

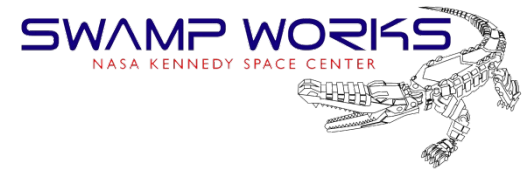
# **2022 LUNABOTICS ROBOTIC MINING COMPETITION FOR UNIVERSITIES**

**Space Resources Roundtable, XXII Meeting  
June 7-10, 2022  
Colorado School of Mines  
Golden, Colorado USA**

**Rob Mueller  
Senior Technologist  
Exploration Research and Technology Programs  
NASA  
Kennedy Space Center, Florida, USA**



# Introduction

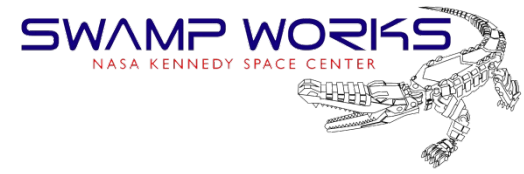


- Annual NASA Competition since 2010
- Regolith Excavation Robot Controlled Remotely or Autonomously
- Visual and Auditory Isolation from Operator
- Excavates Black Point 1 (BP-1) Lunar Basalt Regolith Simulant
- Weight Limit - 80 kg
- Dimension Limits - 1.50m length x 0.75m width x 0.75m
- Designed, Built and Tested by University Student Teams
- Uses NASA systems engineering methods
- Held at NASA Kennedy Space Center, Florida each May





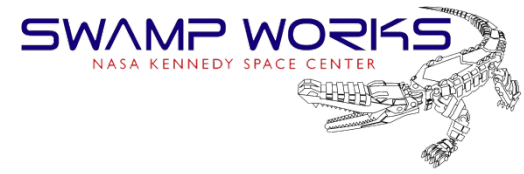
# Lunabotics Arena



- Each mining lane is 6.8 meters long (3.6 meter obstacle zone plus a 3.2 meter excavation zone) and 2.5 meters wide.
- 2 cm diameter gravel rock at bottom: 15 cm depth (simulates icy regolith)
- Overburden of Black Point (BP)-1 regolith simulant: 30 cm depth
- Must mine more than 1 kg of gravel to qualify for Mining points



# On-Site Entries List



GROUP 1 Universities Names	Number of students attending
California State University, Long Beach	10
Colorado State University	7
Florida Institute of Technology	7
Iowa State University	10
Miami Dade College Kendall	10
Michigan Technological University	9
Milwaukee School of Engineering	10
New Mexico Tech	10
New York University Tandon School of Engineering	10
Purdue University	10
Saginaw Valley State University	6
The University of Akron	10
The University of Alabama	10
The University of North Carolina at Charlotte	9
The University of Utah	10
United States Military Academy	9
University of Rochester	8
17 Schools	155

**74** Universities Registered in August 2021  
**70** submitted a Project Management Plan.

**39** Universities invited to attend at KSC in May 2022  
**332** students invited to attend in May 2022

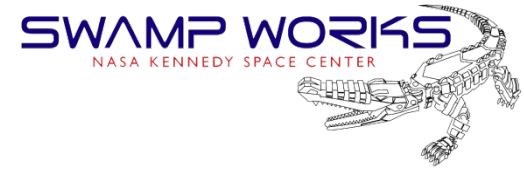
GROUP 2 Universities Names	Number of students attending
Auburn University	7
College of DuPage	10
Lone Star College - CyFair	8
Marquette University	10
Montana Technological University	6
North Dakota State University	10
Oakton Community College	7
San Diego State University	9
Sonoma State University	5
South Dakota School of Mines and Technology	9
Temple University	10
University of Illinois at Chicago	6
University of Kentucky	6
University of Maine	5
University of Nebraska-Lincoln	10
University of New Hampshire	10
University of North Dakota	10
University of North Florida	9
University of Portland	9
University of Virginia	10
Worcester Polytechnic Institute	10
Youngstown State University	5
22 Schools	181





# 2022 Excavator Types

---



19 Bucket ladders (49%)

6 Augers (15%)

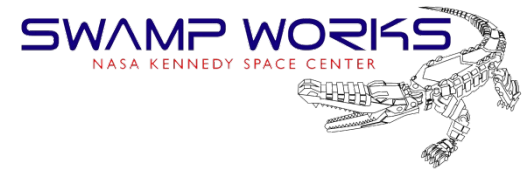
6 Bucket Drums (15%)

3 Front End Loaders (8%)

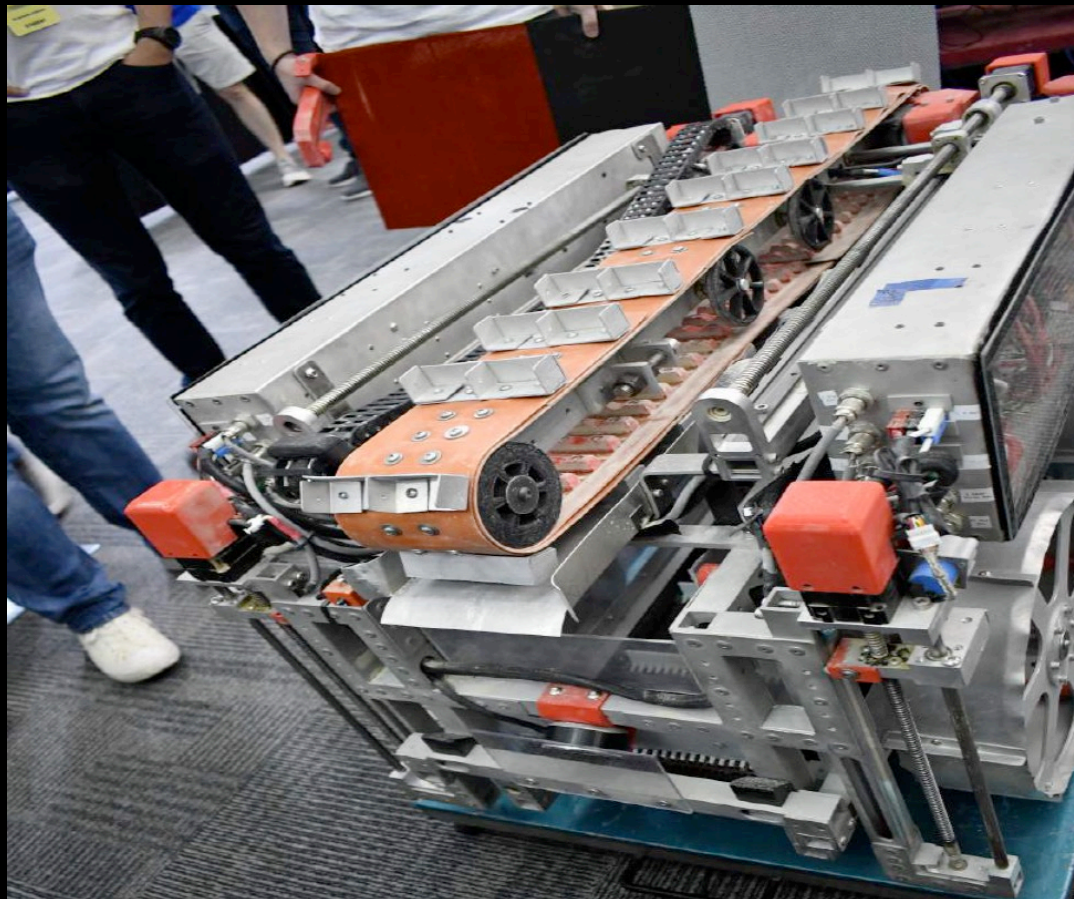
5 Did Not Compete (13%)



