

Autonomous Snowplow Competition



**ION North Star Section
Outreach Program**

Autonomous Snowplow Committee



**Competition Meeting Presentation
2019 Competition**

7 December 2018

Meeting Agenda

- Overview of Ninth Annual Competition
 - North Star Committee
 - Sponsors
 - Competitors
- Venue
 - Sidewalk Labs Facility
 - Toronto Canada
- Vehicle Status Meeting
- Reception and Poster Session
- Competition Overview
- AUVSI Conference
 - May 2019 in Chicago
- Team Questions

Contact List

Committee Contacts

Suneel I. Sheikh, Ph.D.

CEO & Chief Research Scientist
ASTER Labs, Inc.
651-484-2084, sheikh@asterlabs.com

Wayne Soehren

Manager Senior Technology
Honeywell, Inc.
763-954-6771, wayne.soehren@honeywell.com

Kristen Gerzina

Aero/Mechanical Design & Analysis Engineer
Orbital ATK
763-744-5553, kristen.gerzina@atk.com

Mike Ward

Co-Owner
Stray Robotics
708-606-4066, mward@strayrobotics.com

Richard Caylor

Honeywell, Inc.
651-428-7492, richard.caylor@honeywell.com

Linda Gutzkow

Business Associate
ASTER Labs, Inc.
651-484-2084, linda.gutzkow@asterlabs.com

Andrew Carlson

Past Twin Cities AIAA President
763-218-4854, andrew.carlson57@yahoo.com

Isaac Allen

Research Scientist
Aster Labs, Inc.
651-484-2084, isaac.allen@asterlabs.com

Jonah Roux

Research Scientist
ASTER Labs, Inc.
651-484-2084, jonah.roux@asterlabs.com

Kristen Sheikh

Achievement Rewards for College Scientists
ARCS
651-484-2086, kristen@bruitdelamode.com

Hamid Mokhtarzadeh

Founder
Organic Navigation
hamid@organicnavigation.com

David Frenkel

Past Twin Cities AIAA President
VSI Labs
612-237-1966, david@frenkel.co

Sara Sargent

VSI Labs
sara@vsi-labs.com

Alexander Fernandez

Former Competitor
alexander.u.fernandez@gmail.com

Karilena Heikkila-Black

Business Intern
ASTER Labs, Inc.
651-484-2084, karilena-heikkila-black@asterlabs.com

Jack Riedel

riedejh@msn.com

Teri Riedel

Business Associate
Caterpillar
riedel_teri_a@cat.com

ION National Office Contacts

John Raquet, Ph.D.

President, The Institute of Navigation
937-304-7299, john.raquet@afit.edu

Frank van Diggelen, Ph.D.

Satellite Division Chair, The Institute of Navigation

Lisa Beaty

Executive Director, The Institute of Navigation
703-366-2723, lbeaty@ion.org

Sponsorship



Sponsorship

- **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
 - Oshkosh Corporation
 - Left Hand Robotics
 - ANSYS
 - Polaris Industries, Inc.
 - Douglas Dynamics & Western Snowplows
 - Nuts & Volts and Servo Magazines
 - Achievement Rewards For College Scientist Foundation
 - Proto Labs, Inc.
 - Hitching Post Motorsports
- This group has been very generous to the Competition and excellent people to work with
- Please notify them when you meet any of their representatives that we all greatly appreciate their contributions
- Always looking for additional sponsors and funding!!
 - Please let us know if you have any groups we should contact

2019 Competitors



<u>Institution Name</u>	<u>Team Name</u>
Case Western Reserve University	“OTTO XL”
Case Western Reserve University	“Snö Jök”
Dunwoody College of Technology	“Snow Devils 1001 ₂ ”
Dunwoody College of Technology	“Wendigo 2019”

2019 Competitors



<u>Institution Name</u>	<u>Team Name</u>
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Iowa State University
Robotics Club

“Cyplov”

North Dakota State
University

“THUNDAR”

University of Michigan
- Dearborn

“Yeti IX”

