UND Robotic Mining Competition Team

Presented by: Michael Parsons, Isaiah Klingfus, and Katy Hahn

UNIVERSITY OF NORTH DAKOTA
LEADERS IN ACTION

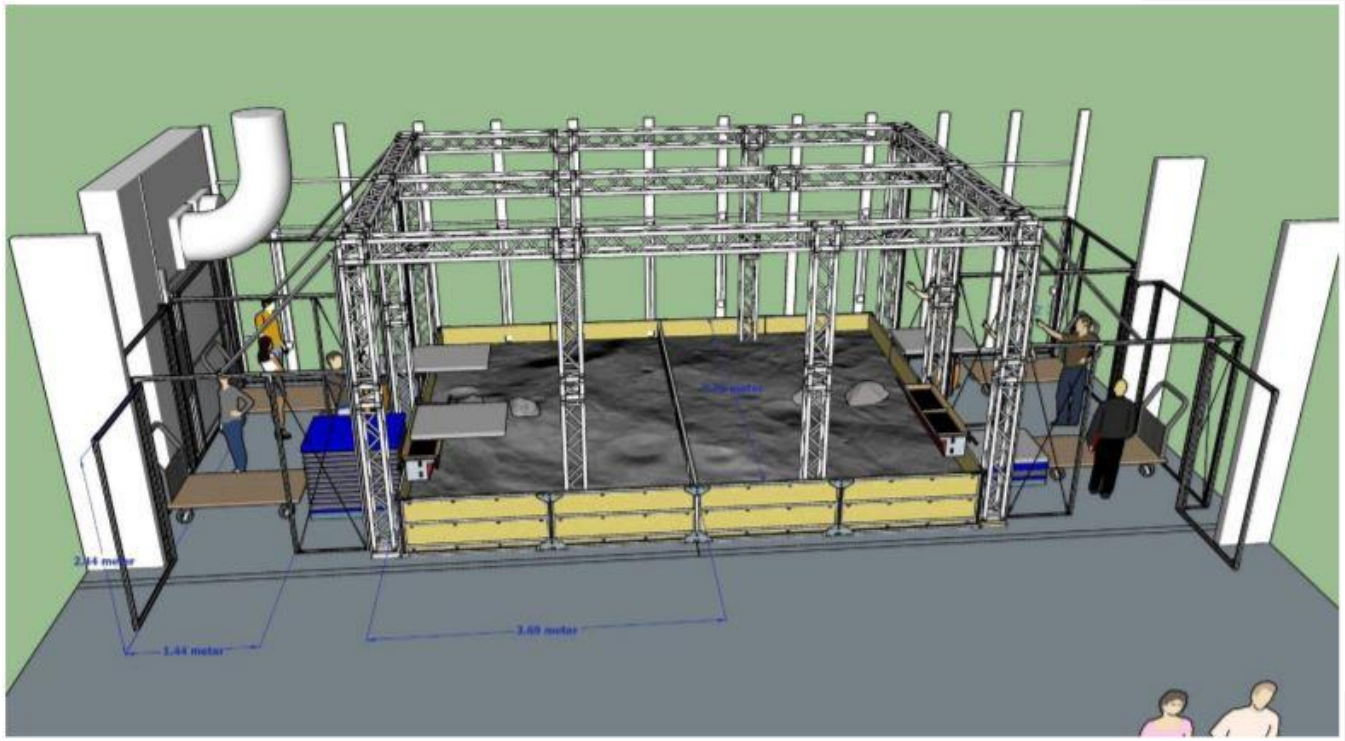
Presentation Overview

- NASA Robotic Mining Competition
  - Competition Scoring
  - Estimated Score
- Outreach
- Final Robot Design
- Project Goals
- Acknowledgments

UND UNIVERSITY OF NORTH DAKOTA

NASA Robotic Mining Competition

- Competition Purpose:
  - Design and Build a robot capable of traveling on Mars' Surface
  - Robot must be able to excavate and deposit icy regolith (gravel) to simulate a resource mining operation on Mars