# Bucket Ladders

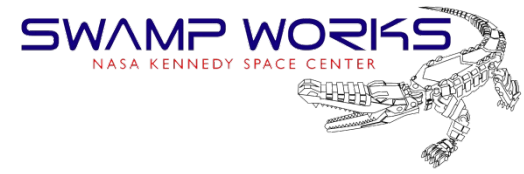


## University of Alabama

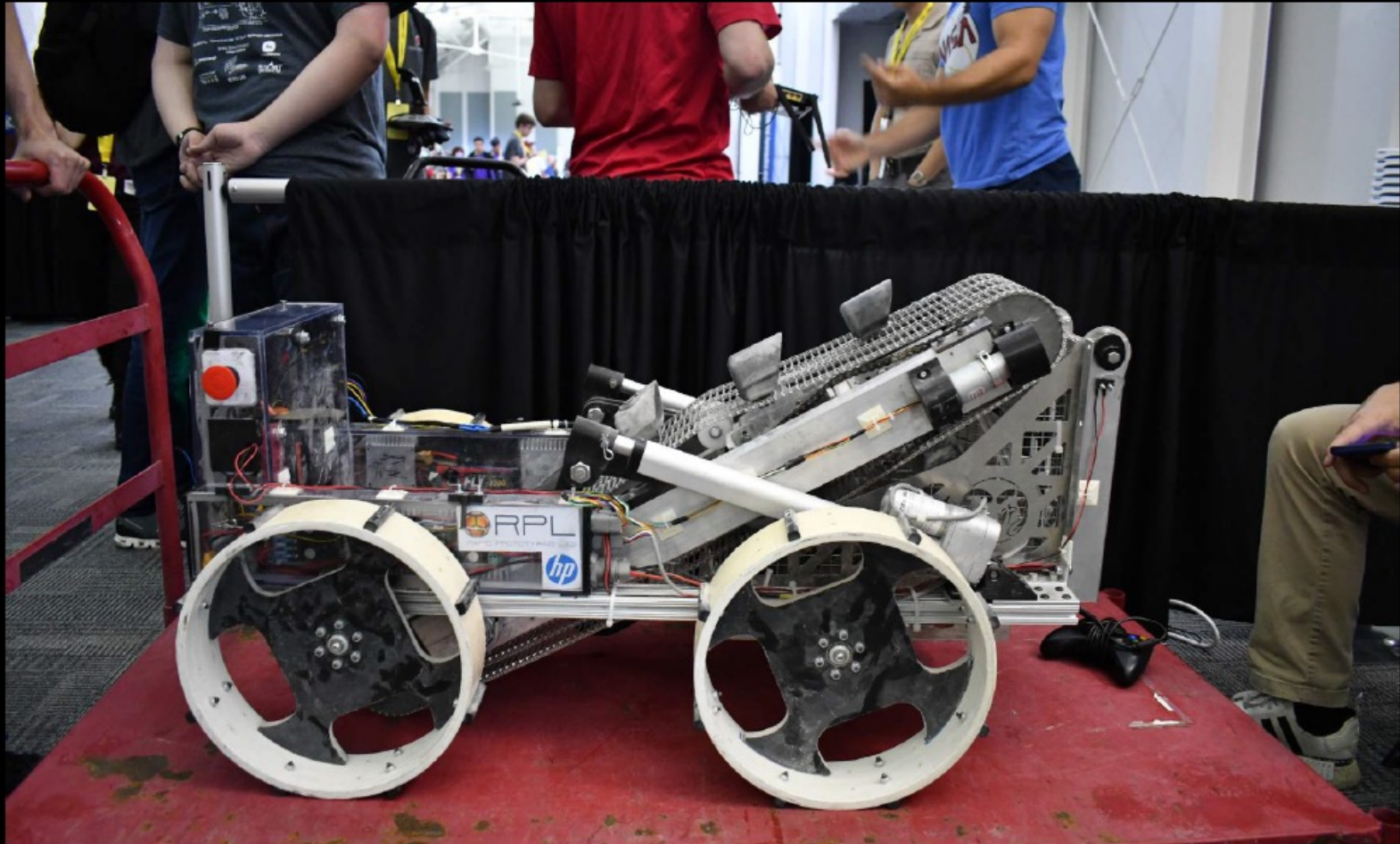




# Bucket Ladders



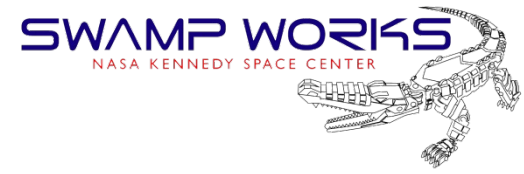
## Colorado State University



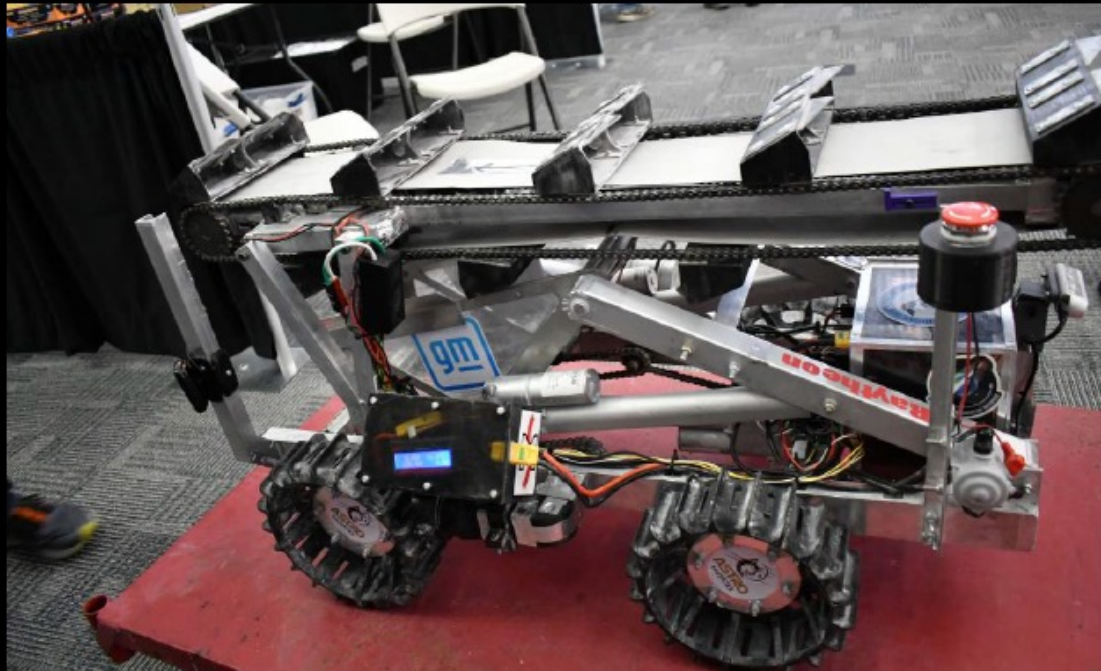




# Bucket Ladders



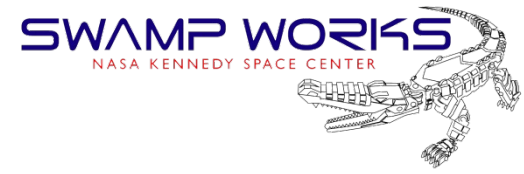
## Michigan Tech



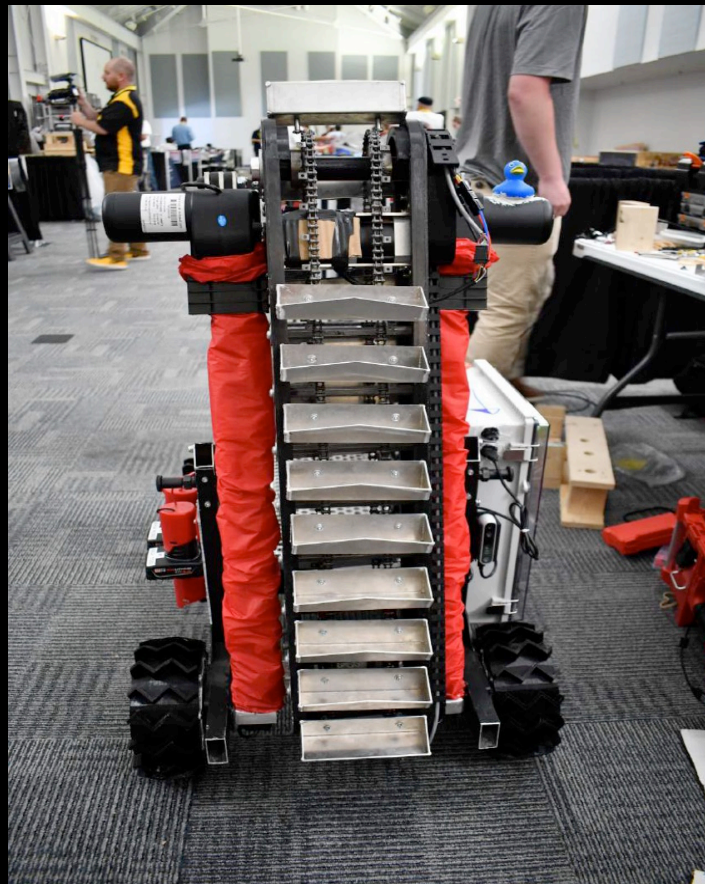




# Bucket Ladders

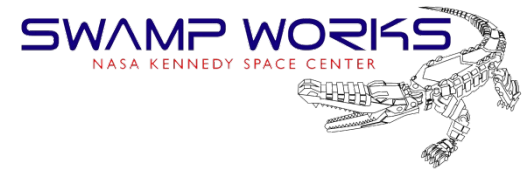


## Milwaukee School of Engineering

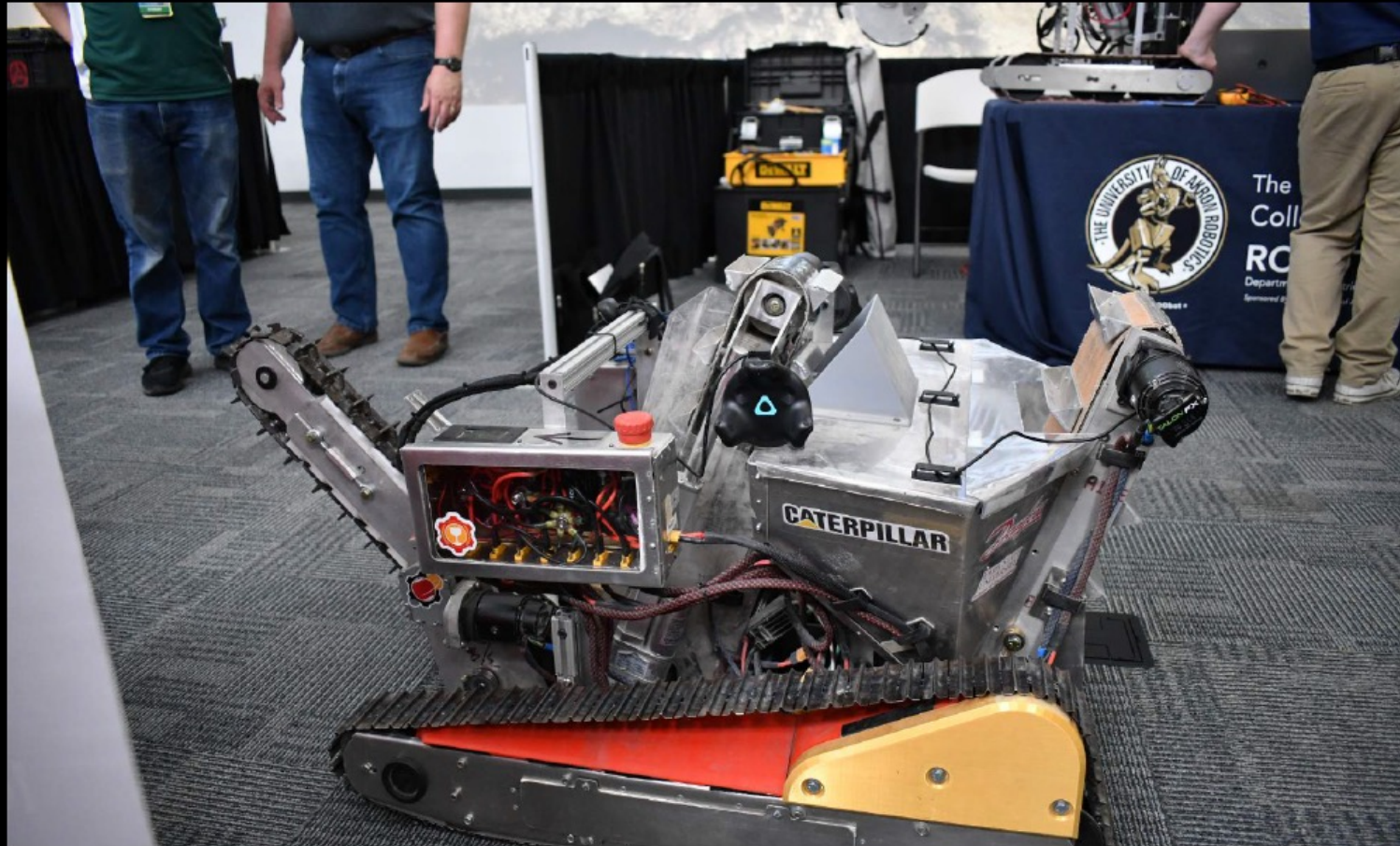




# Bucket Ladders



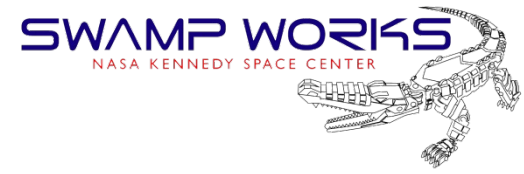
## Iowa State University



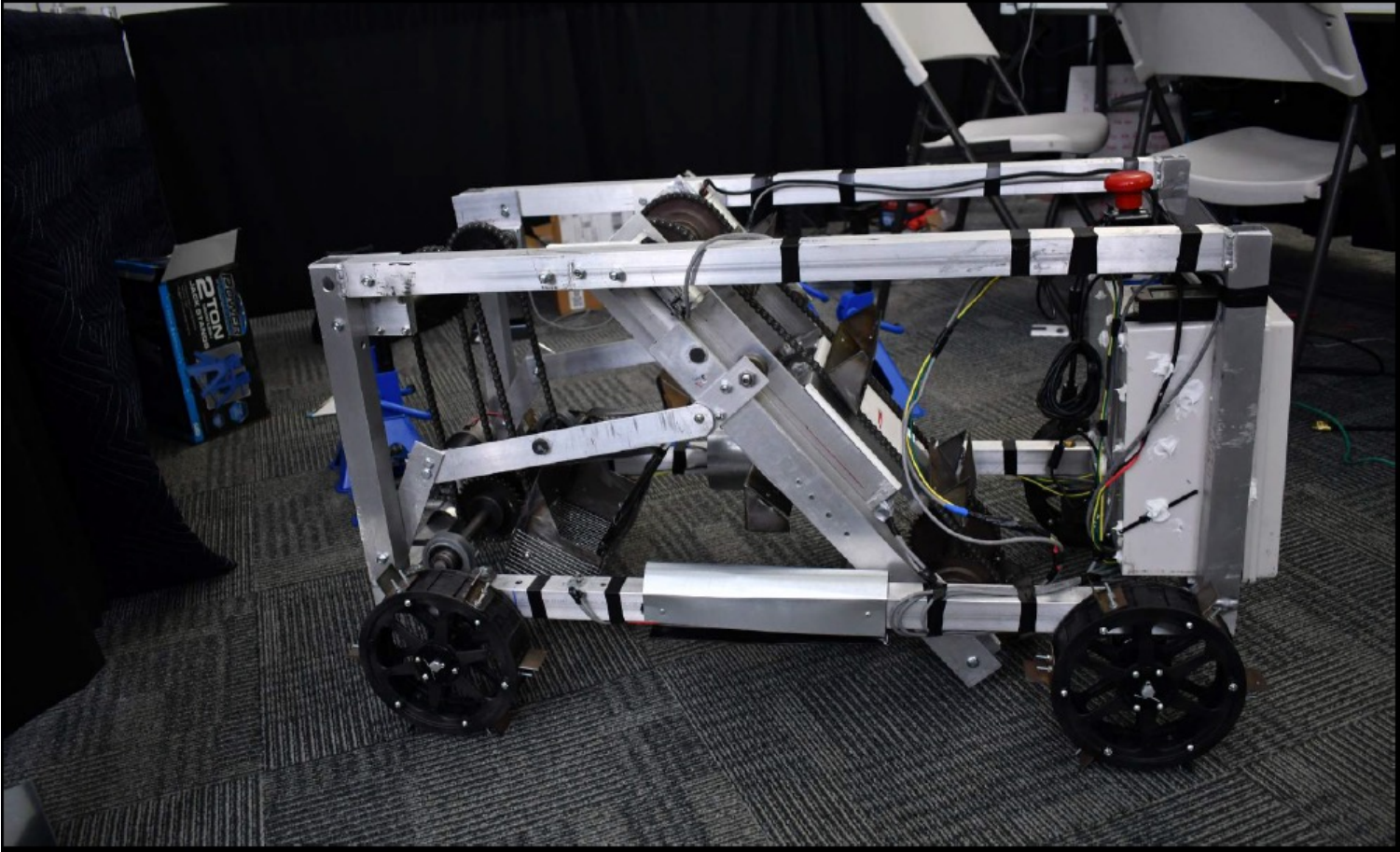




# Bucket Ladders

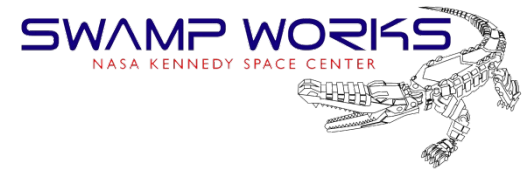