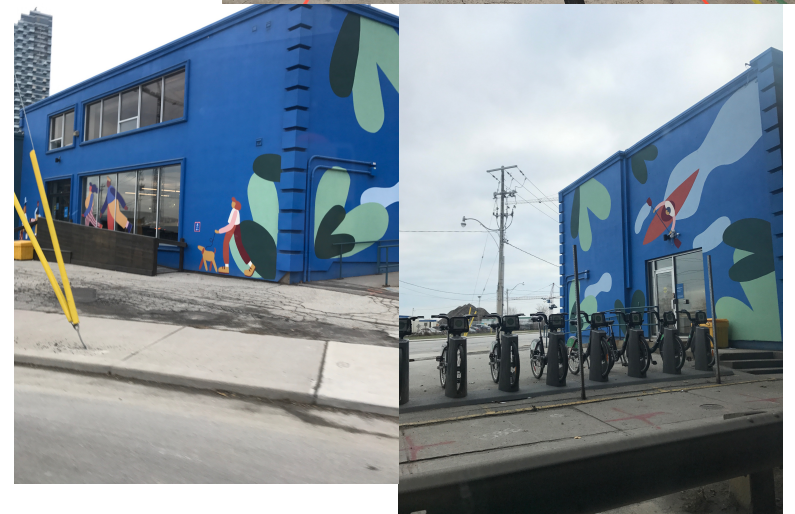
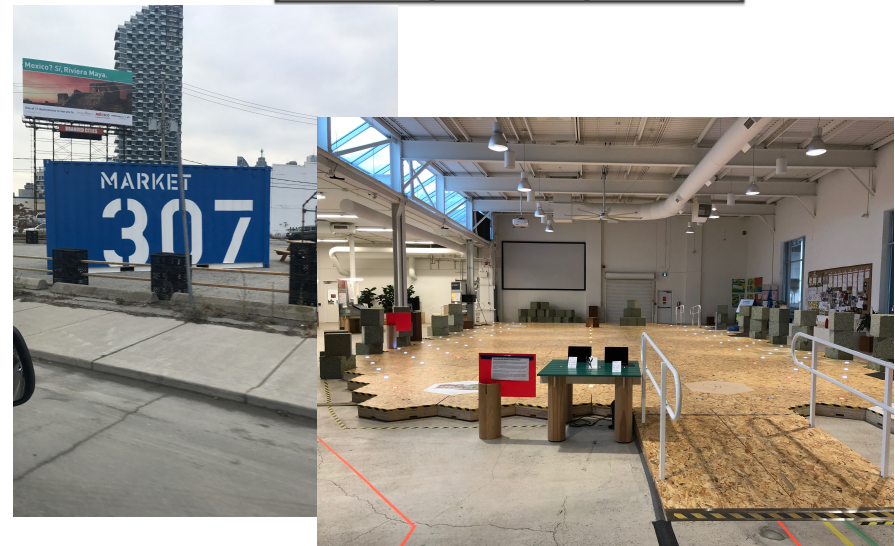
University of
Minnesota

“Snow Squirrel”

Competition Venue

- Sidewalk Labs
 - Toronto, Canada
 - 307 Lake Shore Blvd East
 - 24-26 January 2019
 - Our Contacts For Event:
 - Jeff Tarr
 - Principle Engineer, NY Office
 - Taylor K. (TK) Gesner
 - Associate Director, Toronto
 - Jen Neilands
 - Events, Toronto
 - Exciting new venue for our Competition

SIDE WALK LABS



Competition Venue



Hotels In Toronto

- **Holiday Inn Express**

111 Lombard Street

416-367-5555

- **The Westin Harbour**

1 Harbour Square

416-869-1600

- **Hotel Novotel**

45 The Esplanade

416-367-8900

- **Chelsea Hotel**

33 Gerrard Street West

416-595-1975



In process of getting group rate pricing. When we get all the information, we will block a group of rooms and notify teams

Competition Venue

- Sidewalk Labs
 - Parking
 - Large surface lot at 333 Lake Shore Blvd E, Toronto
 - Across the street from Sidewalk Labs
 - Smaller surface lot at on Small Street
 - Also across the street, but in other direction
 - **No planned security**
 - Public Transportation
 - Buses
 - Light-rail Transit
 - Traffic in Toronto is **VERY** challenging in the downtown area
 - Please plan to drive as little as possible
 - Food
 - Thursday Reception: Dessert
 - Friday Set Up: Snacks
 - Saturday Competition: Lunch and Snacks

