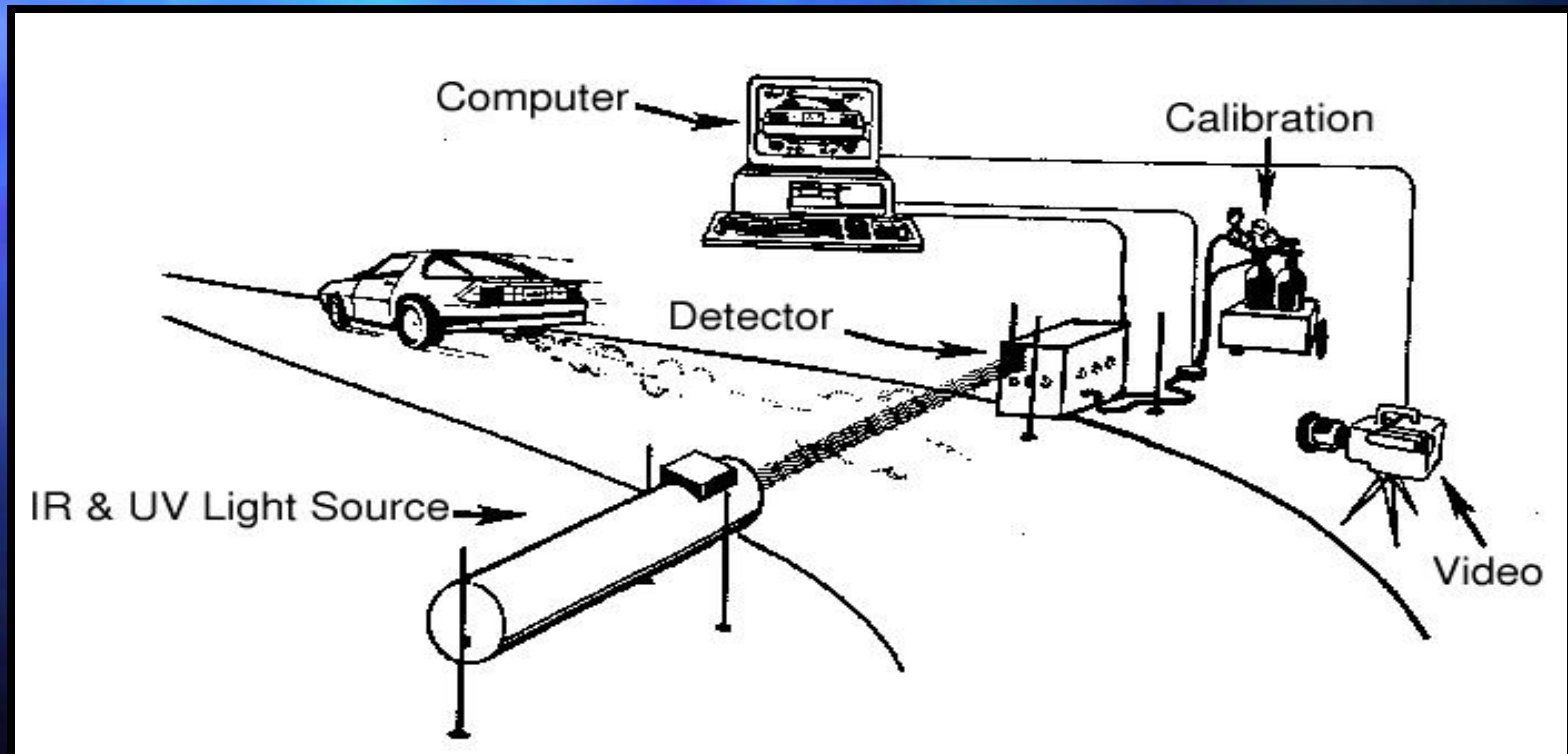
# Events - Emission Tests

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- ◆ Measured CO and UHC only
- ◆ In-field measurements via IR remote monitoring system
- ◆ Two modes of test:
  1. Gentle acceleration
  2. Steady-state of 20mph up a 4% grade

