

Autonomous Snowplow Competition



**ION North Star Section
Outreach Program**

Autonomous Snowplow Committee



**Competition Kickoff Meeting Presentation
2017 Competition**

4 October 2016

Meeting Agenda

- Welcome to the Seventh Annual Competition!
- Introductions
 - Autonomous Snowplow Competition Committee Members
 - 2017 Sponsors
 - 2017 Teams
- Venues
 - Saint Paul Winter Carnival
 - Student Final Presentations
 - Science Museum of Minnesota
 - Hosted by AIAA
- Rules and Operations
 - Snowfield
 - New Moving Obstacle
 - Preliminary Design Review Discussion
- Team Questions



Contact List

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Sponsorship

- Current Sponsors

- ION Satellite Division
- Lockheed Martin, Inc.
- ASTER Labs, Inc.
- Honeywell Inc.
- Orbital ATK Inc.
- UTC Aerospace Systems
- Space Exploration Technologies Corp.
- The Toro Company
- Deere and Company
- SICK, Inc.
- U.S. Bancorp
- Polaris Industries, Inc.
- Nuts & Volts and Servo Magazines
- Proto Labs, Inc.
- Achievement Rewards For College Scientist Foundation



UTC Aerospace Systems



JOHN DEERE



POLARIS
INDUSTRIES INC.



- Always looking for additional sponsors & funding!!



ION North Star Section Outreach Program

2016-2017 Competitors



<u>School Name</u>	<u>Team Name</u>
Case Western Reserve University	"OTTO X"
Case Western Reserve University	"The Robot Formerly Known as Snow Joke"
Dunwoody College of Technology	"Snow Devils 0111 ₂ " (Team 1)
Dunwoody College of Technology	"Snow Devils 0111 ₂ " (Team 2)

2016-2017 Competitors



**Michigan
Technological
University**



School Name

Team Name

Iowa State University

“Robotics Club
Snowplow”

Michigan Technological
University

“Longshot”

North Dakota State
University

“Lil Bison”

North Dakota State
University

“THUNDAR 3.0”

2016-2017 Competitors

<u>School Name</u>	<u>Team Name</u>
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University of Michigan
- Dearborn

“Z-3PO (Zenith 3.0)”

University of Michigan
- Dearborn

“Yeti 7.0”



University of
Minnesota

“GOFIRST –
Snow Squirrel”



University of
Saint Thomas

“Blizzard Byter”

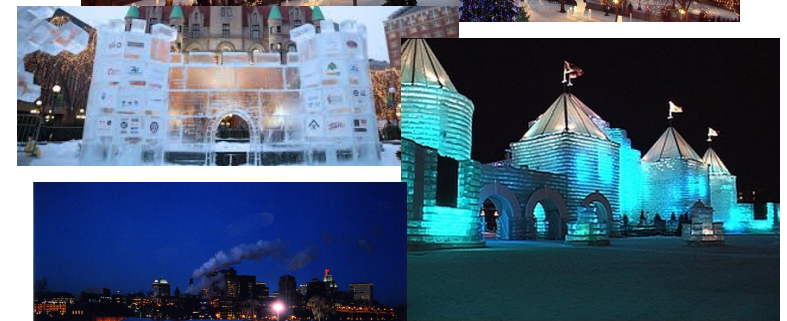


Wayne State
University

“Snow Wizard 1.0”

Competition Venue

- The Saint Paul Winter Carnival
 - Rice Park, Downtown Saint Paul
 - Gain lots of media attention
 - 350,000 visitors per year
 - 26-29 January 2017
 - 2017 is the 131st year anniversary of Carnival
 - Rosanne Bump
 - CEO & President, Saint Paul Festival and Heritage Foundation
 - Expect all Competition operations to remain the same and go smoothly
 - This is a great venue to have our Competition – very lively during the events
 - Enthusiastic, inquisitive crowds