Competition Site

Toronto, Canada

Lake Shore Blvd & Gardiner Expressway

Sidewalk Labs Building

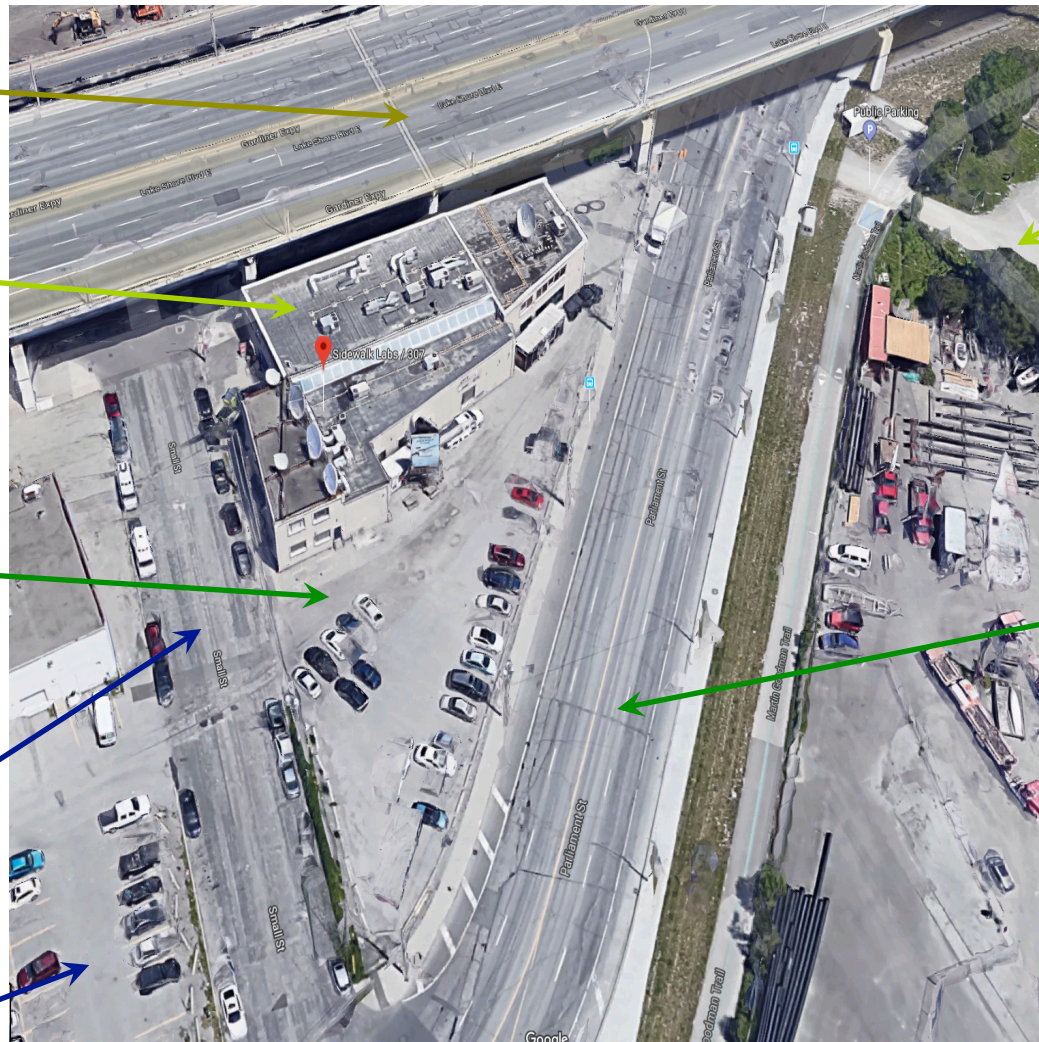
Competition Site

Small Street
(Secondary Site)