## Saginaw Valley State U

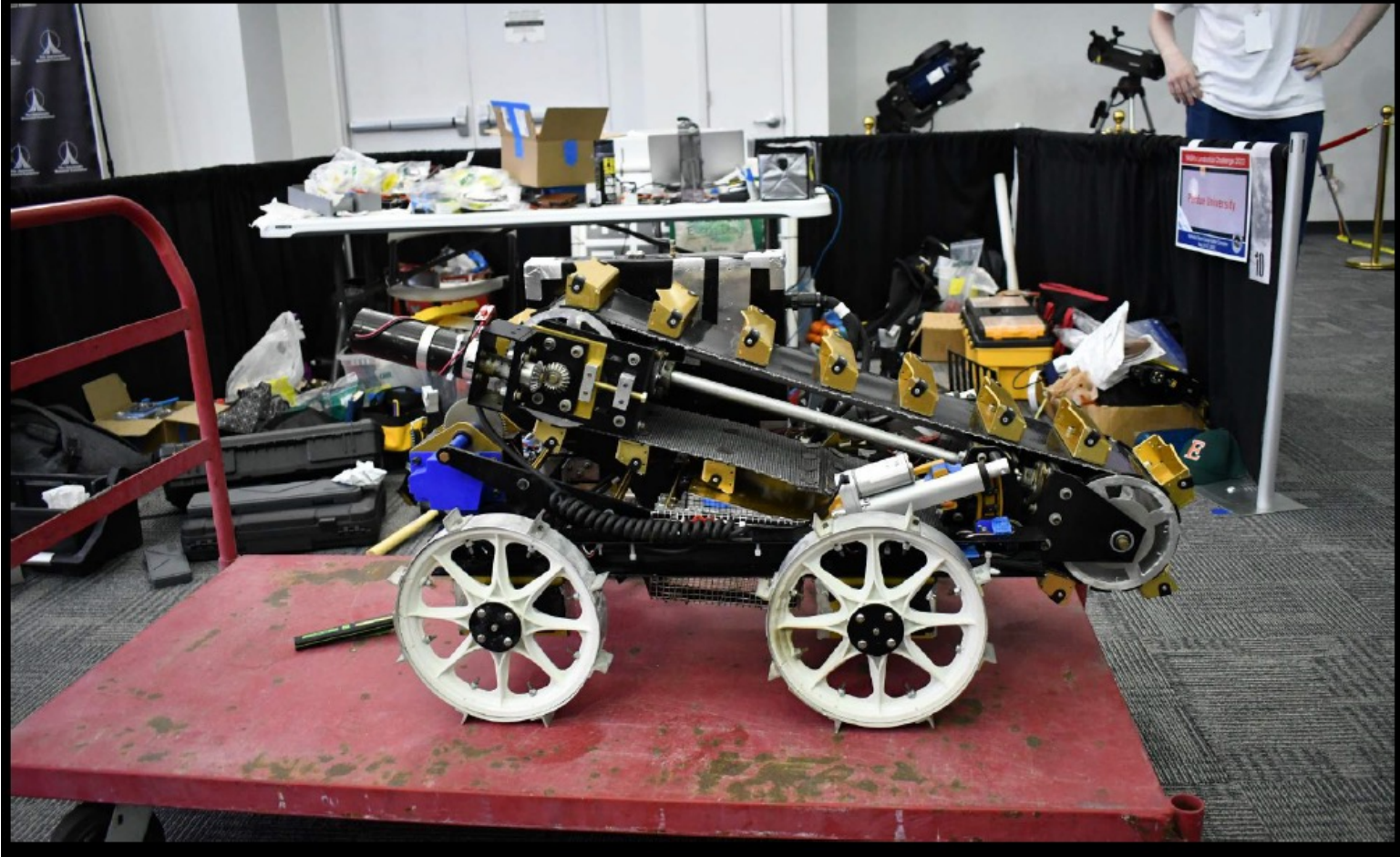




# Bucket Ladders



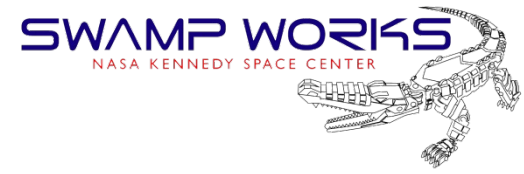
## Purdue University



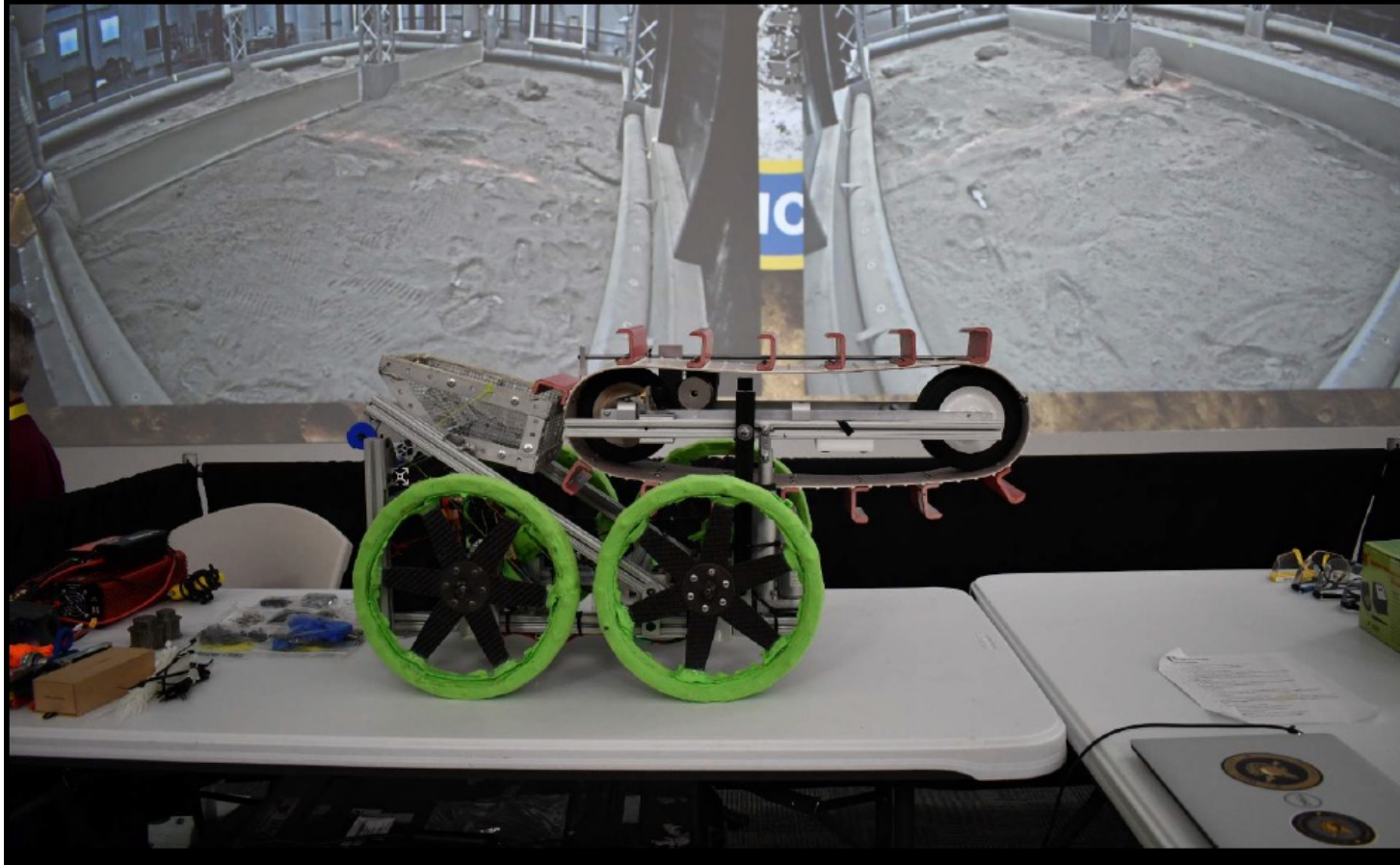




# Bucket Ladders

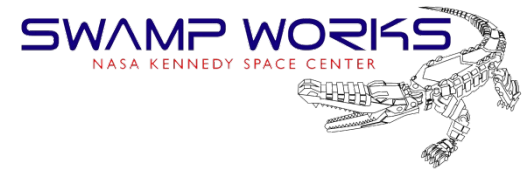


## United States Military Academy

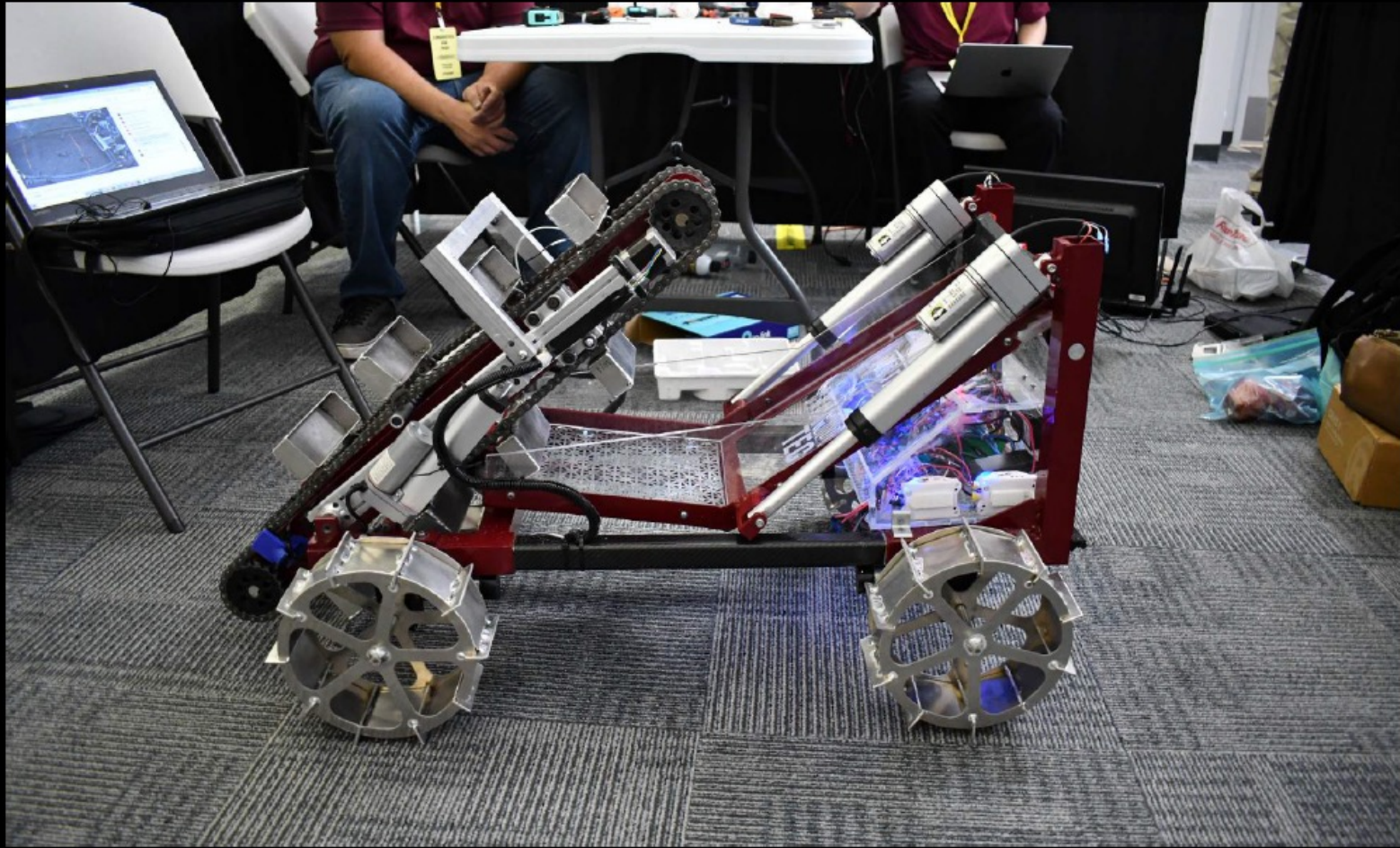




# Bucket Ladders



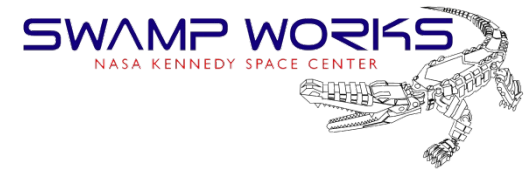
## Florida Institute of Technology



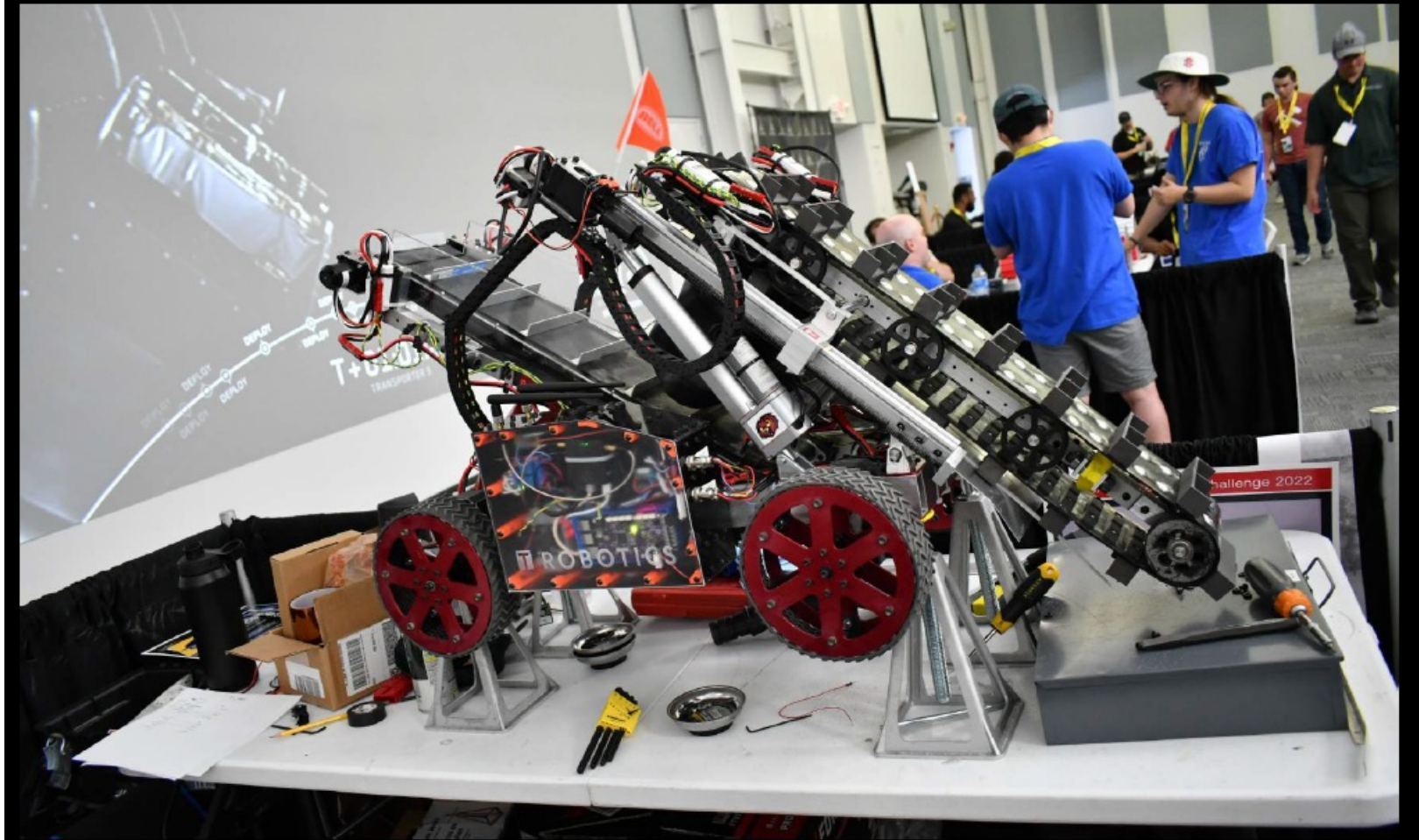




# Bucket Ladders

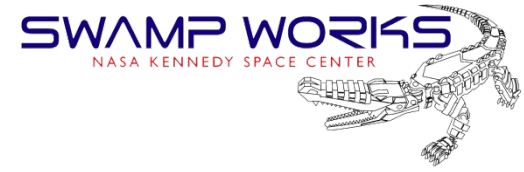


## Temple University

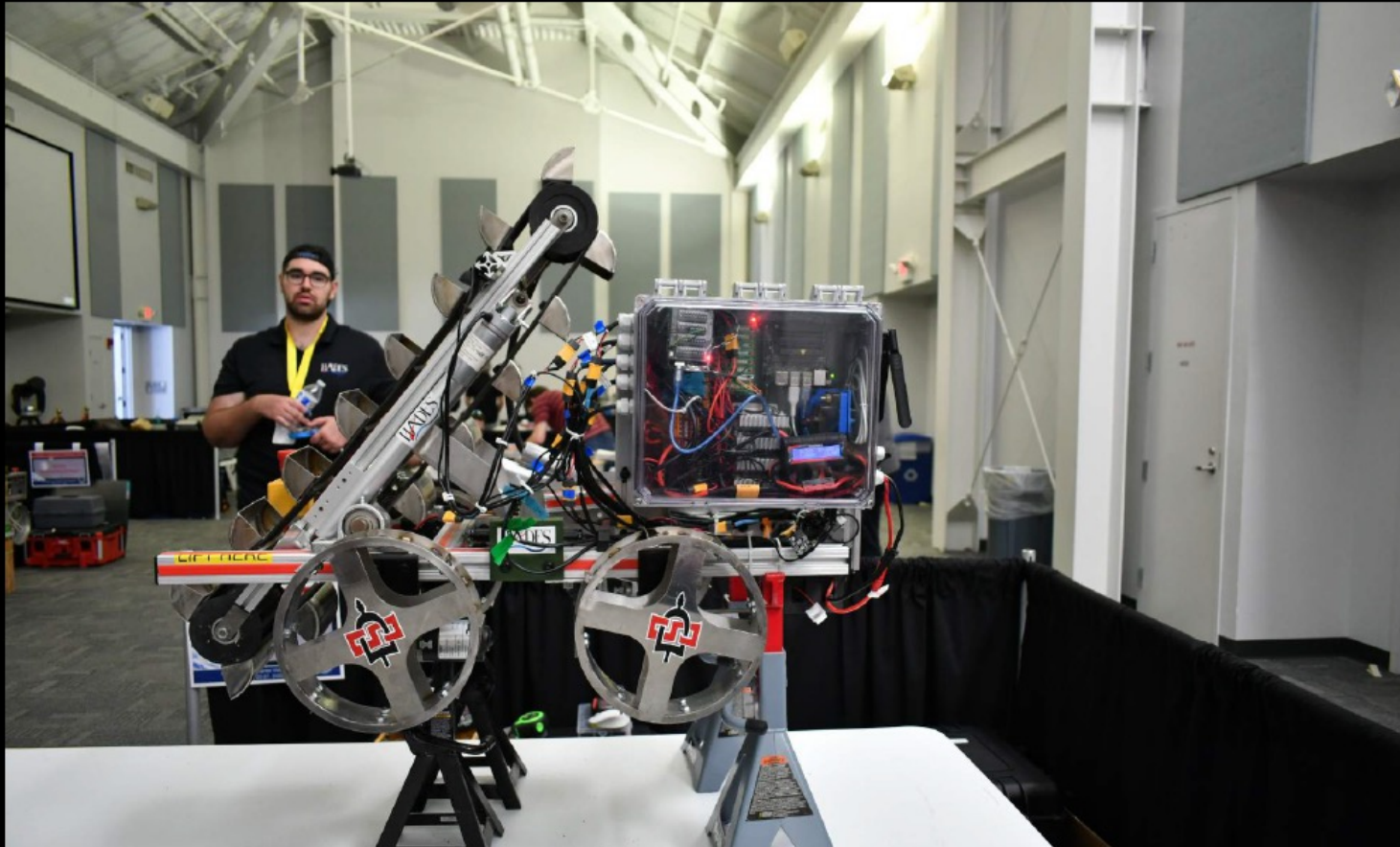




# Bucket Ladders



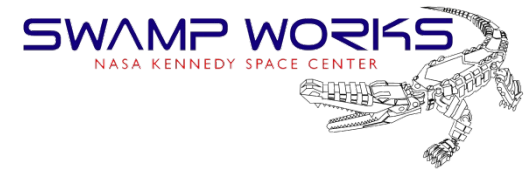
## San Diego State U







# Bucket Ladders

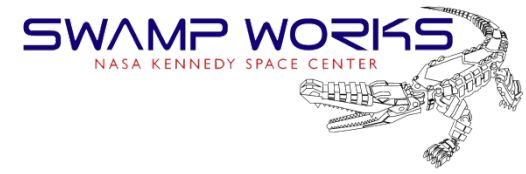