UND UNIVERSITY OF NORTH DAKOTA

Competition Scoring

Mining Category	Points Available	Units	2018 Score	2019 Estimated Score
Pass Inspection	0 or 1000	Pass or Fail	1000	1000
Icy Regolith	+15/kg	kg	4	10
Average Bandwidth	-1/50 kb/sec	kbps/sec	21	20
Camera Bandwidth usage	200 kb/camera	kbps/camera	2	2
Robot Mass	-8/kg	kg	52.45	45
Reported Energy Consumption	-1/watt-hour	watt-hour	27.2	40
Dust Tolerance	0 to +100	Judge Decision	30	50
Autonomy	50, 150, 250, or 500	Judge Decision	0	500

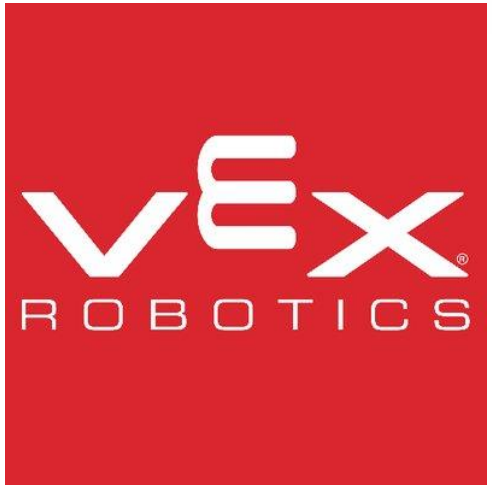
2018 Total Score: 654

2019 Total Score: 1300

UND UNIVERSITY OF NORTH DAKOTA

Outreach

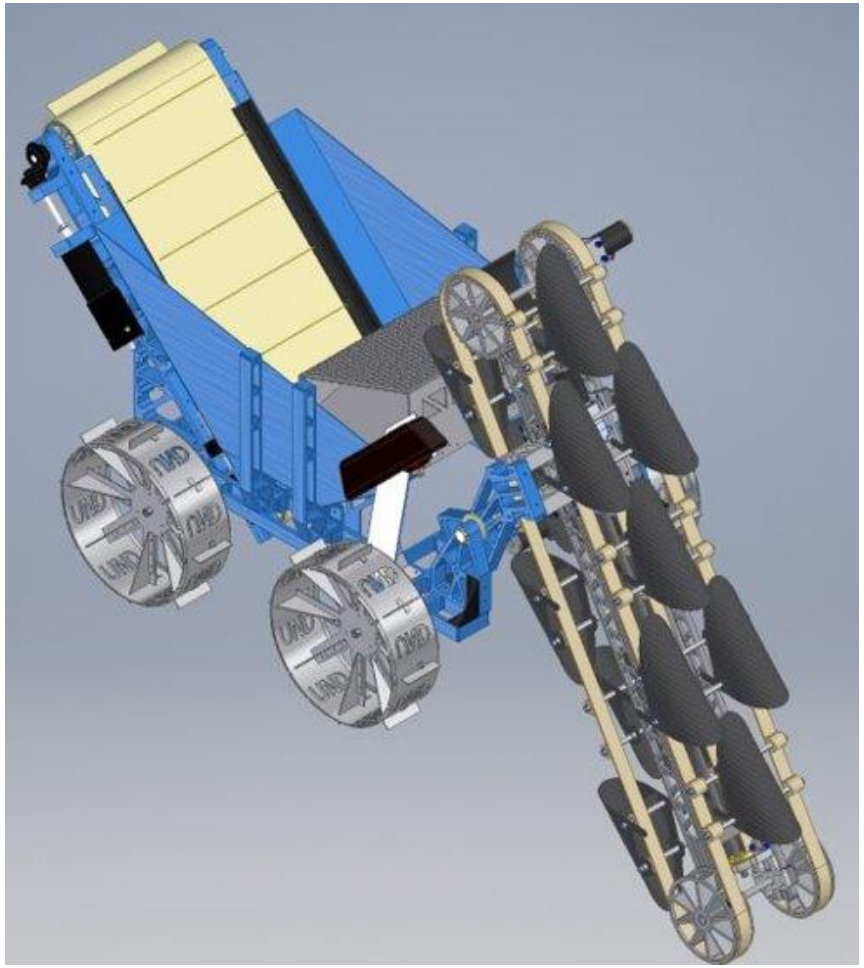
- Outreach Events:
  - High school Job Fair (Alerus Center)
    - CEM representation
  - Vex Robotics Highschool Competition
  - Thompson School presentation
  - Aerospace Day
  - FIRST Lego League Competition
  - CEM tours throughout the year