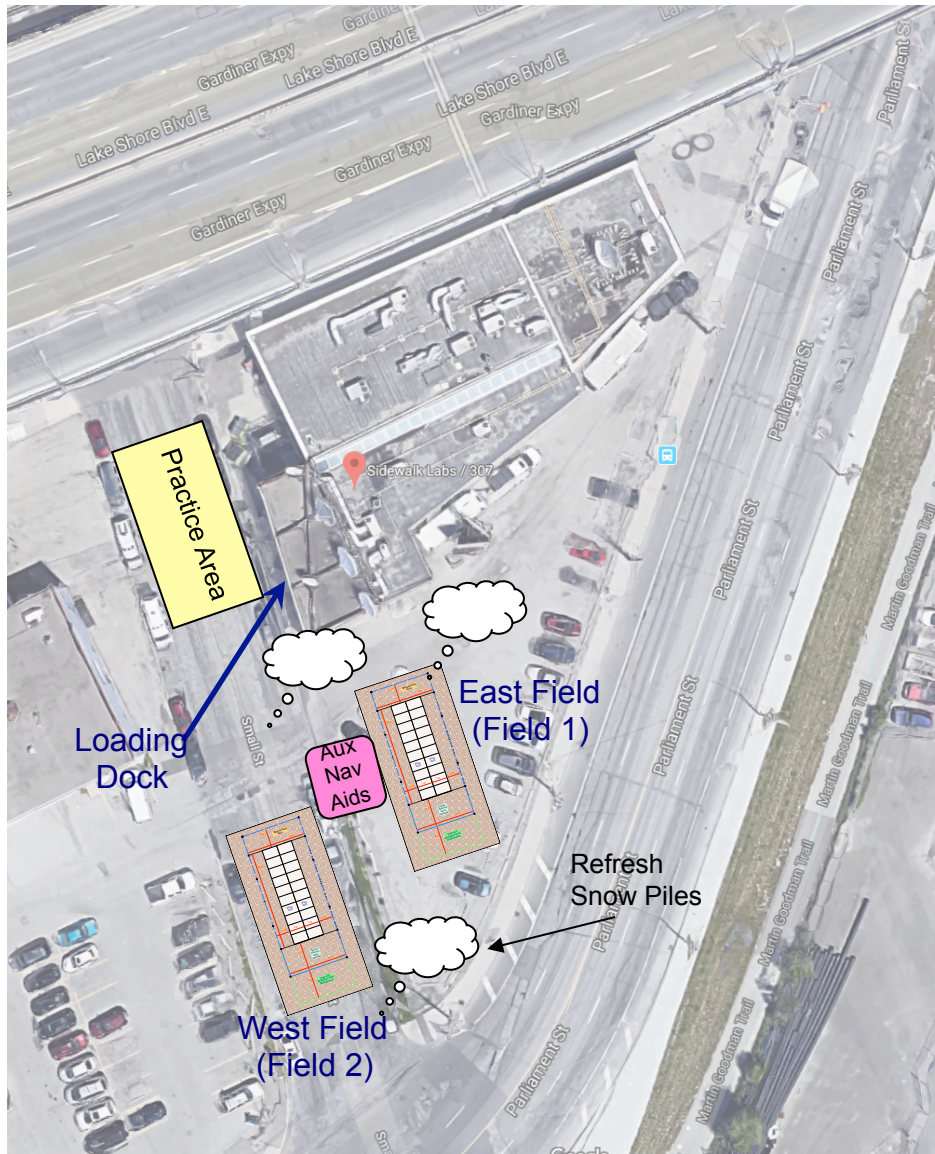
Day Parking

Large Surface
Lot For Parking
Trailers

Parliament Street



Competition Site: Layout



- Competition site: two snowfields set up directly on Sidewalk parking lot (primary) and Small Street (secondary)
- Practice Area: available for all teams
 - On Small Street
- Snow Piles
 - Fresh set up of each snowfield
- Barriers installed to stop crowds from entering competition areas

Competition Site: Sidewalk Labs



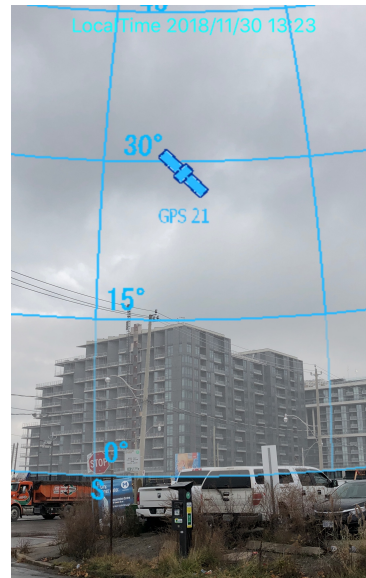
- Competition site: larger driveway and parking lot outside Sidewalk Labs offices
- Currently is asphalt, but will be replaced using special pavers soon
- Long enough for two Single 'I' Fields put end to end
- **Primary site for competition and Collaborative Operational Challenge**