Final Presentation Venue

- The Student Final Presentations will be held at:
 - Science Museum of Minnesota
 - 120 W. Kellogg Blvd.
Saint Paul, MN 55102



- Students are encouraged to visit the Science Museum as an attraction
 - Free wristbands for entrance prior to Student Presentations will be provided
 - Museum is very close (few blocks) to the Competition site

Competition Time Line

- Sep 2016 – Application Forms Due
(ION National office requests outstanding items to be provided soon)
- Oct 2016 – Kickoff Meeting
(Please ask questions!)
- Nov 2016 – Preliminary Design Review
(Saturday, 5 November 2016 planned date)
- Dec 2016 & Jan 2017 – Review status with teams
(Vehicle status, Trip planning, etc.)
- Jan 2017 – Seventh Year of Competition
Final Presentations, Vehicle Qualifications, &
Snowplow Competitions

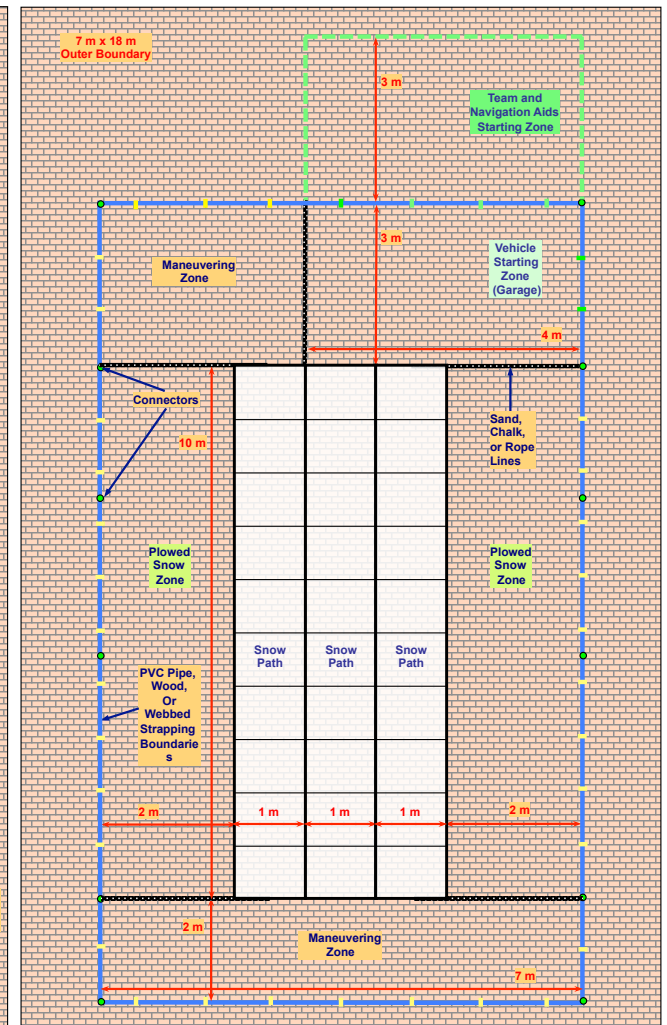
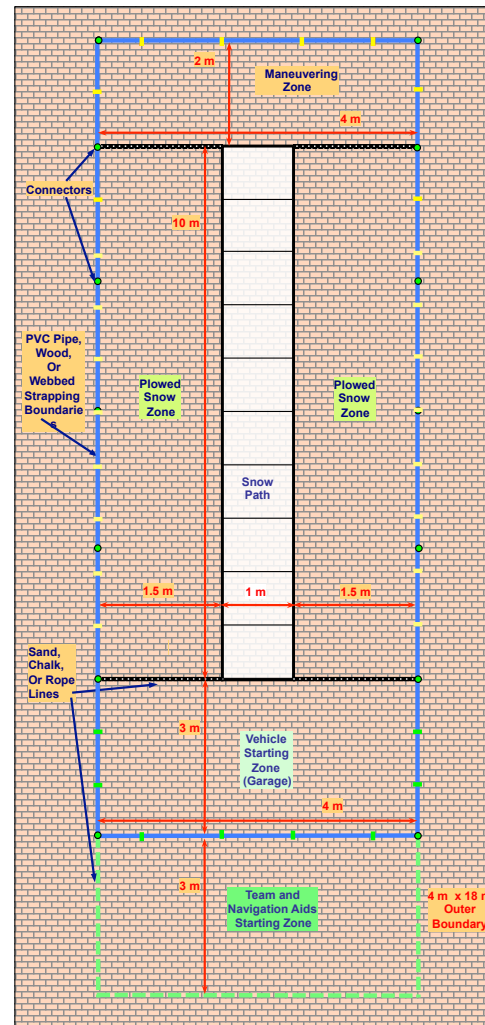