## University of Illinois Chicago





# Bucket Ladders



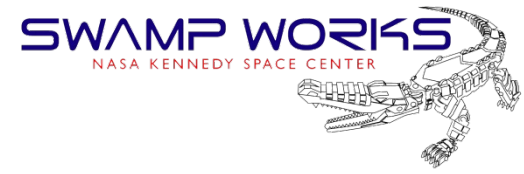
## University of North Dakota







# Bucket Ladders

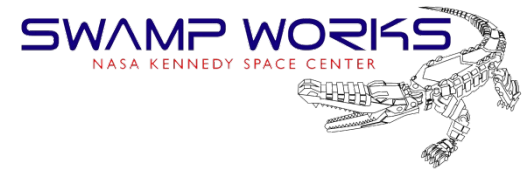


## South Dakota School of Mines and Tech

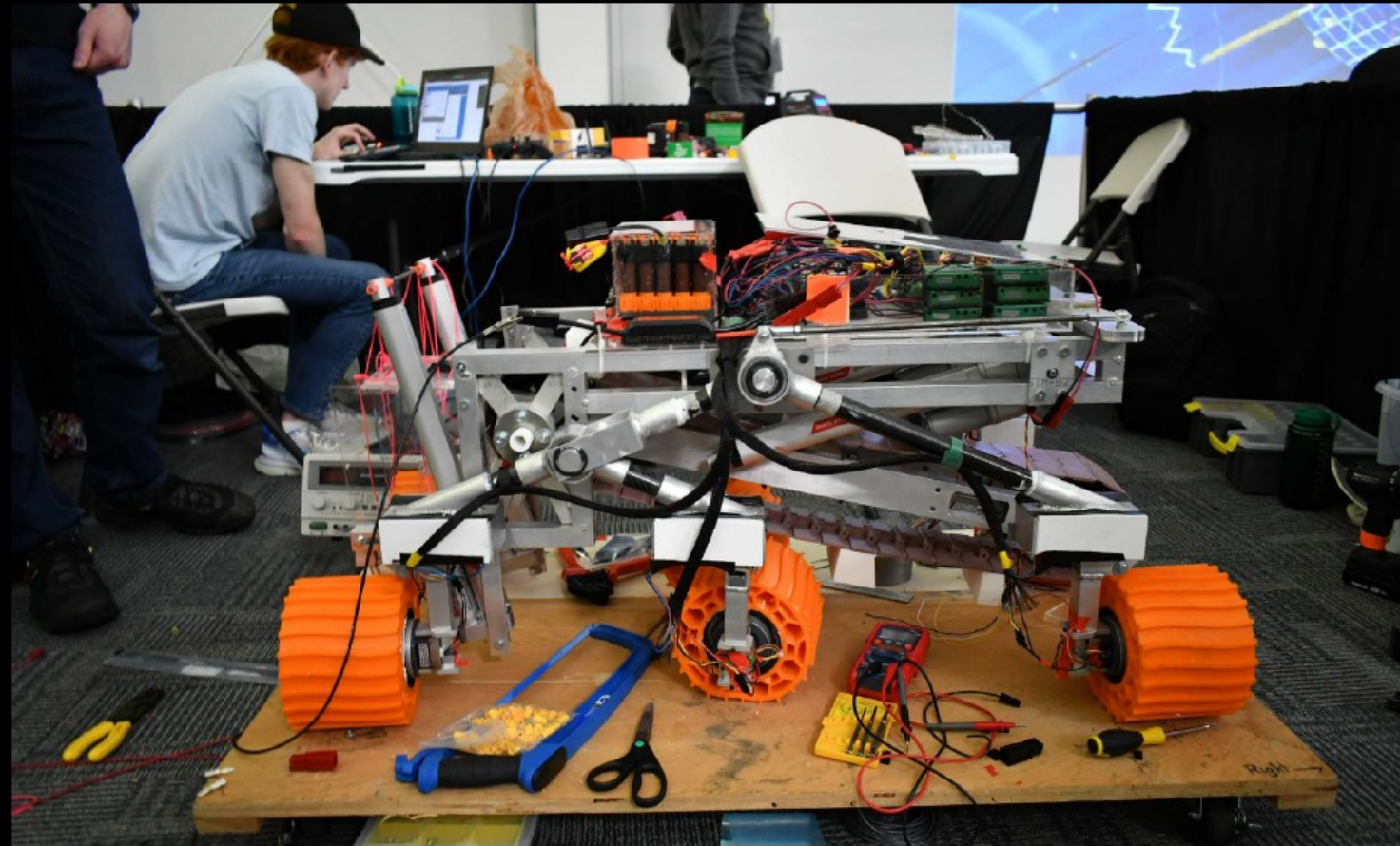




# Bucket Ladders



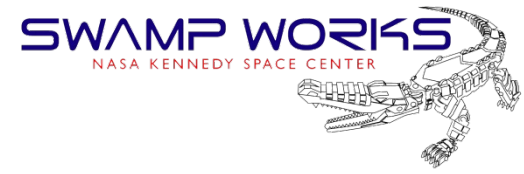
## University of Portland



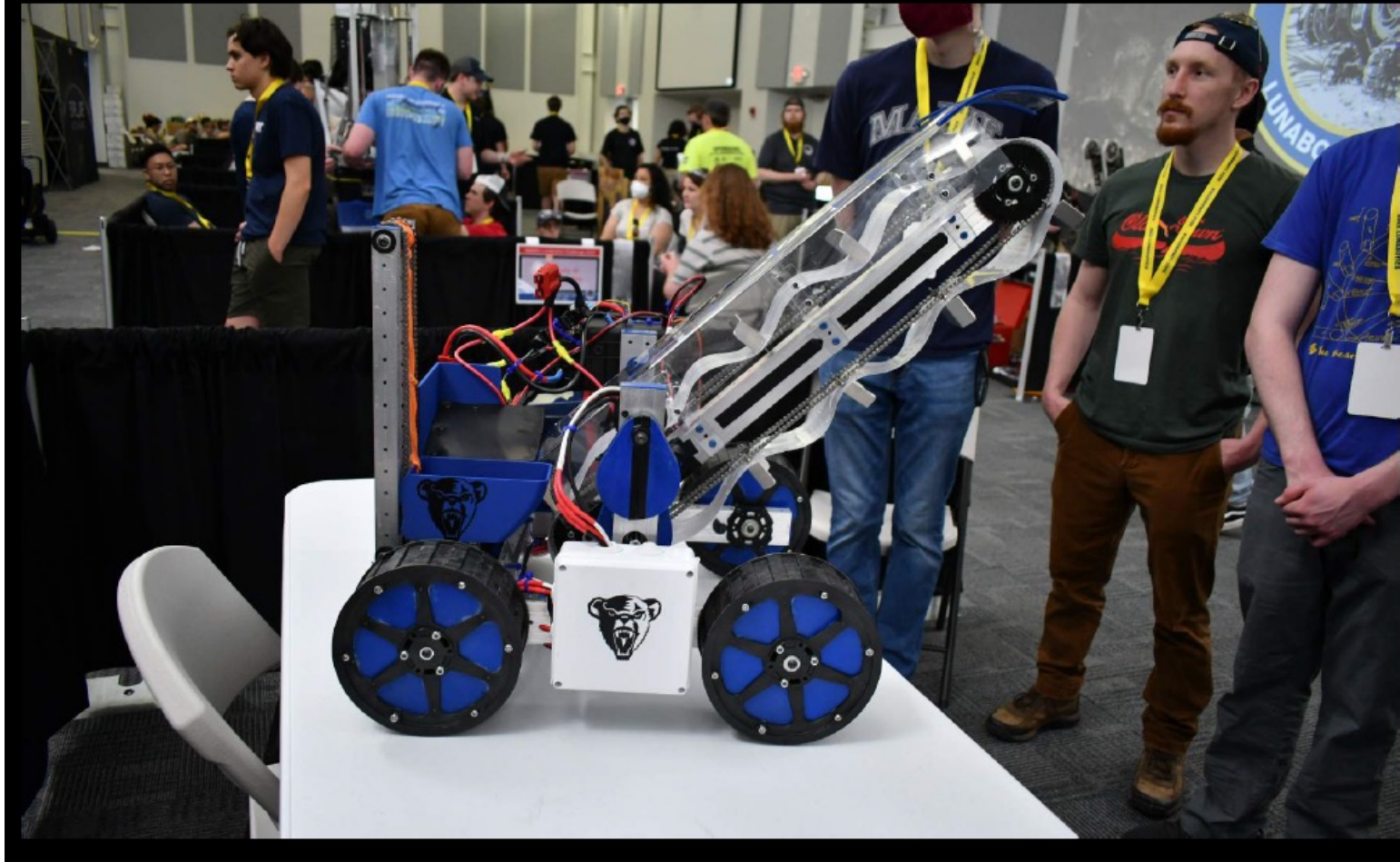




# Bucket Ladders

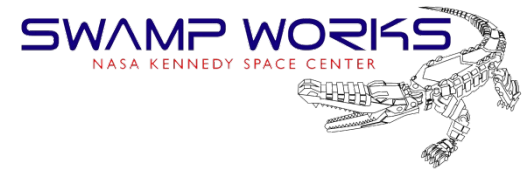


## University of Maine

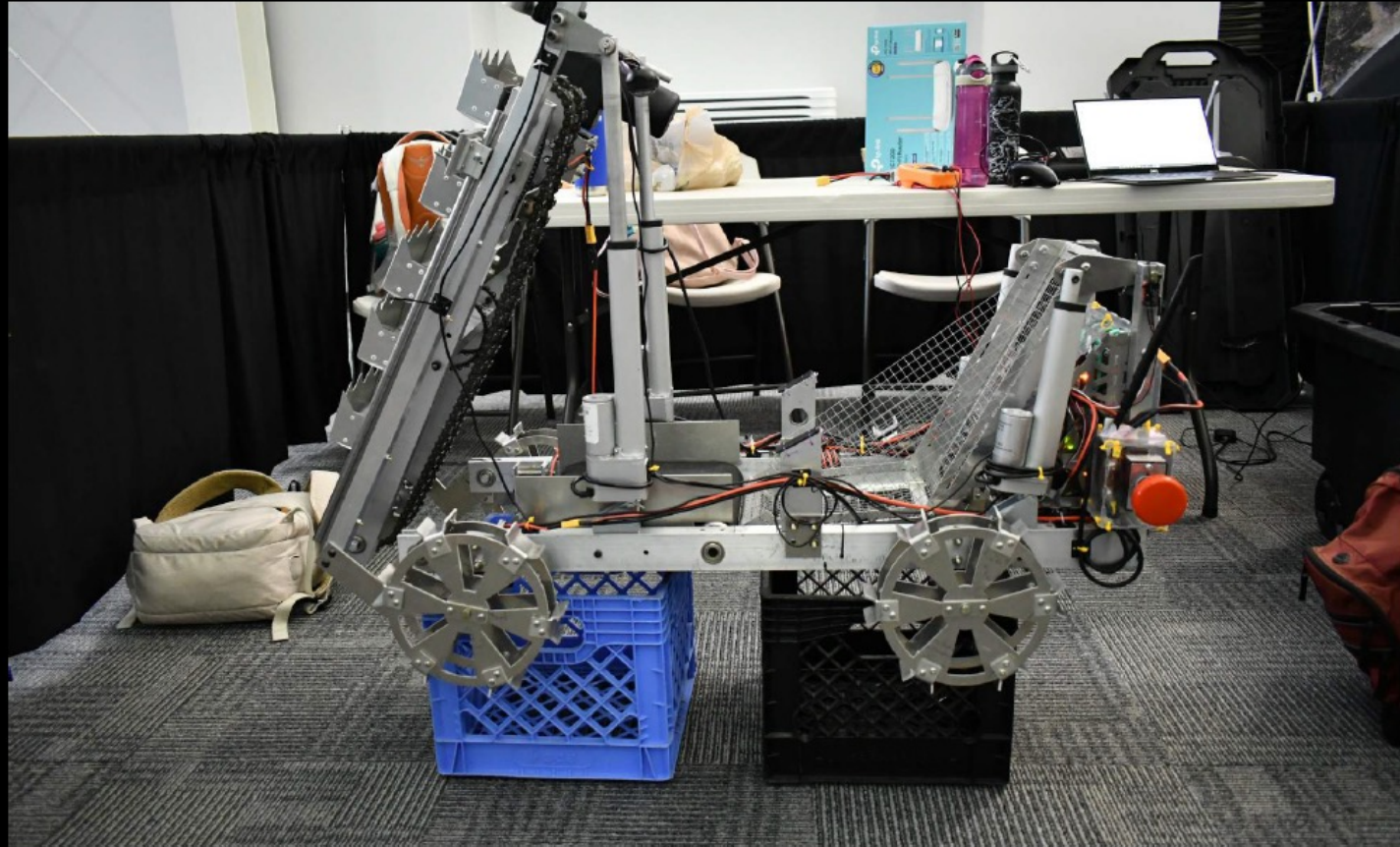




# Bucket Ladders



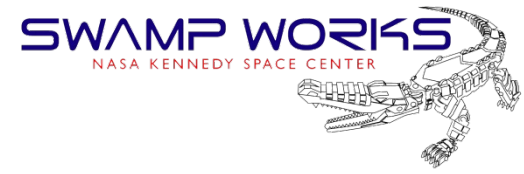
## University of Virginia







# Bucket Ladders



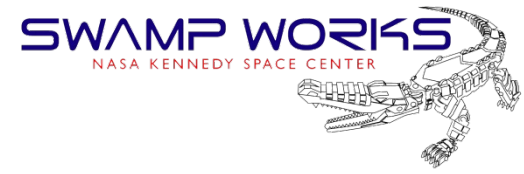
## University of North Florida



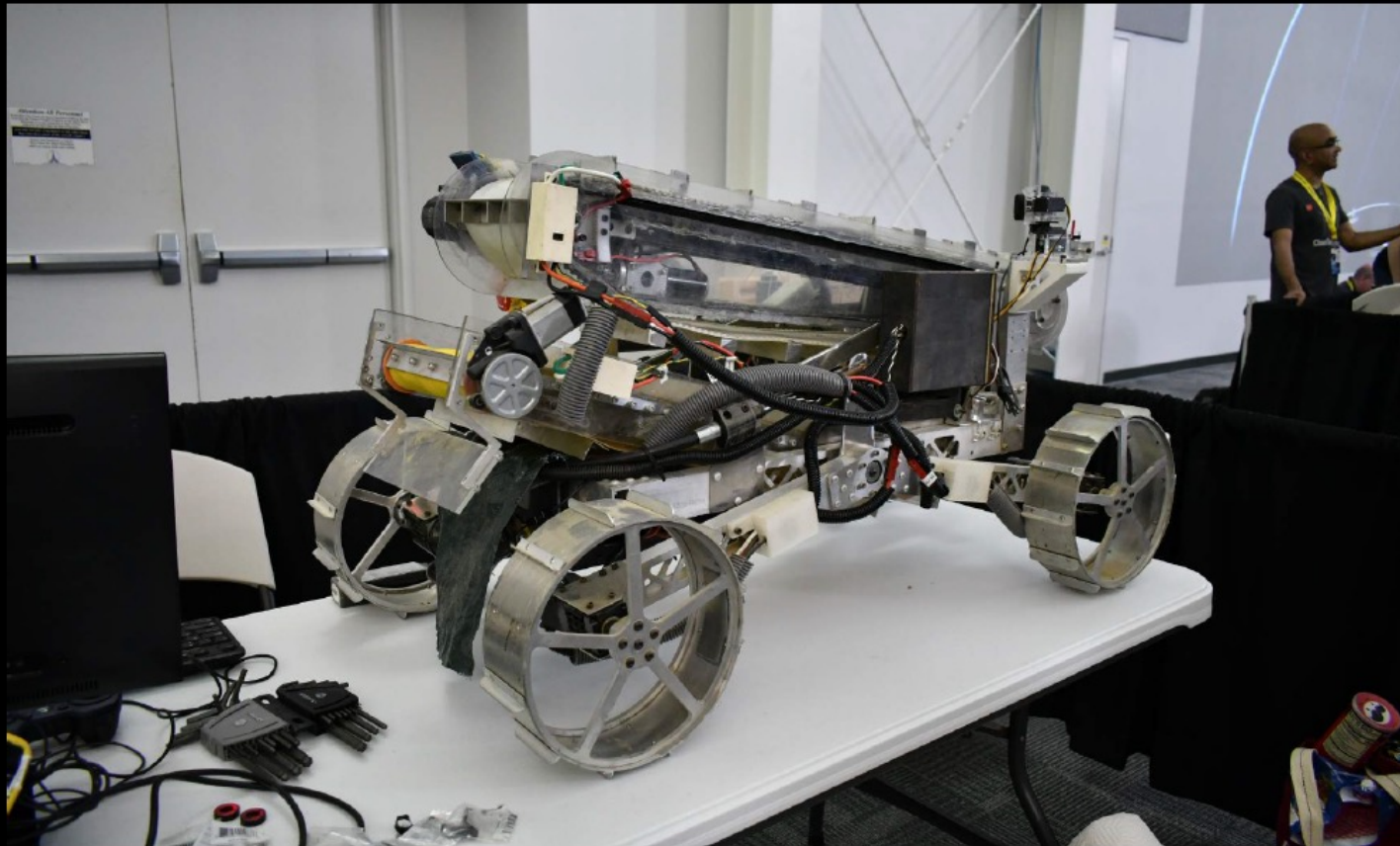