Sky Visibility

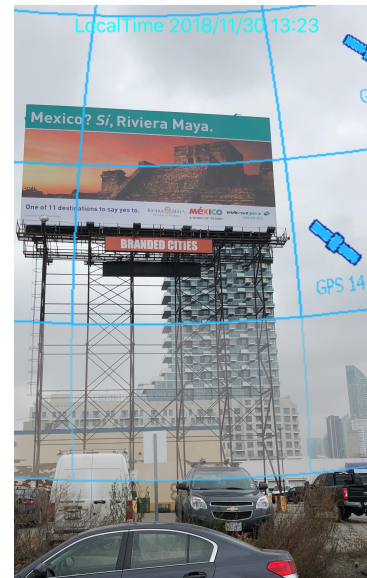
- Tested GNSS Satellite Visibility
 - Fairly good visibility above 15° mask angle
 - Obstructions:
 - Large billboard to West (but narrow in field-of view)
 - Gardiner Expressway overpass (but will be far from competition field)



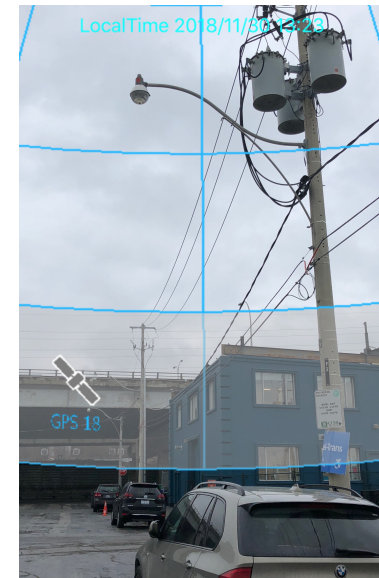
South



Southwest



West



North

Competition Site: Paver Surface



- Competition site: Hexagonal pavers being set into current asphalt driveway
- 1-m in shape
- Some pavers have lights
- Some pavers are porous concrete
- Some pavers are heated
- It is the competition's task to use these and provide feedback for Sidewalk Labs on durability and ease of use

Competition Site: Small Street



- Competition site: Small Street is next to Sidewalk Labs, Toronto
- Working with City of Toronto to close off the street on Saturday for competition use
- We will continue to plan as if we have this street for use
 - But there is a chance we will only have Sidewalk property for use

Competition Time Line

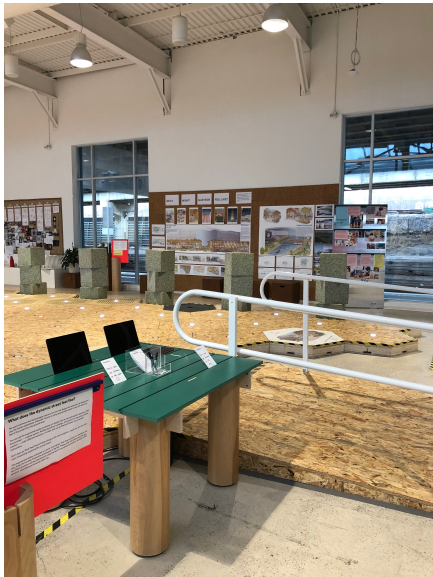
- Sep 2018 – Application Forms Due
(ION National office requests outstanding items to be provided soon)
- Nov 2018 – Kickoff Meeting
(Please ask questions!)
- Dec 2018 & Jan 2019 – Review status with teams
(Vehicle status, Trip planning, etc.)
- Jan 2019 – Ninth Year of Competition
Poster Presentations, Vehicle Qualifications, &
Snowplow Competitions

Presentations for 2019

- **Vehicle Status Review**
 - Important to fully describe vehicle to update Judges on vehicle current state
 - Is not a scored event, but will ask to confirm safety and operations
- **Poster Session - Reception**
 - Public presentations
 - Stand by your posters and answer questions
 - Energy comparison
 - Your vehicle power usage versus heating required to melt snow on pavers
- **AUVSI Presentation**
 - Opportunity for presentations in 2019
 - May, Chicago