Competition Rules

- Rulebook is available to teams, and may be updated throughout competition
www.autosnowplow.com

- Challenging competition
 - Vehicle Garage
 - Team Starting Zone
 - Snow Path Depth: 5-15 cm
 - Post within Snow Path
 - Post next to Snow Path
 - Moving Obstacle

- Two competition snowfields
 - Single Straight “I”
 - 1-m width path
 - Triple Straight “I”
 - Three 1-m width paths



Competition Site

Downtown Saint Paul, MN

Landmark Center

Ice Rink

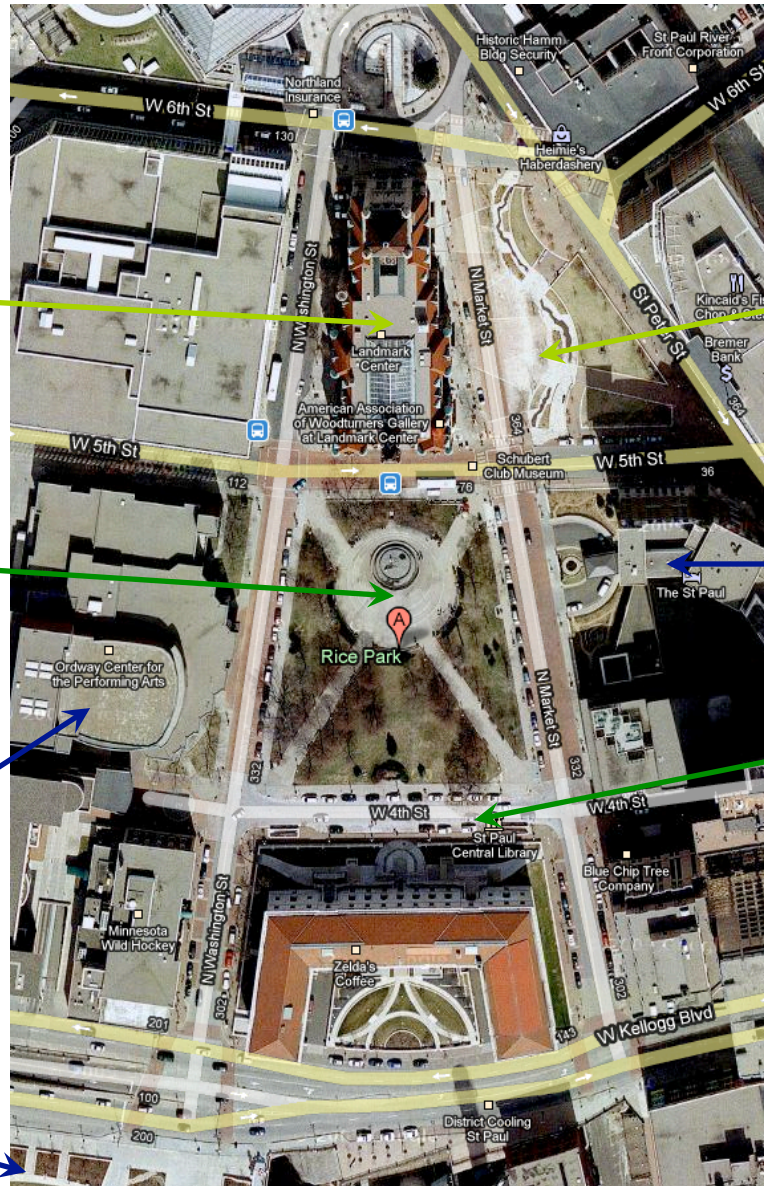