# Bucket Ladders

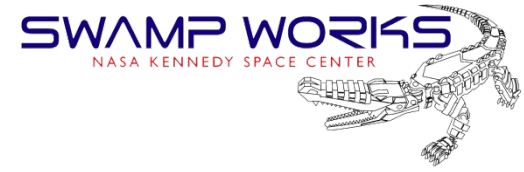


## Worcester Polytech

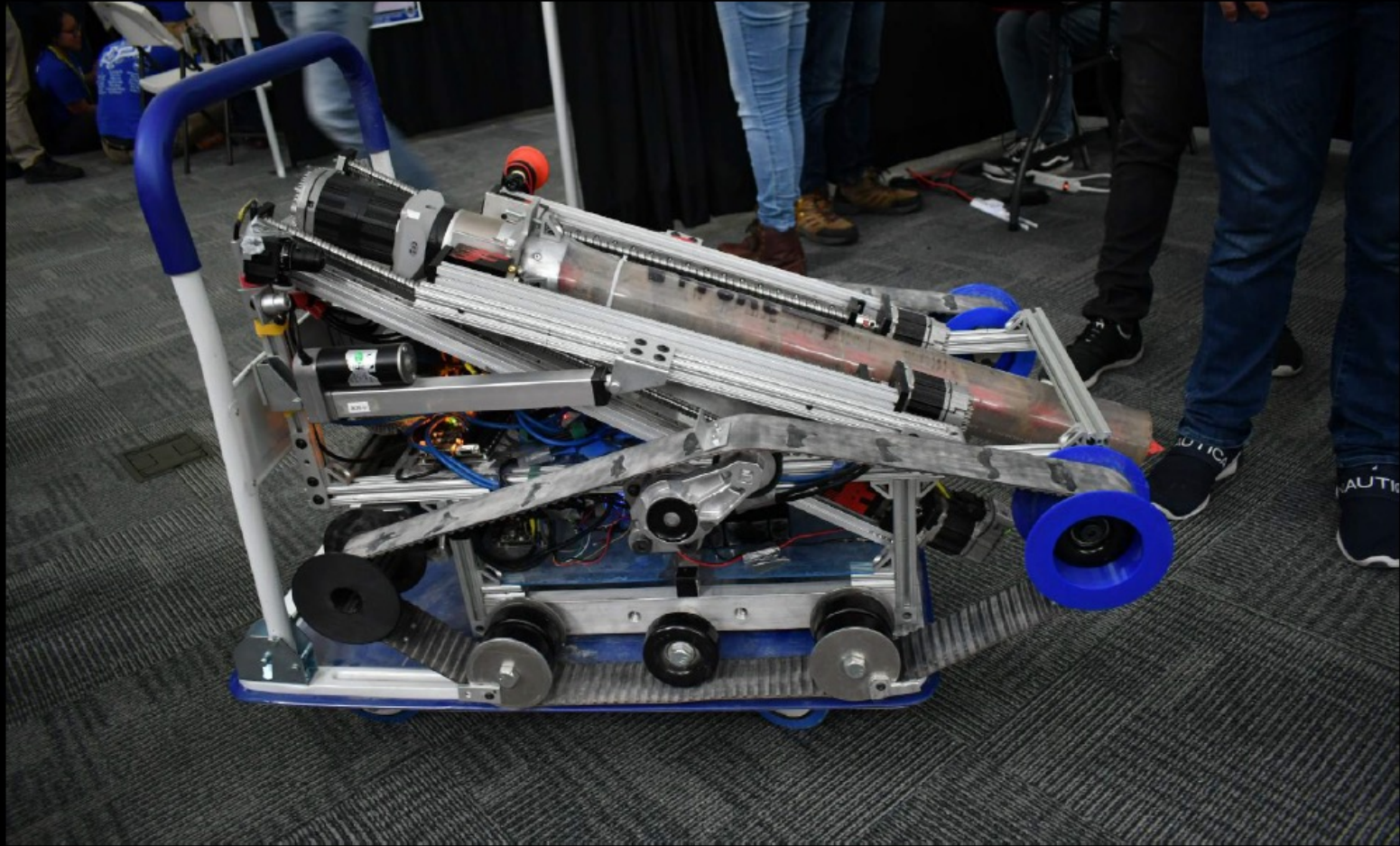




# Augers



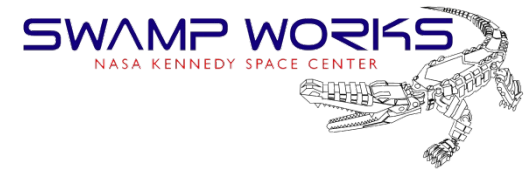
## New Mexico Tech







# Augers



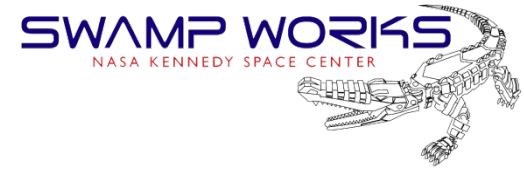
## New York University



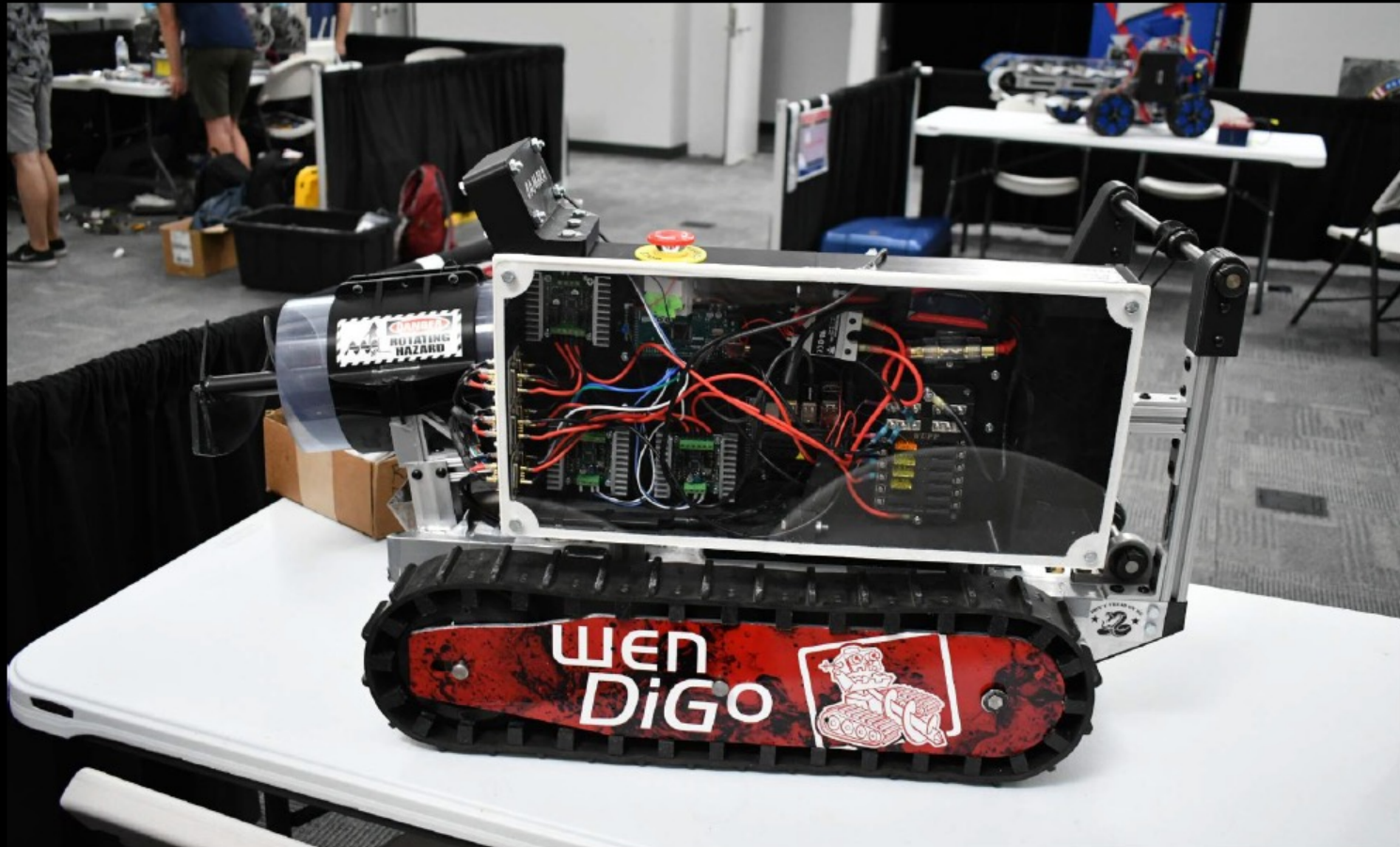




# Augers

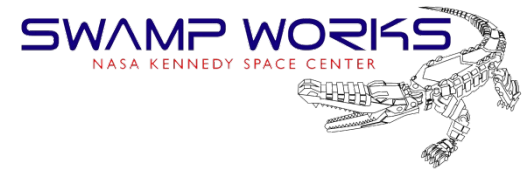


## University of Nebraska Lincoln

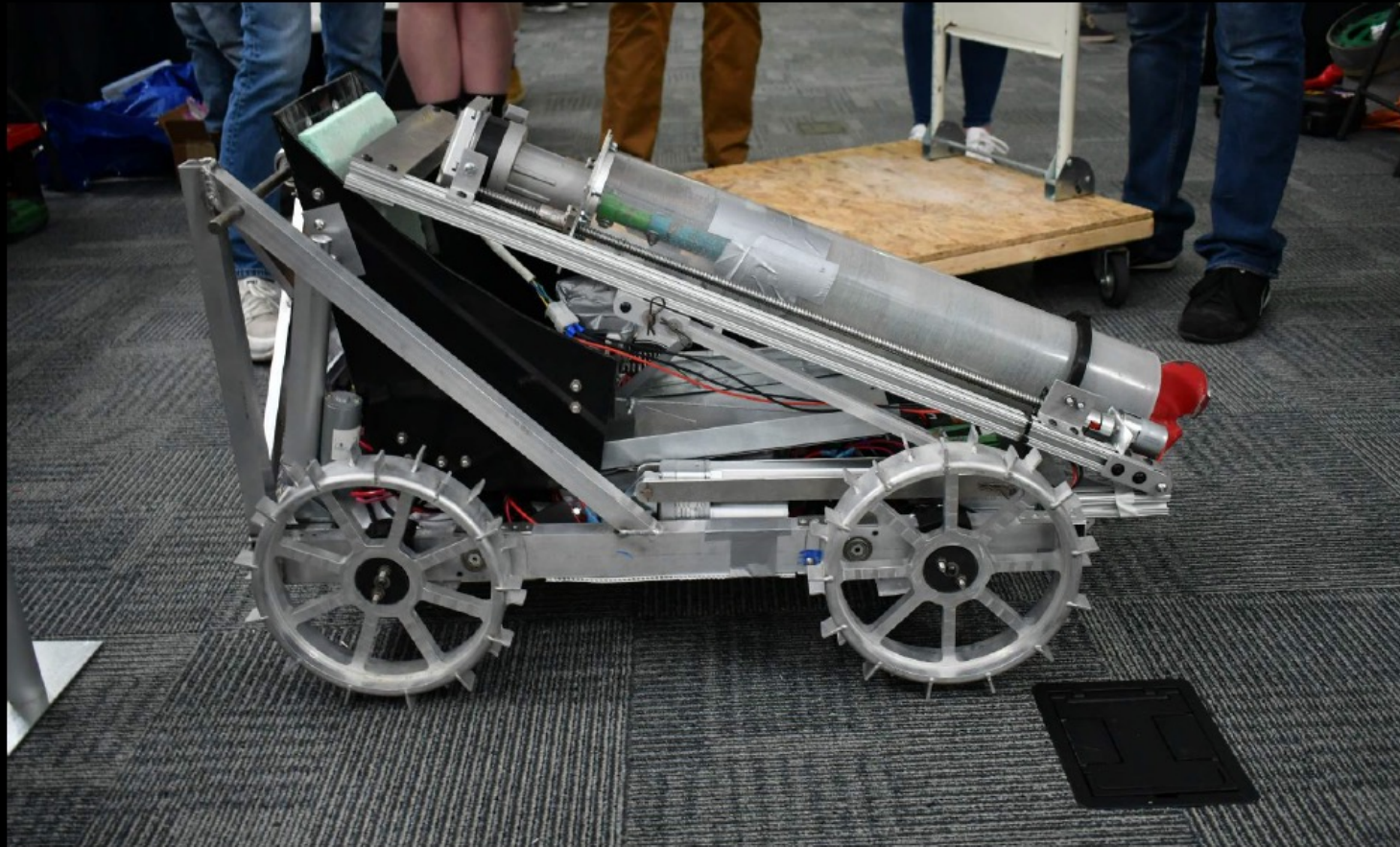




# Augers



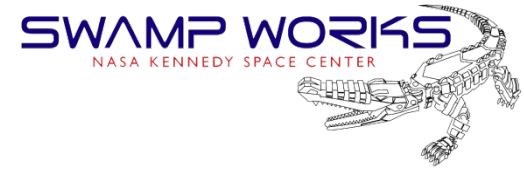
## University of New Hampshire







# Augers



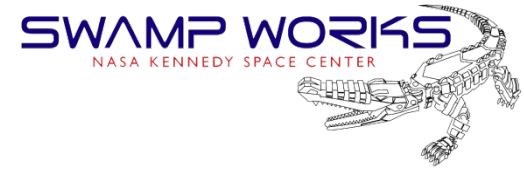
## Marquette University



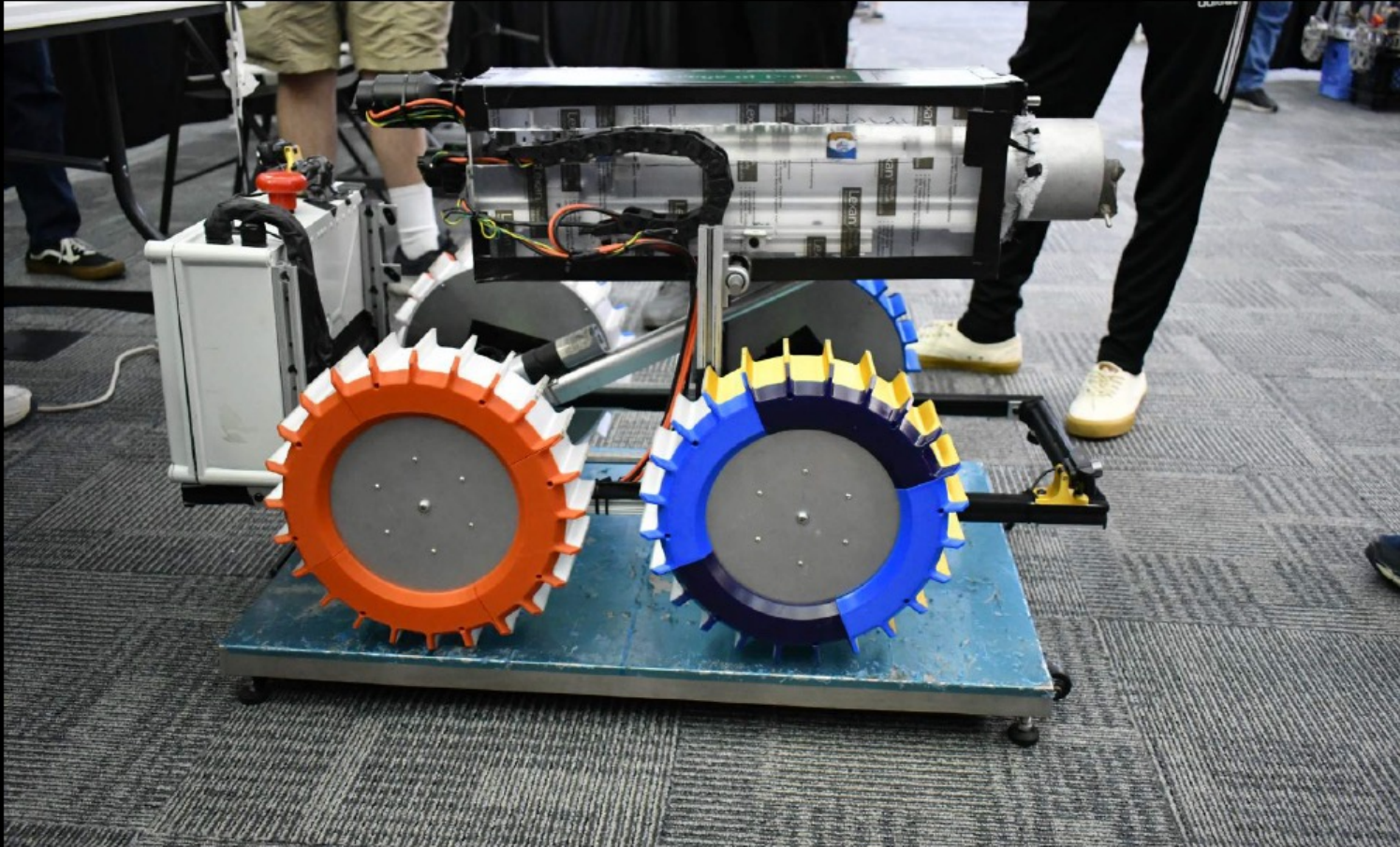




# Augers

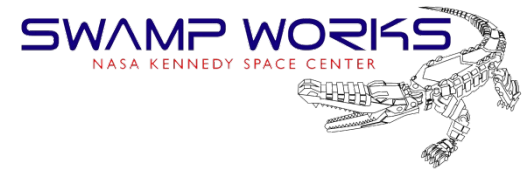


## College of Du Page

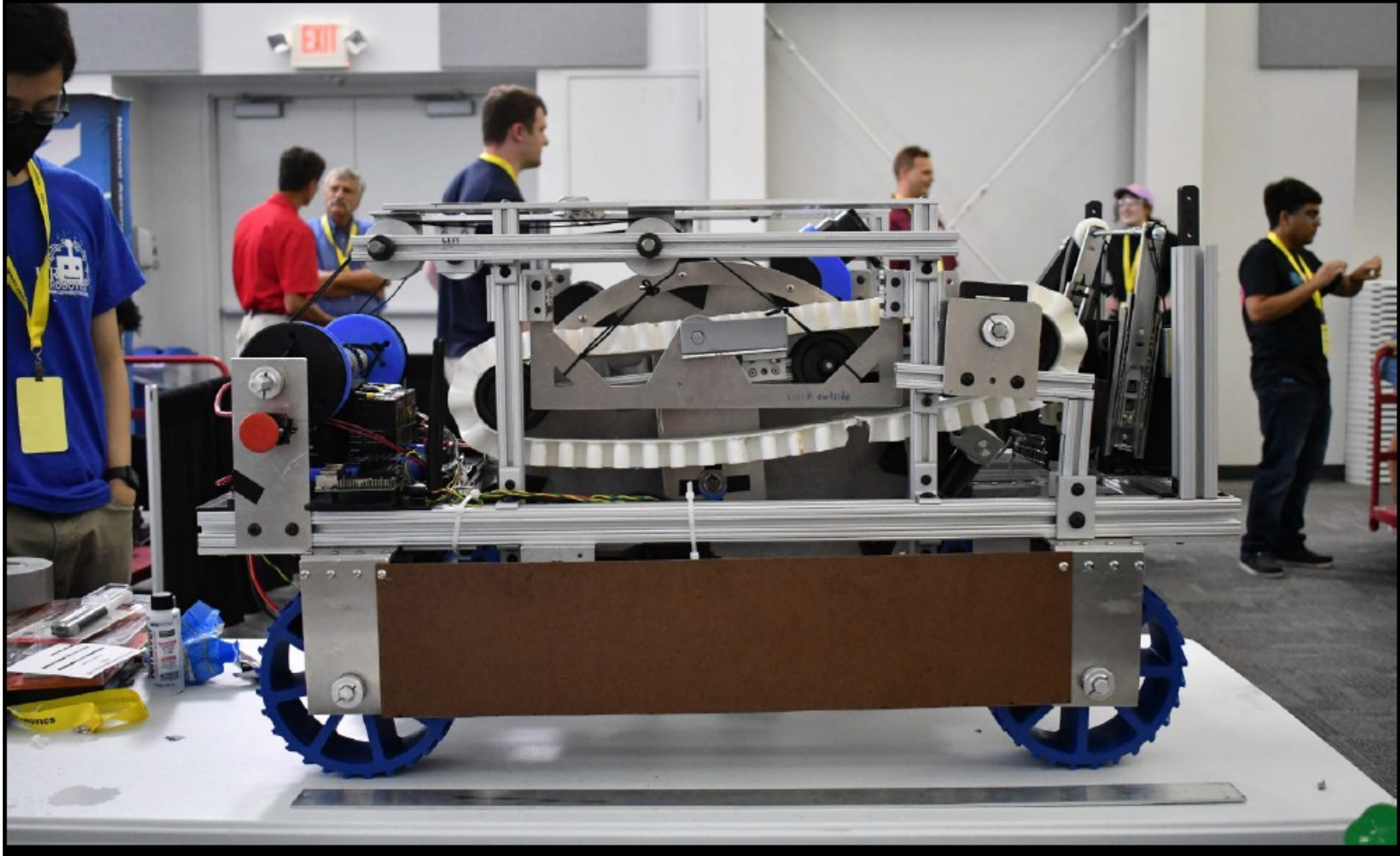