Presentations for 2019

- Poster Session – Reception
 - At Sidewalk Labs
 - Thursday Evening
 - 24 January 2019, 7-9 pm
 - Open to the public

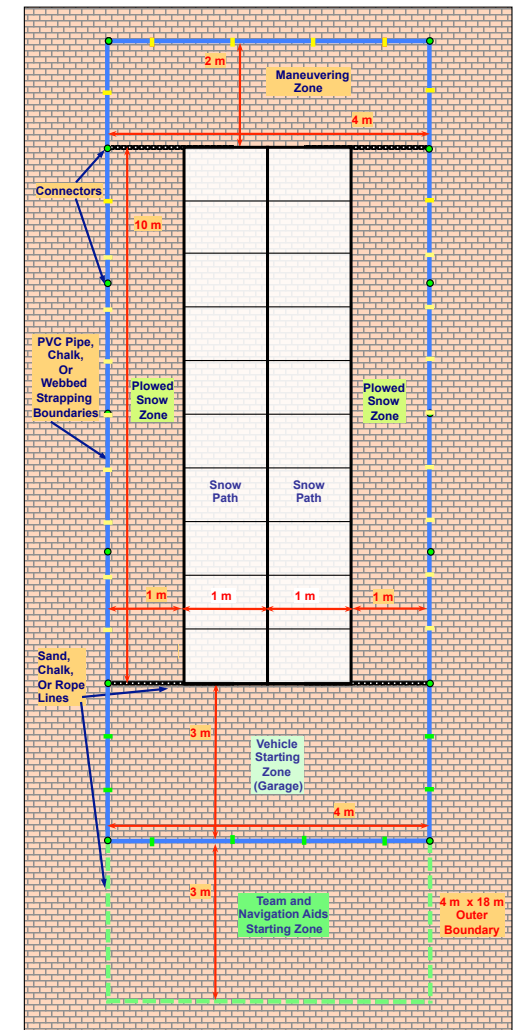
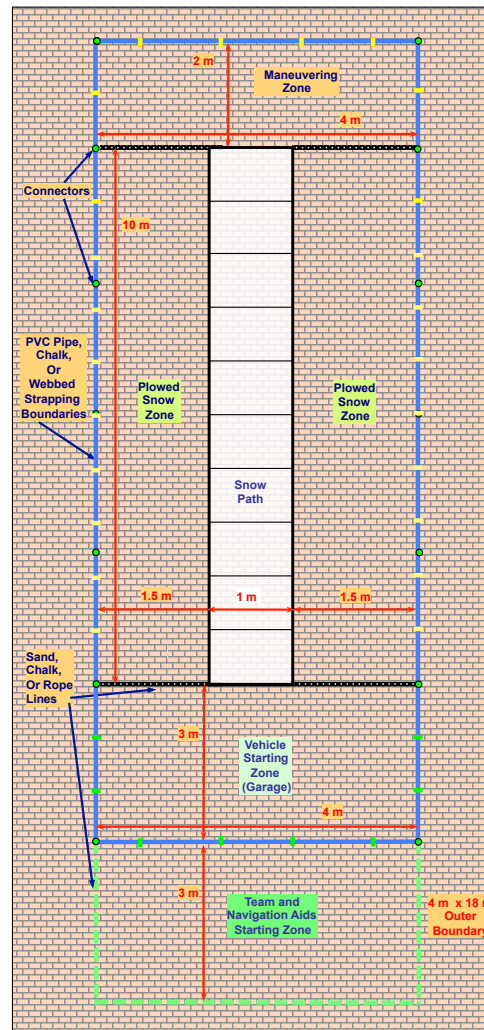


Competition Rules

- Rulebook will be available soon to teams, and may be updated throughout competition

www.autosnowplow.com

- Challenging competition
 - Vehicle Garage
 - Team Starting Zone
 - Snow Path Depth: 5-15 cm
- Two competition snowfields
 - Single Straight "I"
 - One 1-m width path
 - Double Straight "I"
 - Two 1-m width paths