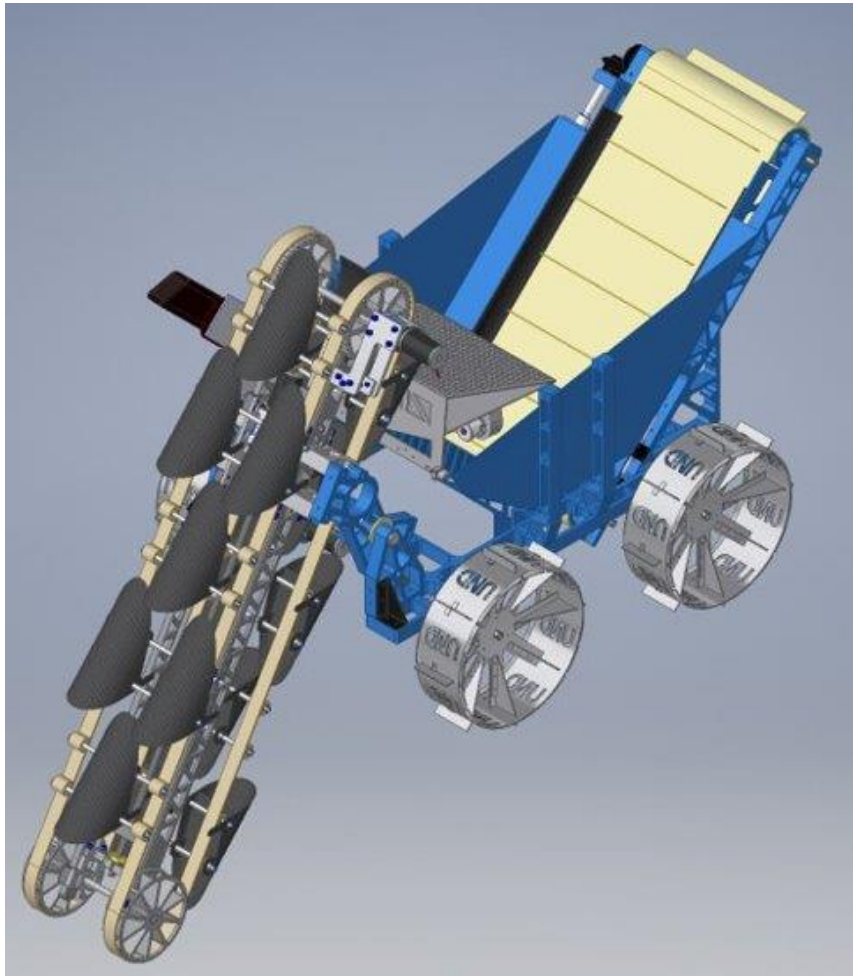


UND UNIVERSITY OF NORTH DAKOTA

UNIVERSITY OF NORTH DAKOTA

Final Robot Design

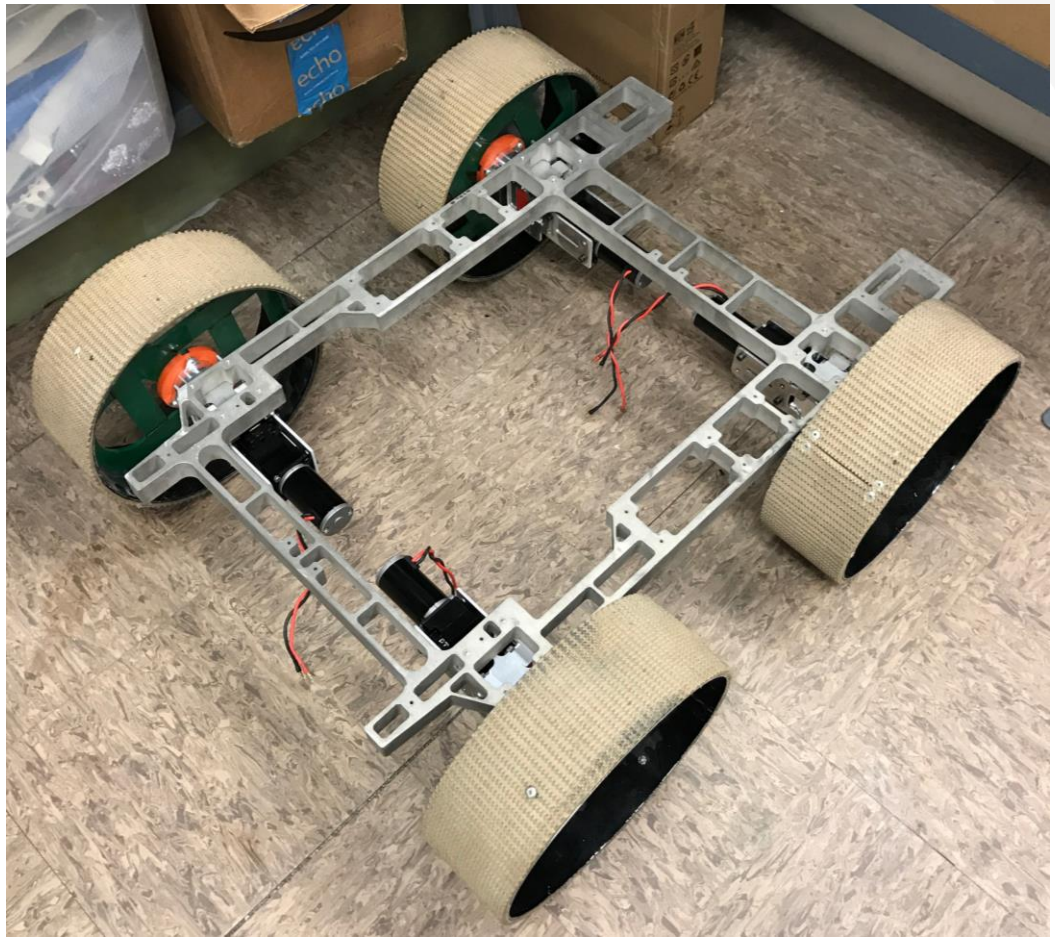




UND UNIVERSITY OF NORTH DAKOTA