# Bucket Drum



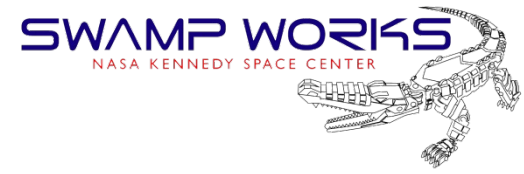
## University of Rochester



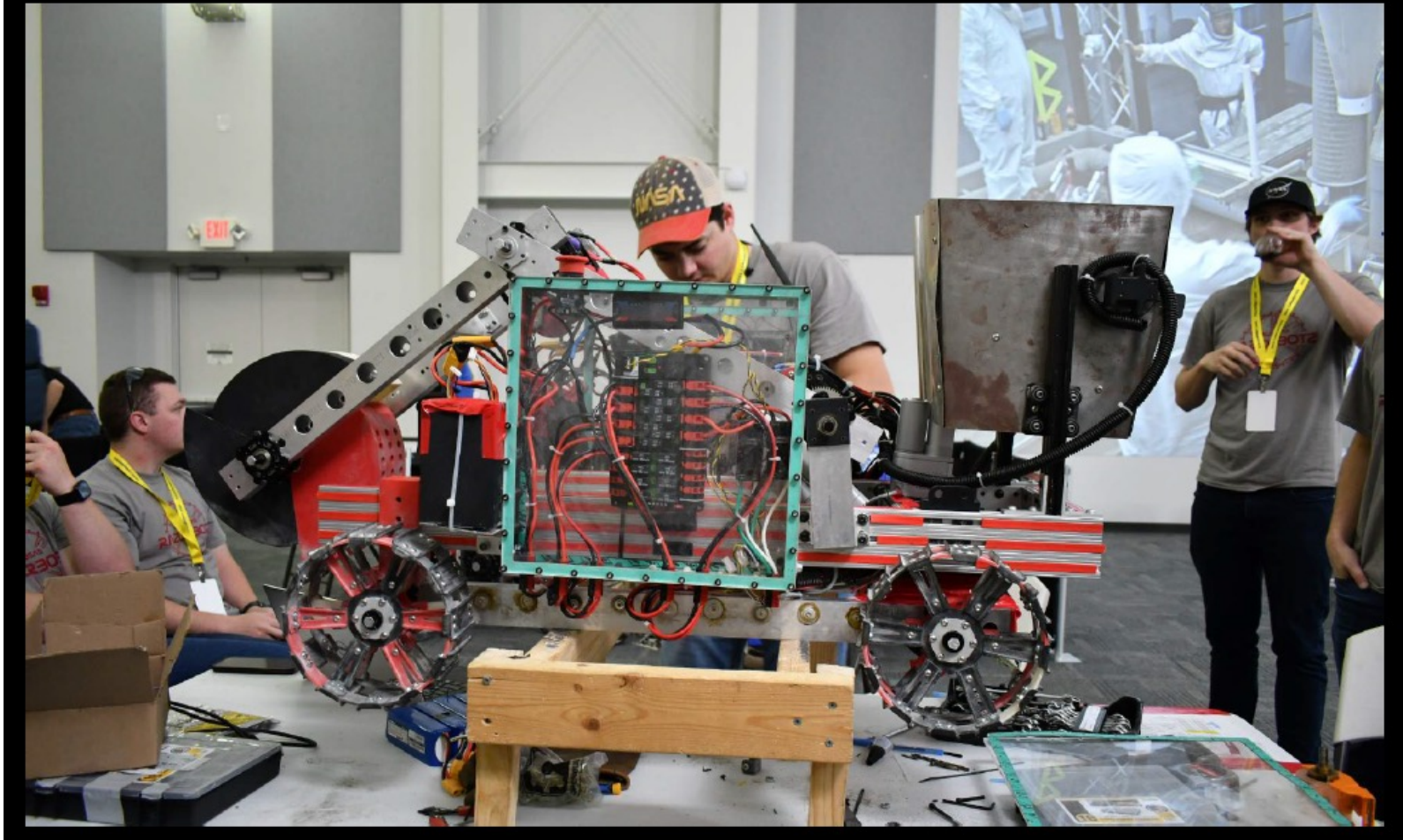




# Bucket Drums

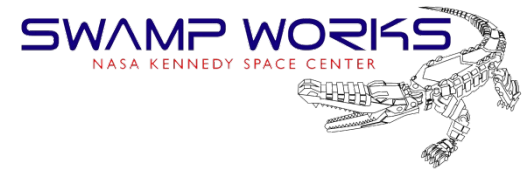


## University of Arkansas

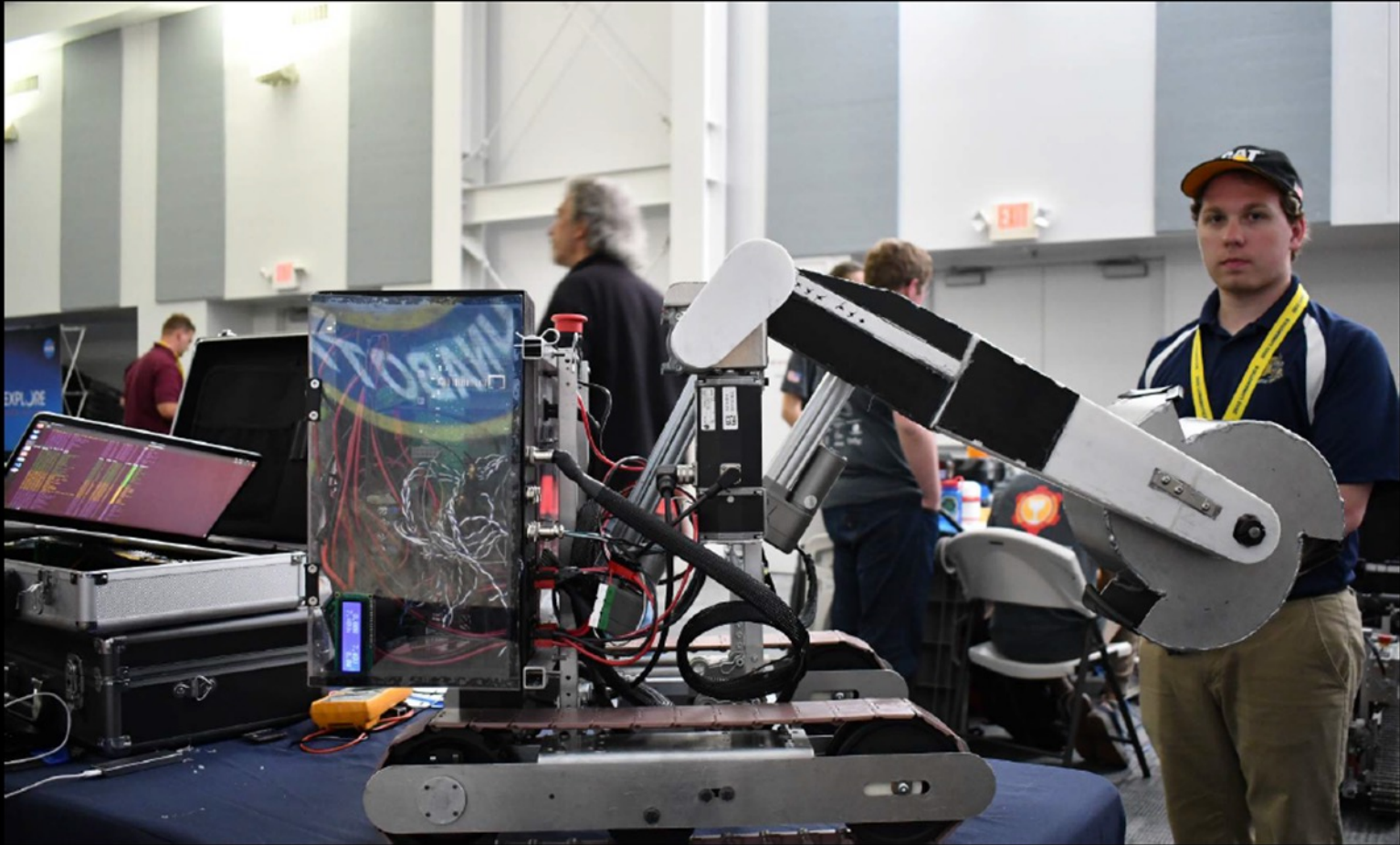




# Bucket Drums



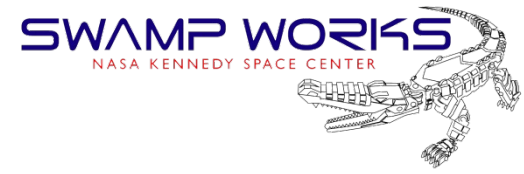
## University of Akron







# Bucket Drums

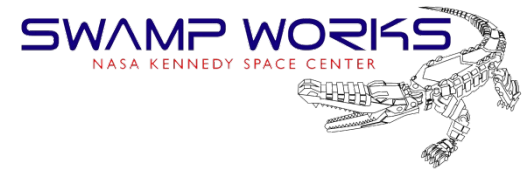


## University of Utah





# Bucket Drums



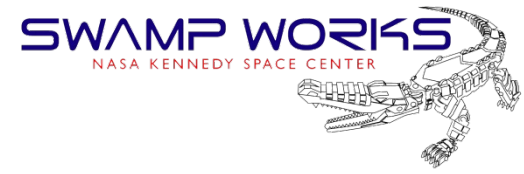
## Miami Dade College Kendall



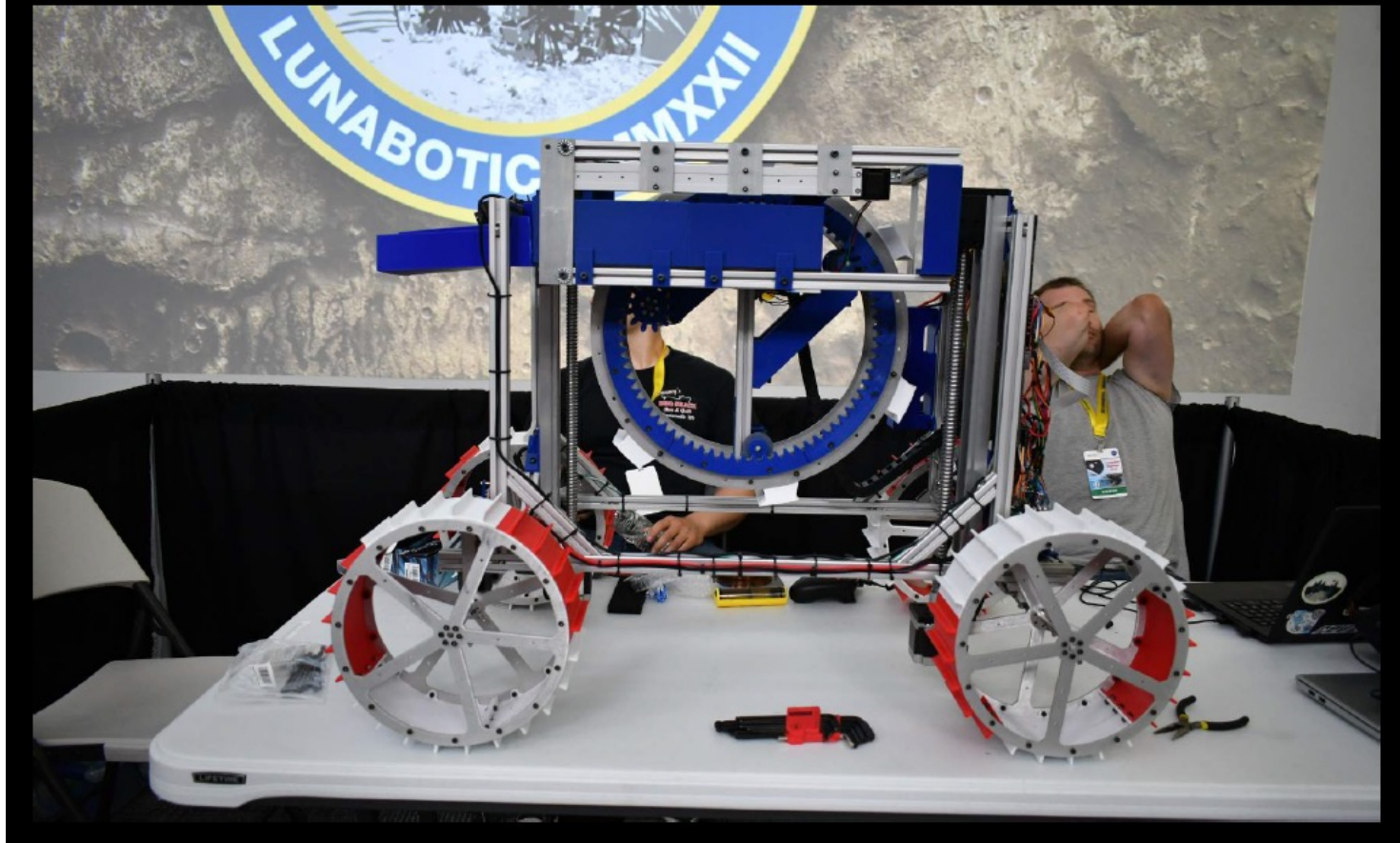




# Bucket Drums

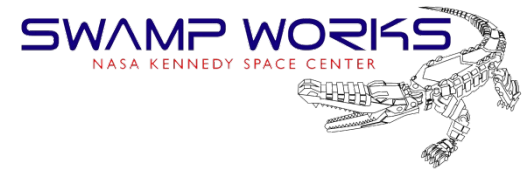


## Sonoma State





# Front End Loaders



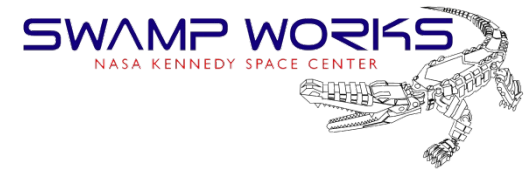