Tournament Competition

- Tournament Style Event
 - Change this year to have a *timed* event
 - Fastest team wins between two-team head-to-head bracket event
 - Multiple rounds until final winner is determined
 - All teams get at least one event run for each tournament
 - If time during day, we may be able to consolation bracket
 - However, must have 50% snow cleared from path to qualify you time
 - And time points may be penalized for less than 100% cleared
 - Potential to have head-to-head simultaneous competition runs
 - Two teams compete at once
- Two Tournaments
 - Single 'I' Field
 - Saturday morning event
 - Double 'I' Field
 - Saturday afternoon event

Competition Procedures

- Competition Run and Set up Time
 - Single maximum 20-minute run for each team
 - Teams may set up their navigation aiding sources systems as needed, prior to the 20-minute run
 - Secondary navigation aiding zone (e.g. DGPS stations) can also 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 of less consistent snow
- No After-Hours Operations within the Competition Area
 - Due to insurance and safety, as well as snowfield protection

Competition Procedures

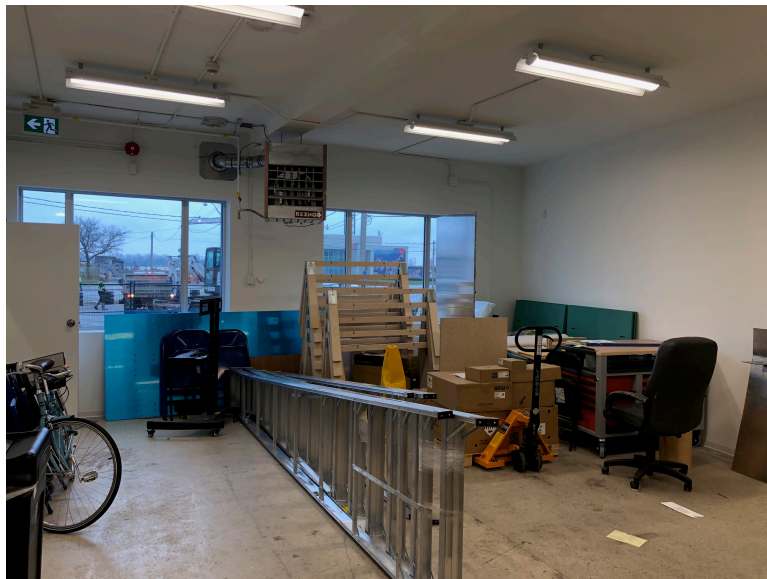
- Competition Zones
 - Vehicle Starting Zone (Garage)
 - Starting position for vehicle
 - Vehicle must return to Garage on own power at end of run
 - Lose points if no portion of vehicle enters Garage
 - Team and Navigation Aids Starting Zone
 - All team members must stay within this Zone
 - Except for team member with E-stop button, who may travel with Safety Officer
 - Maneuvering Zones
 - Areas for maneuvering vehicle and snow
 - Plowed Snow Zones
 - Areas where all snow must be placed
- 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

Competition Components

- **Parking In Garage**
 - Vehicle must return to Garage (Vehicle Starting Zone) autonomously using its own power
 - **20%** time penalty if snowplow vehicle fails to park autonomously
 - Can not take advantage of “restart” declaration to park in garage at end of run
- **Simulated Posts**
 - Two Posts may again be positioned around field
 - These should be avoided
 - However, no points lost or gained if posts are struck
- **Moving Obstacle**
 - No moving obstacle planned for this year’s event

Competition Pit Area

- Tool Room Inside Sidewalk Labs
 - Warm this year!
 - Digital electricity for power!
- Loading Dock



Competition Loading Dock

- Loading Dock
 - 30" dock height
 - **Need ramps!!**



Collaborative Operational Challenge

- **Demonstration Event**
 - This demonstration would show the spectators and public the operation of two vehicles functioning in tandem on same course
 - Likely an “S”-shaped course for each vehicle
 - Square shaped “S” using 1-m squares
 - Backwards “Z” shaped using 1-m squares
 - We are still working on details of the Challenge
 - Willing to accept inputs from teams
- **Not A Competition**
 - A demonstration only
 - To be held over the lunch hour during Saturday
 - Would like to have at least two runs of this operation
 - CWRU
 - OTTO and Sno Jok
 - Dunwoody College of Technology
 - Snow Devils and Wendigo
 - Others?

Team Questions

- Any Questions?
- General Discussion



2018 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

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>