# Events - Emission Tests

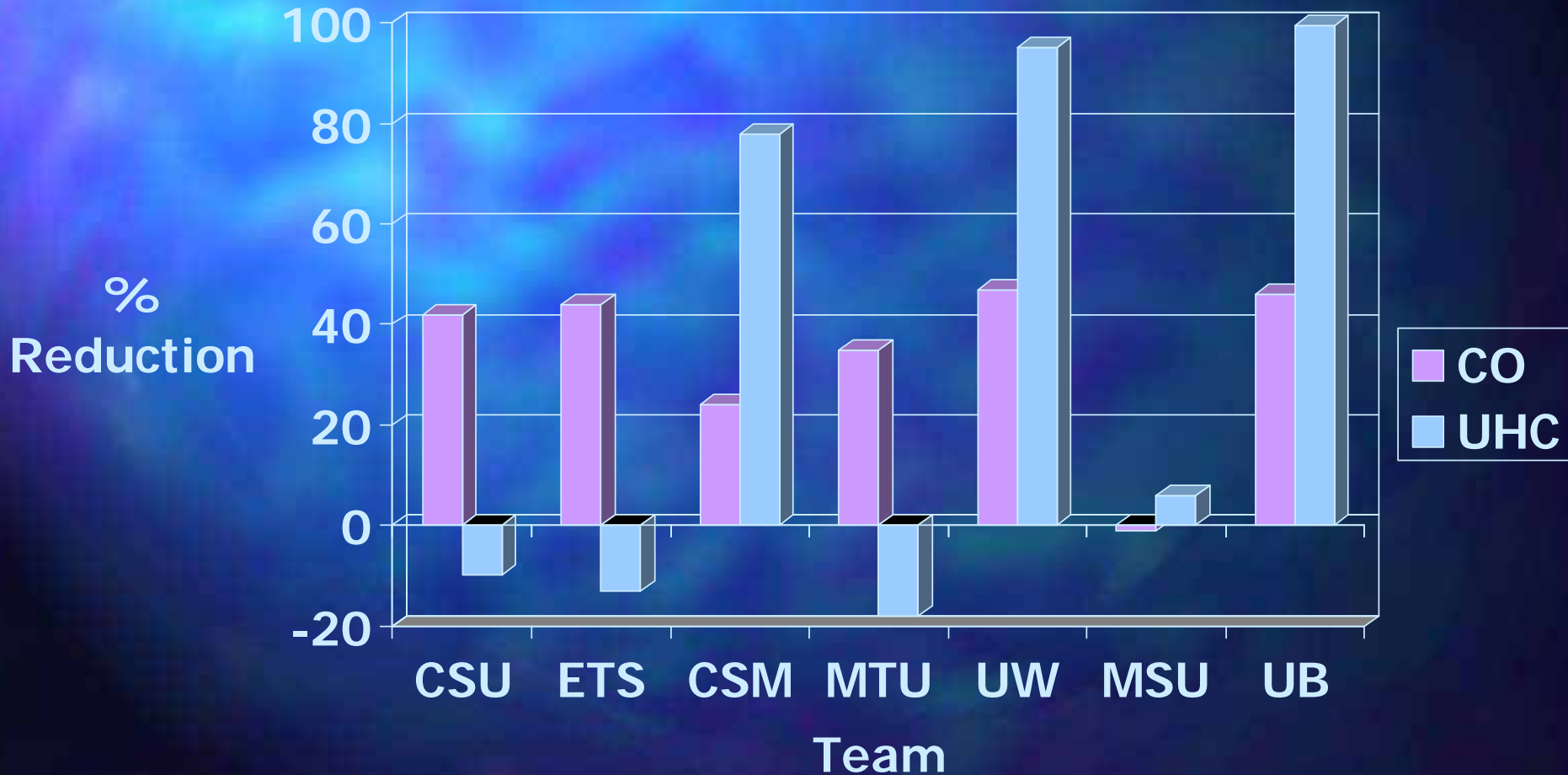
## Schematic of IR remote monitoring system