Project Goals

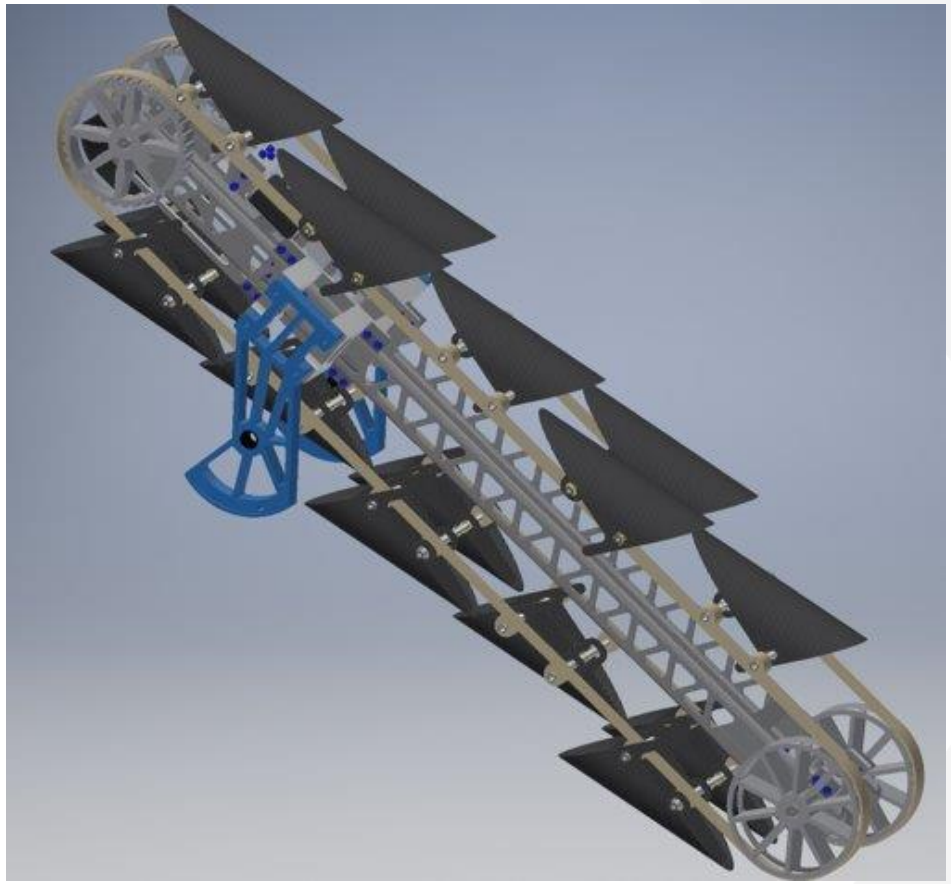
- Mining system redesign
- Active material separation
- Drive system redesign
  - Wheel redesign
- Electrical system redesign
- Full autonomy