## North Dakota State



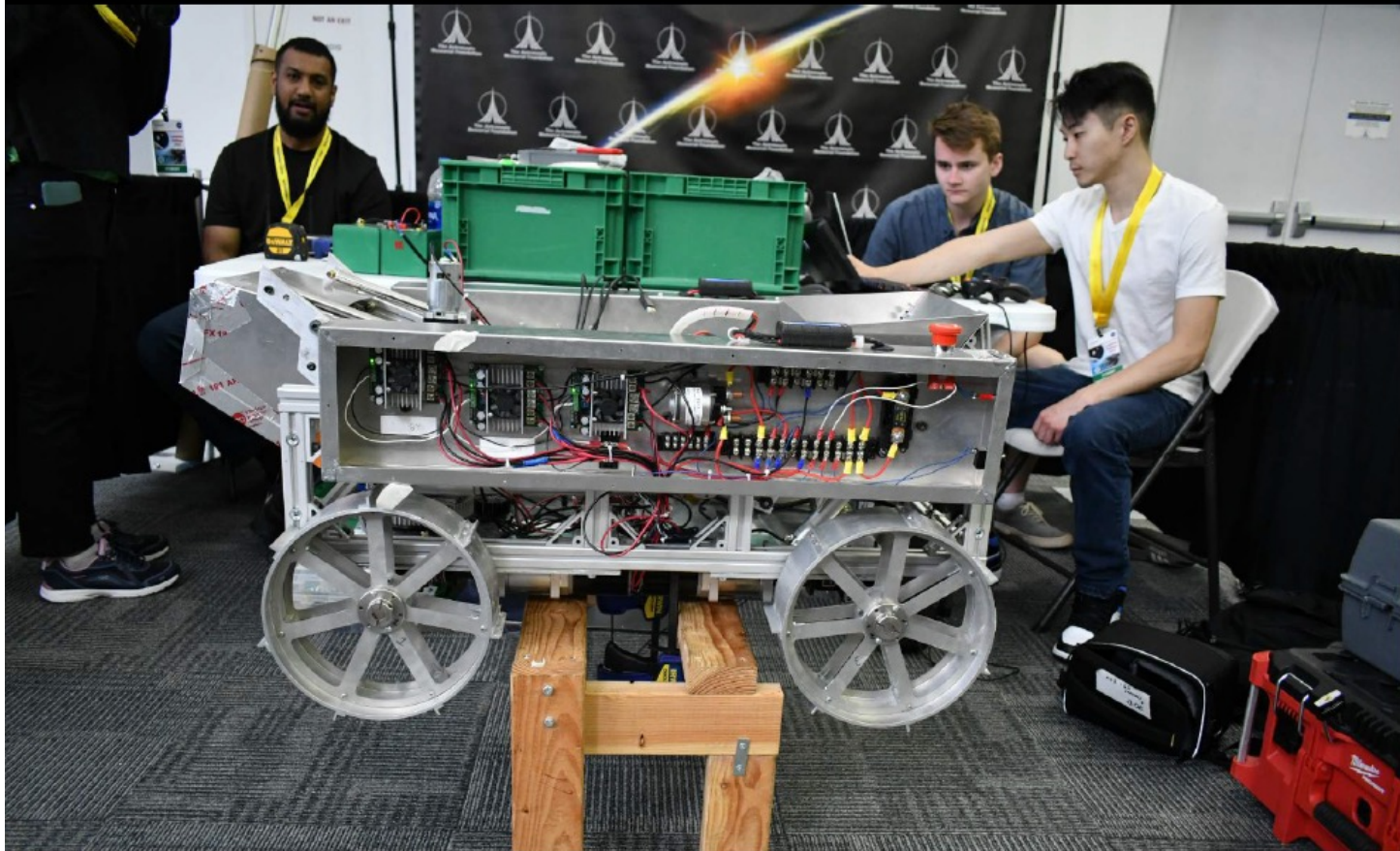




# Front End Loaders

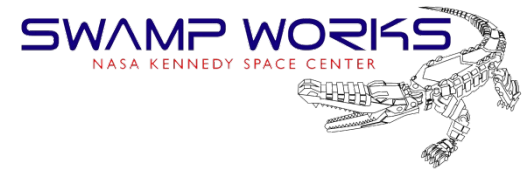


## Oakton Community College

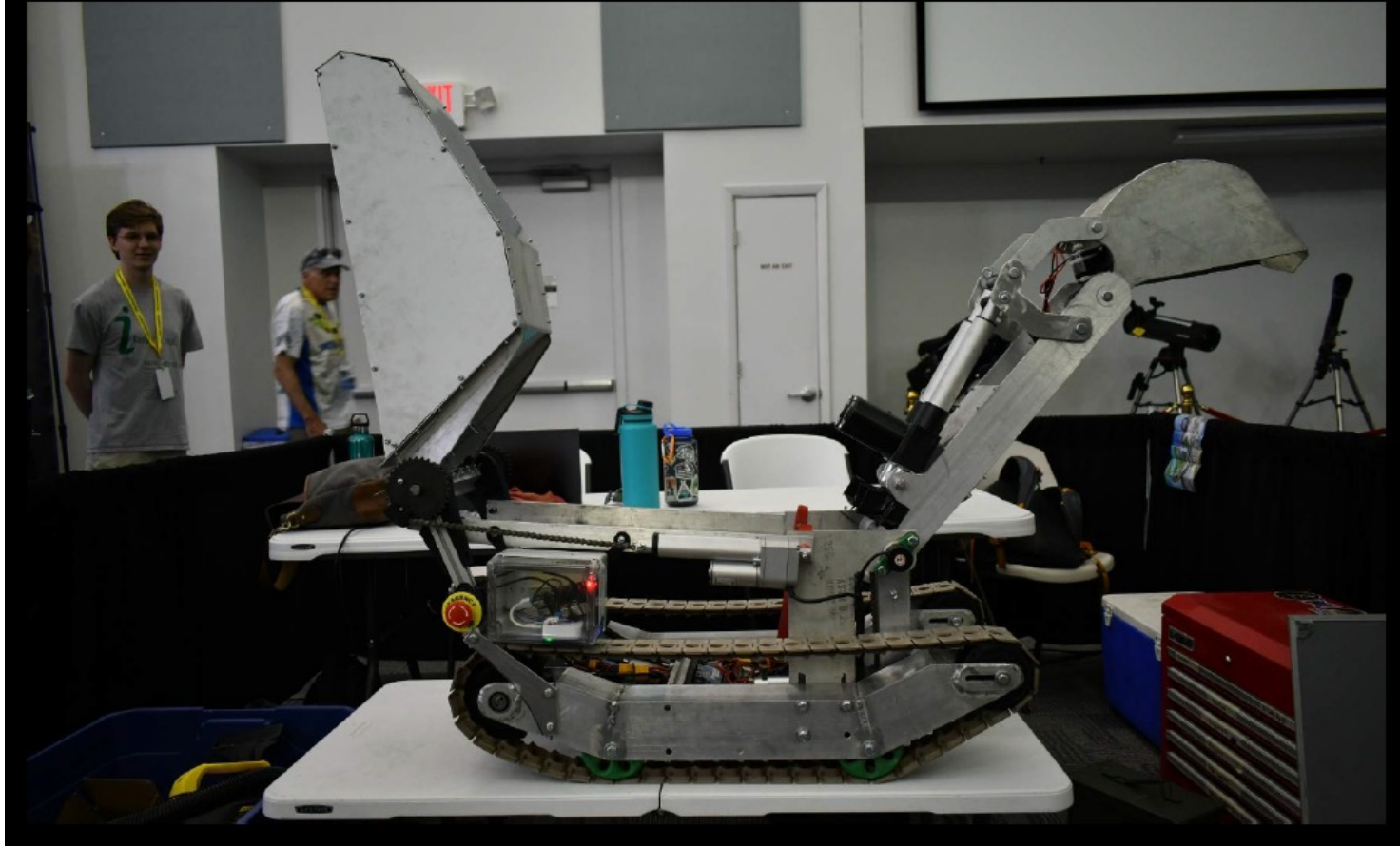




# Front End Loaders



## Montana Tech

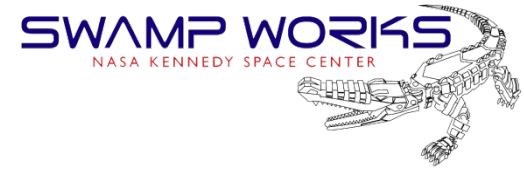






# Competition Videos

---



Lunabotics Competition “As Run” video

Monday May 23, 2022, - [https://youtu.be/glLQZzP\\_uT0](https://youtu.be/glLQZzP_uT0)

Tuesday May 24, 2022 - <https://youtu.be/M7ufpy61Eow>

Thursday May 26, 2022 - <https://youtu.be/c4toC1WJCWI>

Friday May 27, 2022 - <https://youtu.be/K1pp-x1cyaU>

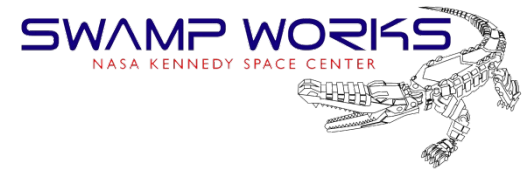
Two teams were able to qualify (minimum of 1 kg of simulated ice gravel):

University of Alabama

Montana Technological University



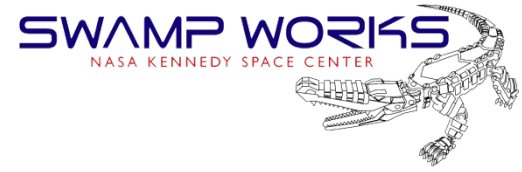
# Competition Run Video







# Summary



- Mobility in regolith was the most challenging issue for the Lunabots in the arena
- Mining the gravel proved to be difficult – very dense and compacted
- Autonomy was only partially attempted this year
- There was a COVID effect on all the teams and the competition was affected with less teams competing and less ambitious designs and software
- None of the teams have been able to completely master simulated icy regolith mining under an overburden, with full autonomy
- There is room for improvement from the universities – the competition is still hard
- Several evolution possibilities are being considered for future Lunabotics competitions

See you at Lunabotics next year!