# Events - Emission Tests

## Emission Test Results



# Events - Fuel Economy/Range

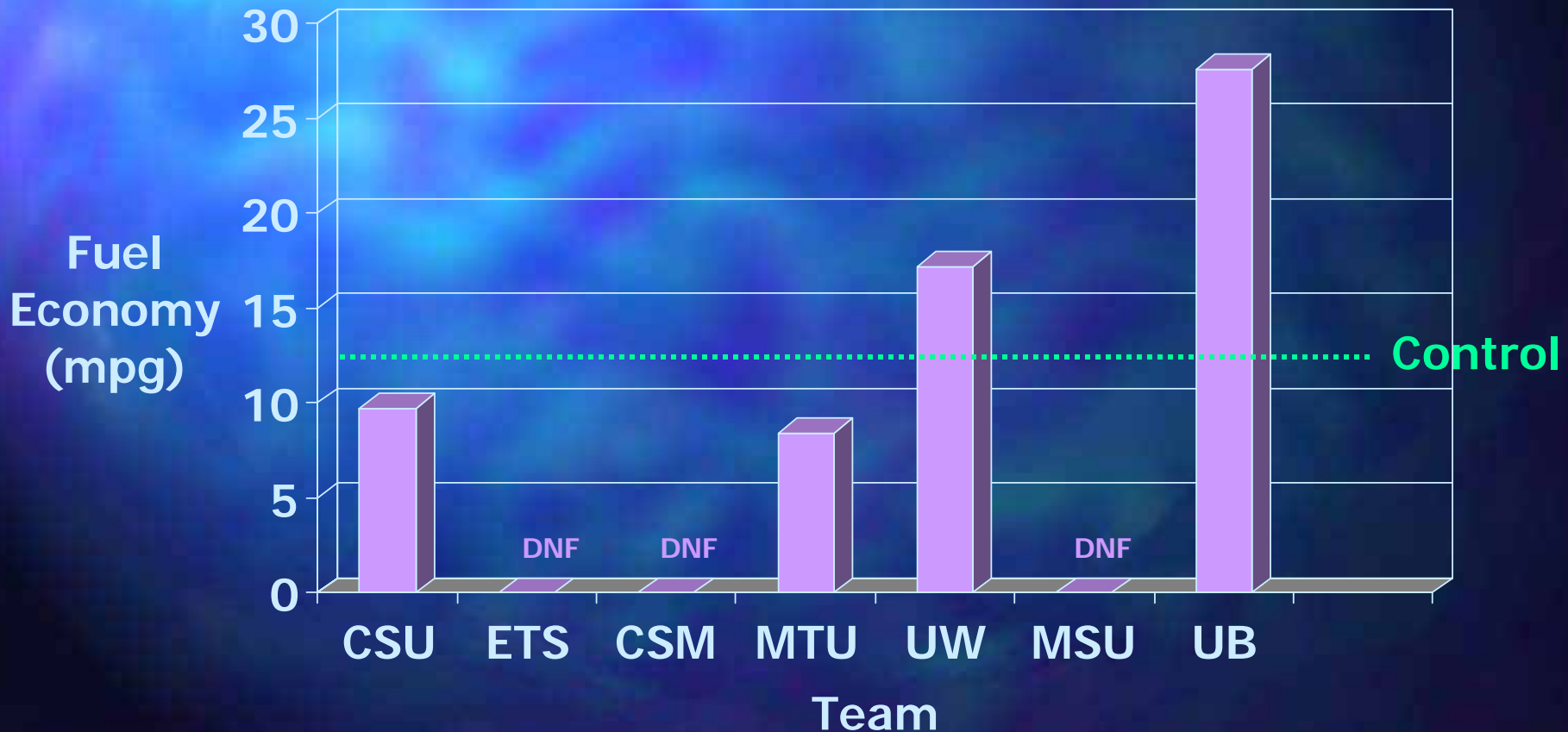
- ◆ Measured fuel economy during 45mph steady-state operation on groomed trail in Yellowstone National Park
- ◆ 100 mile range required