UNIVERSITY OF NORTH DAKOTA

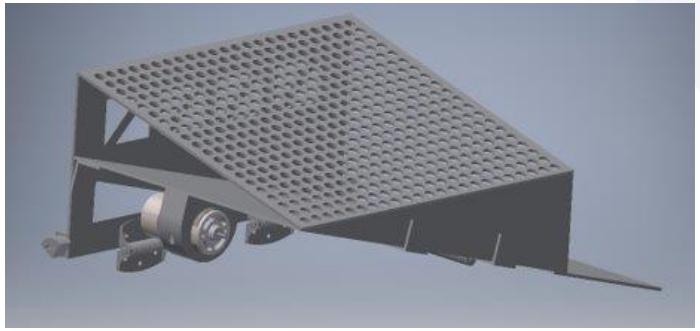
Mining System

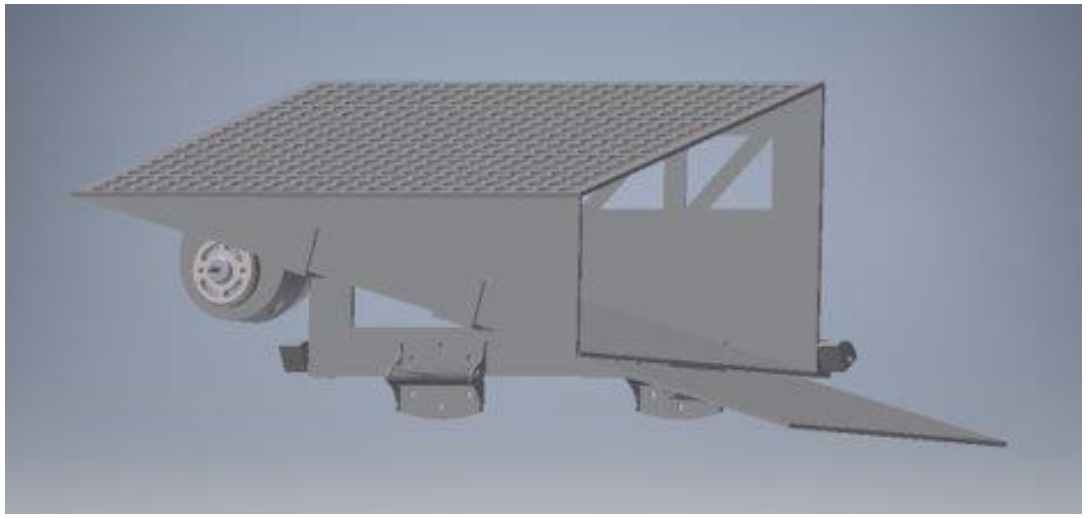
- Reverse mining direction
- New Scoop design
  - Lowers forces
  - Increases mining speed
- Screw Deployment
- Weight:
  - New: 12.247 Kg, Old: 15.875 Kg

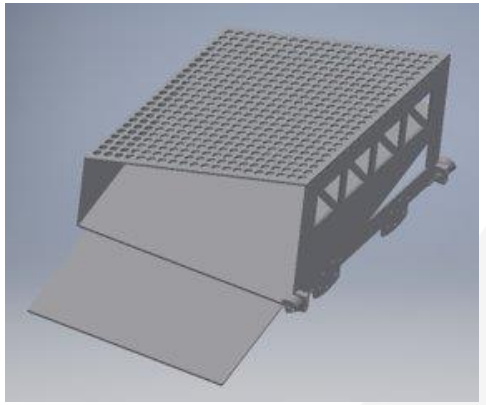


Active Material Separation

- Located between mining system and hopper conveyor
- Using an Eccentric Rotating Mass (ERM)



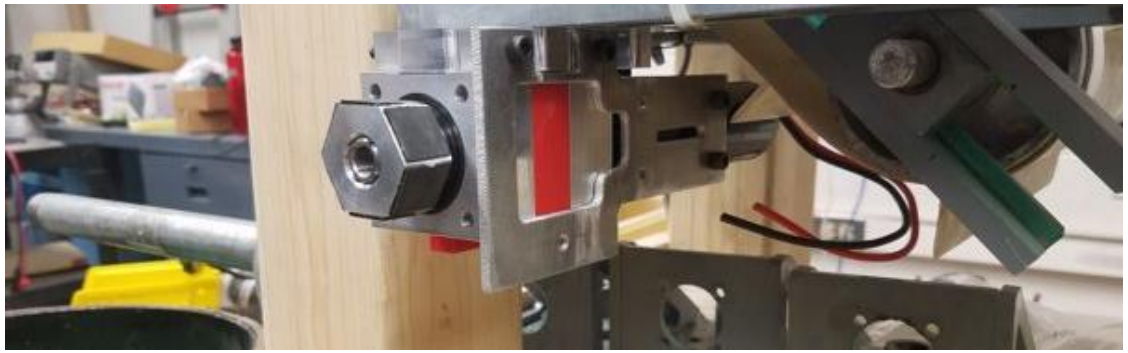




UNIVERSITY OF NORTH DAKOTA

Drive System – Motors

- Vex Bag motors + encoder & gearbox
  - Weight:
    - New: 0.77 Kg/motor
    - Old: 1.62 Kg/motor
  - Cost:
    - New: $170/configuration
    - Old: $655/configuration