Rice Park

The Saint Paul Hotel

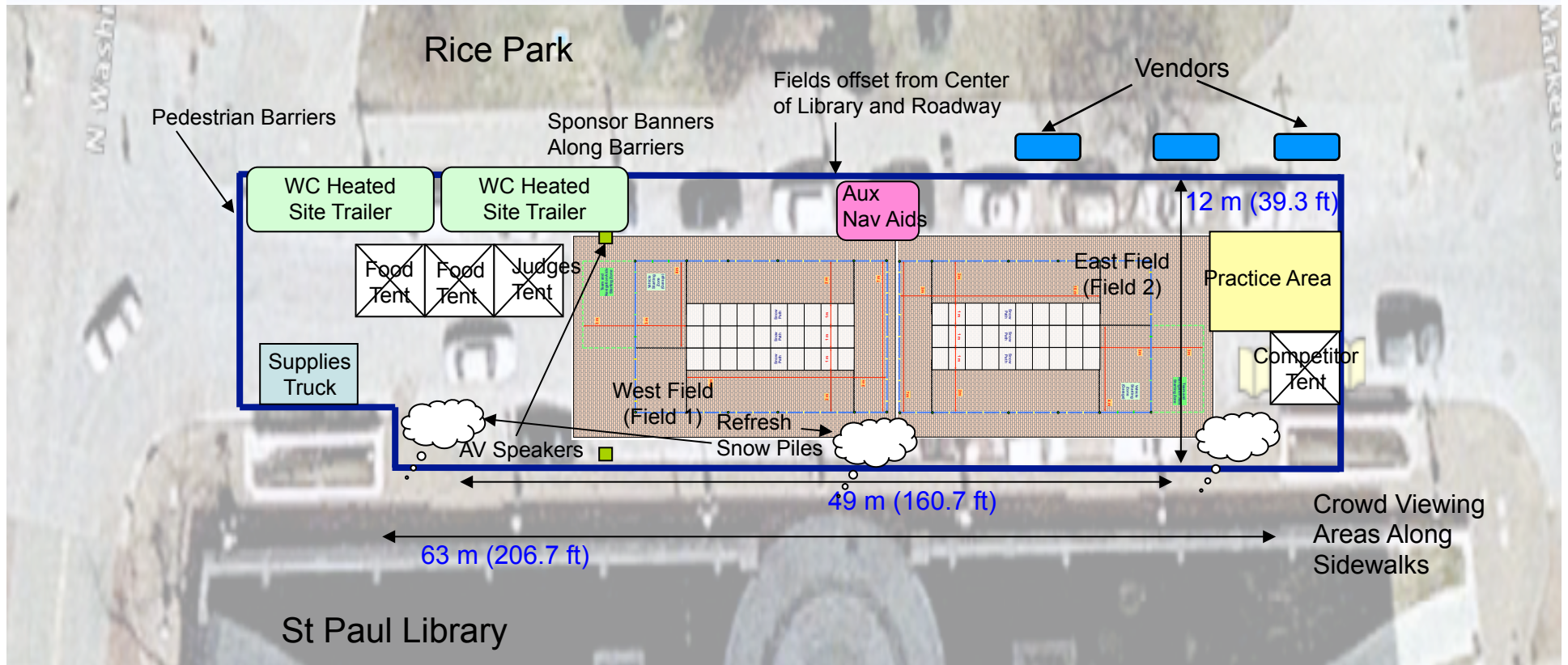
Ordway Center

W 4th Street

Science Museum



Competition Site: Layout



- Competition site: two snowfields set up directly on road, W 4th St, Saint Paul, MN
- Practice Area: available for all teams
- Snow Piles: for fresh set up of each snowfield
- Barriers installed to stop crowds from entering competition areas
- Viewers can stand and watch all along barriers and steps of Central Library
- Vendors positioned close to draw in viewers