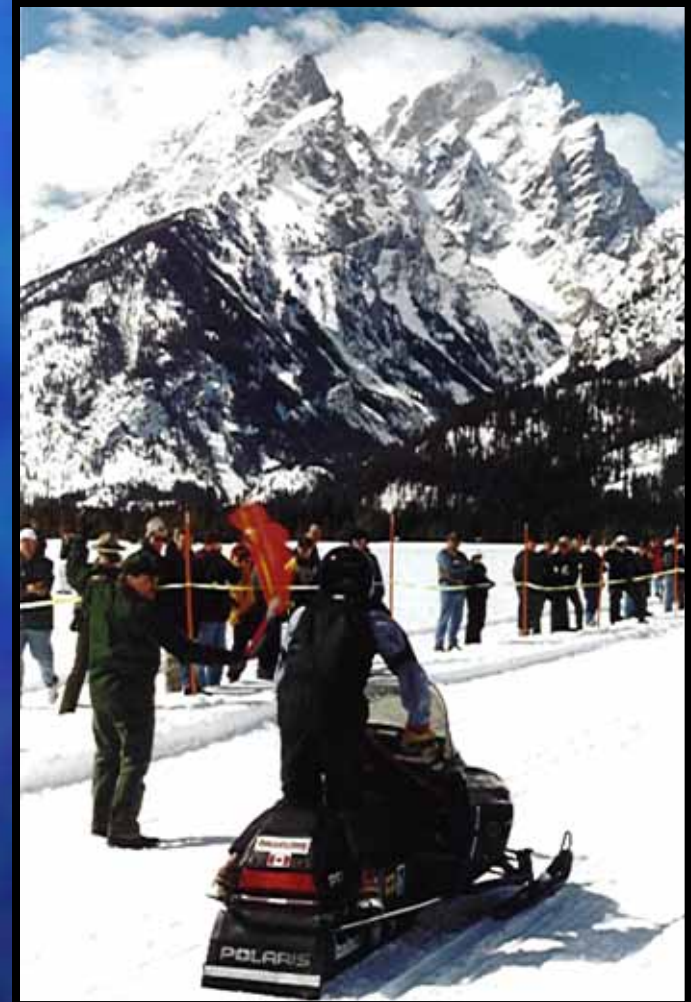
# Events - Fuel Economy/Range

## Fuel Economy/Range Test Results



# Events - Acceleration/Noise

- ◆ Two trials
- ◆ **ACCELERATION:**  
Best time to 500 feet
- ◆ **NOISE:**  
Maximum dBA,  
50 feet from road  
( $\leq 74$  dBA to pass)



# Events - Acceleration/Noise

## Acceleration/Noise Results

Team	Max Sound (dBA)	Best Acceleration (sec)
CSU	83.4	7.615
ETS	DNF	DNF
CSM	75.5	8.277
MTU	75.4	7.286
UW	78.3	7.241
MSU	73.0	8.594
UB	66.8	10.025
Control	75.0	7.841

# Events - Cold Start, Handling, Hill Climb

- ◆ **COLD START**  
-6°C, 1 min to start
- ◆ **HANDLING:**  
Subjective evaluation
- ◆ **HILL CLIMB:**  
Time to reach gate,  
World Championship



# Events - Cold Start, Handling, Hill Climb

## Cold Start/Handling/Hill Climb Results

Team	Cold Start	Handling Score (out of 50)	Hill Climb Score (out of 100)
CSU	Pass	50	DNF, 0
ETS	Fail	DNF, 0	DNF, 0
CSM	Pass	0	DNF, 0
MTU	Pass	DNF, 0	100
UW	Pass	32	DNF, 0
MSU	Fail	42	DNF, 0
UB	Pass	29	DNF, 0

# Events - Written, Oral, Display

- ◆ **WRITTEN DESIGN:**  
Technical paper on design modifications
- ◆ **ORAL PRESENTATION:**  
Public presentation on design modifications
- ◆ **STATIC DISPLAY:**  
Display at Hill Climb



# Events - Written, Oral, Display

## Written/Oral/Display Results

Team	Written (out of 100)	Oral Pres. (out of 100)	Static Display (out of 50)
CSU	81	64	42
ETS	72	59	28
CSM	67	61	29
MTU	45	44	30
UW	84	66	38
MSU	77	60	34
UB	63	74	41

# Summary of Winners

- ◆ University at Buffalo, State University of New York won:

1st Place

Best Emissions

Best Fuel Economy

Best Design

Quietest Snowmobile



- ◆ University of Waterloo won:

2nd Place & Best Performance

- ◆ Colorado State University won 3rd Place

# Conclusions

- ◆ Snowmobile noise and emission challenges can be met through technological advances
- ◆ **UB Four-stroke with catalyst:**
  - Reduced UHC >99.5%, CO 46%
  - Improved Fuel Economy to 27.6 mpg
  - Reduced Sound to 66 dBA @ 50ft
  - Decreased Performance
- ◆ **UW Lean-burn Two-stroke with catalyst:**
  - Reduced UHC 95%, CO 47%
  - Improved Fuel Economy to 17.2 mpg
  - Sound did not meet competition standards
  - Improved Performance

# Video Conclusion

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to the television screen.*



# SAE Clean Snowmobile Challenge 2000

*Acknowledgments*

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By:

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The logo features three grey gears of varying sizes on the left side. A red star with a red circle at its top point is positioned in the lower-left area, overlapping the gears and the text below. The text 'SAE' is in a large, bold, blue font, with 'INTERNATIONAL' in a smaller, blue, spaced-out font below it. To the right of 'SAE' is the tagline 'The Engineering Society For Advancing Mobility Land Sea Air and Space' in a smaller blue font, followed by a registered trademark symbol.

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## Clean Transportation Solutions

From



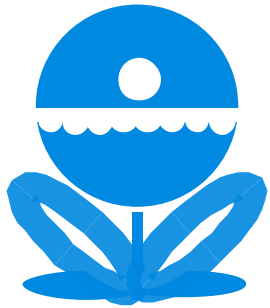
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State of Wyoming

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