UNIVERSITY OF NORTH DAKOTA

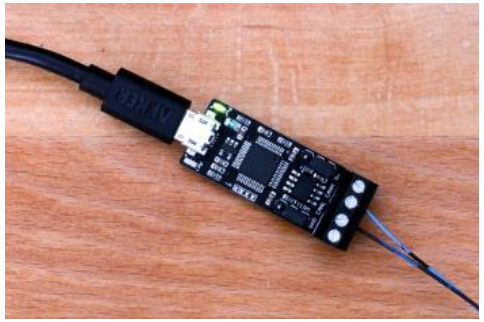
Drive System – Wheels

- Assembled using rivets
- Chamfered rims
  - Helps with turning
- Spokes poke through rim
  - Provides extra support

Electrical System

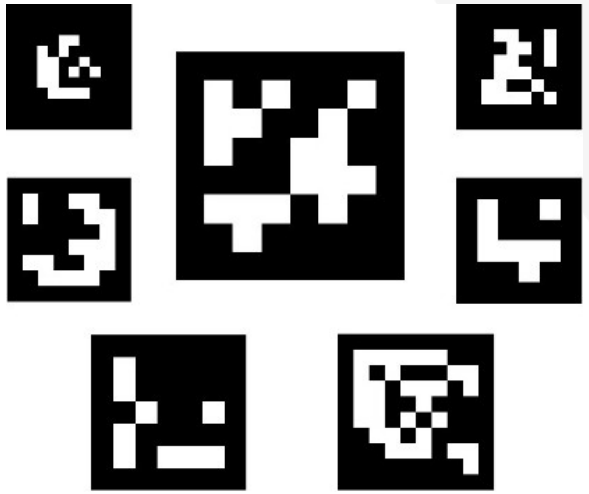
- New system:
  - ~2.5 kg without batteries
  - NVIDIA Jetson TX2 Development Kit
  - ZED stereo camera
  - CANable (USB to CAN Adapter)
  - Talon SRX Speed Controllers