Competition Procedures

- Competition Run and Set up Time
 - Single 20-minute run for each team
 - Teams may set up their navigation aiding sources systems as needed, but aiding source set up time is included as part of the 20-minute run
 - Secondary navigation aiding zone (e.g. DGPS stations) can be set up and be running prior to 20-minute run
- Variable Snow Depth
 - Snow depth can vary between 5 and 15 cm along the snow path for either snowfield
 - Snowplow vehicle may experience areas with deeper snow this year
- No After-Hours Operations within the Competition Area
 - Due to insurance and safety, as well as snowfield protection

Competition Scoring

Category	Scoring (%)
PDR Presentation	10
Final Presentation	15
Single "I"-Shaped Snow Path	25
<u>Triple "I"-Shaped Snow Path</u>	<u>50</u>
Total Competition Points	100



Competition Procedures

- Competition Zones
 - Vehicle Starting Zone (Garage)
 - Starting position for vehicle
 - Vehicle must return to Garage on own power at end of run
 - Lose points if no portion of vehicle enters Garage
 - Team and Navigation Aids Starting Zone
 - All team members must start within this Zone at beginning of run before placing any navigation aids
 - Maximum of 6 team members allowed for setting up navigation aids
 - Maneuvering Zones
 - Areas for maneuvering vehicle and snow
 - Plowed Snow Zones
 - Areas where all snow must be placed



Competition Procedures

- Fast Completion
 - Extra points for clearing snow from the snow paths in under 20 minutes
 - 50% of the Snow Path must be plowed to earn these bonus points
- No items can be dropped/expelled from vehicle in any direction
 - No sand, water, fire, etc.
 - Keeps snowfield road surface the same for all teams

Presentations for 2017

- **Preliminary Design Review**
 - Important to fully describe vehicle
 - Should address all recommended technical items in template provided
- **Final Presentations**
 - Judges would like to see new content each year
 - Please don't recycle last year's presentation, or Judges will deduct points up to 10% per their discretion
 - Teams will be asked to describe year-over-year changes and their biggest design challenges
- **ION GNSS+ Presentation**
 - First Place team is awarded a presentation slot at the ION GNSS+
 - September 2017
 - *A report and presentation are strongly encouraged for that event*

Planned Changes for 2017

- **Simulated Posts**

- Two POINTS Posts this year (similar to last year)
- Simulates a tree or parking meter near or on the snow path
 - A competition fixed “obstacle”
- One post randomly placed outside of Snow Path but within the snowfield boundaries
- One post randomly placed in a 1-m² square of snow path
- Points lost (**15%**) if vehicle hits, moves, or topples over either post
 - However, snow can “hit” post without losing points
 - Snow “void” surrounding post, so snowplow vehicle does not need to plow right against post

- **Parking In Garage**

- Vehicle must return to Garage (Vehicle Starting Zone) autonomously using its own power
- **20%** penalty if snowplow vehicle fails to park autonomously
 - Can not take advantage of “restart” declaration to park in garage at end of run

Planned Changes for 2017

- **Moving Obstacle**
 - A dynamic event during the competition this year!
 - Simulates a pet, person, car, etc. entering into the snow path
 - Obstacle will enter at a random location along snowfield but within the snowfield boundaries
 - Vehicle must come to a complete stop when obstacle enters Snow Path
 - It does not matter what orientation the snowplow vehicle is in when obstacle enters Snow Path – vehicle must stop
 - Points lost (10%) if snowplow vehicle does not stop or hits obstacle
 - Obstacle will exit snowfield after the snowplow vehicle comes to a complete stop
 - Or after obstacle is hit by snowplow vehicle
 - We are still working on details of the obstacles
 - Willing to accept inputs from teams (but Committee will make final decisions)

Fake Snow

- Issue of how to test the vehicles in labs
 - How to test year round and in warm climates?
- Solutions:
 - Ice Rink Snow
 - Fake Movie Snow
 - Fairly inexpensive and does not melt!
- Real snow used for Competition
- **PLEASE, PLEASE, PLEASE!!**
 - **TEST AS MUCH AS YOU CAN BEFORE THE EVENT**
 - **Wet, cold outside environment is not the same as your dry, warm lab!**



<http://www.stevespanglerscience.com/product/1262>



<http://www.amazon.com/Be-Amazing-Toys-4100-Blizzard/>

<http://www.discoverthis.com/super-snow.html>



PDR Presentation

- PDR presentation day: 5 November 2016 (Saturday)
 - Presentation medium: conference call & screen sharing
- PDR presentation slides held in confidence throughout the competition
 - Recommend these to be as complete and professional as possible, as all team materials may be eventually made public
- PDR presentation slides submission deadline: Final Version
 - 9:00 PM (Central); 3 November 2016 (Thursday)
 - Email submission to Vibhor and Suneel:
vibhor.bageshwar@honeywell.com & sheikh@asterlabs.com
 - Please submit a PDF version of the presentation to minimize file size
 - CD submission (not necessary if you email the presentation slides)

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ION North Star Section Outreach Program

Team Questions

- Any Questions?
- General Discussion



2016 Institute of Navigation Autonomous Snowplow Competition

Backup Slides



Introduction

- Goal: Design an Engineering-based Outreach student competition
 - Specific to Guidance, Navigation, and Control (GNC) technology
- Modeled after ION Robotic Lawn Mower Competition
 - Complementary competitions
 - Similar vehicles, sensors, and goals
 - Different seasons
- Take a *winter-approach* to the competition
 - Choose snow-blowing/snow-plowing, instead of lawn-mowing,
 - Winter is a potentially a tougher scenario
 - Less fixed visual cues
 - Covered with snow (pure white)
 - Blowing snow (visibility poor)
 - Changing visual cues
 - Snow drifts change from day to day
 - Harsher environment
 - Cold effects sensors performance
 - Reduced lighting
 - Control challenges
 - Must redirect new snow away from old high snow drifts



Motivation

- Public Outreach
 - Significant publicity and visibility of ION and its members to a new area
 - Promote ION's talents and capabilities to large public audience
- Technology Potential
 - Minnesota Department Of Transportation: Snowplow safety systems
 - Minneapolis Airport Commission and FAA: Automated runway clearing
 - University of Minnesota: Driver-assisted bus and Alaskan highway snowplows
- Encourage growth within ION North Star Section
 - Competition provides a large, local project to which members can immediately contribute towards
- Large public venue
 - St. Paul Winter Carnival (January in MN ... refreshing!)
- Encourage participation in all three ION competitions
 - Mini-Urban Challenge : High School-Level students
 - Robotic Lawn Mower : Spring Event, College-Level students
 - Autonomous Snowplow : Winter Event, College-Level students + public
- Encourage industry sponsorship
 - Mentorship and Judging competition opportunities
 - Meet competent, highly-motivated potential employees

Plowing versus Blowing

- **Snow Plow**

- Move snow from one area to another along the ground



Hand Plow



Wheeled Plows



Yuki-Taro Autonomous Snow Plow Robot



RC Plow

- **Snow Blow**

- Eject snow from one area to another through air



Hand-Wheeled Blowers



Heavy Wheeled Blowers