- No on-board laptop



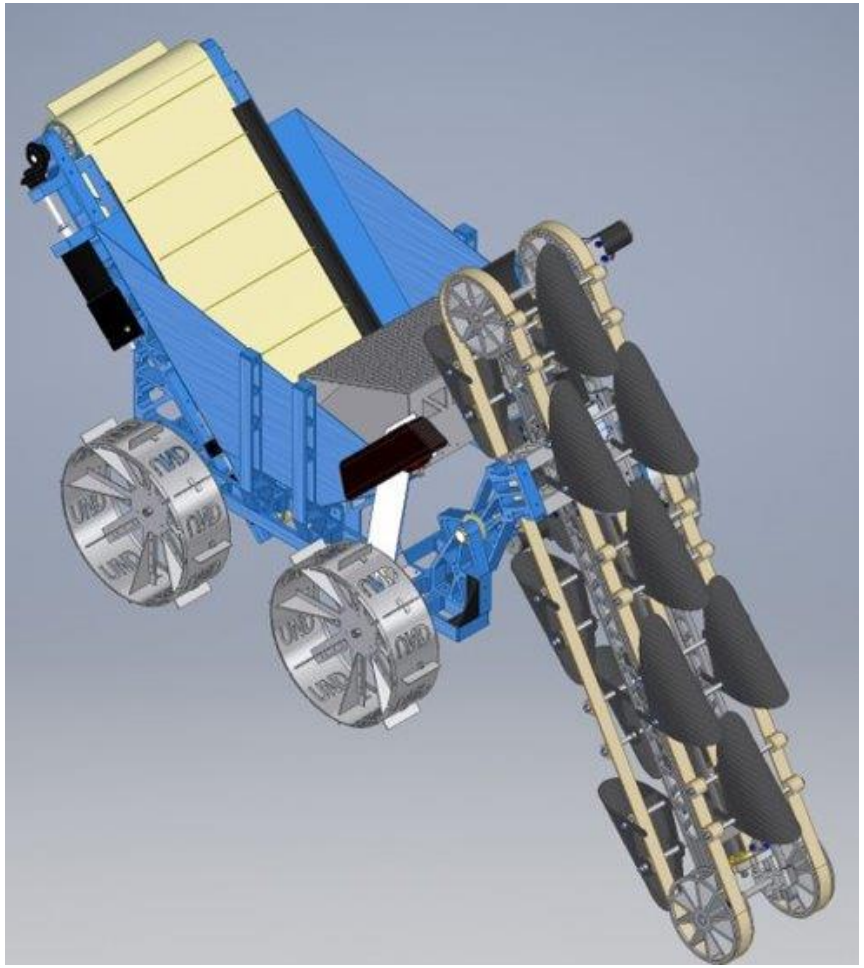
Autonomous Functions

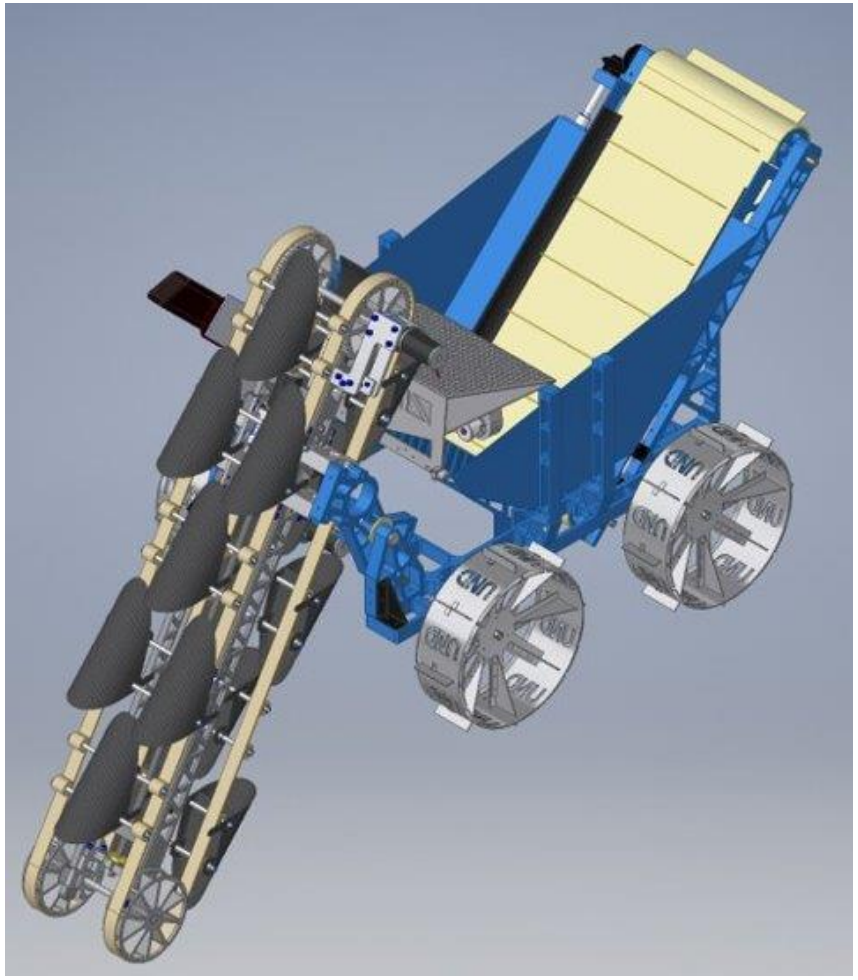
- Open CV with ArUco markers
  - Homing onto depositing bin
  - Estimate distance



- Simultaneous Localization and Mapping (SLAM)
  - Environment mapping
  - Obsticale detection

Final Robot Design





UND UNIVERSITY OF NORTH DAKOTA

Acknowledgements

- Dr. Jeremiah Neubert
- Jay Evanstad
- Mr. Dominik Steinhauer
- ND Space Grant Consortium
- Rydell
- Otter Tail Power Company
- S.O.F.A
- Emerson
- PS Doors Manufacturing
- Cirrus Aircraft
- Tagnite
- ComDel Innovations

Questions?

UND UNIVERSITY OF NORTH DAKOTA