Markhor: Robotic Mining Platform – WPI 2017

Domenic Bozzuto (RBE, CS), Rene Jacques (RBE), Aaron Jaeger (RBE),Brian Peterson (ME), Yu-sen Wu (RBE, ME)
Advisors: Michael Ciaraldi, Kenneth Stafford

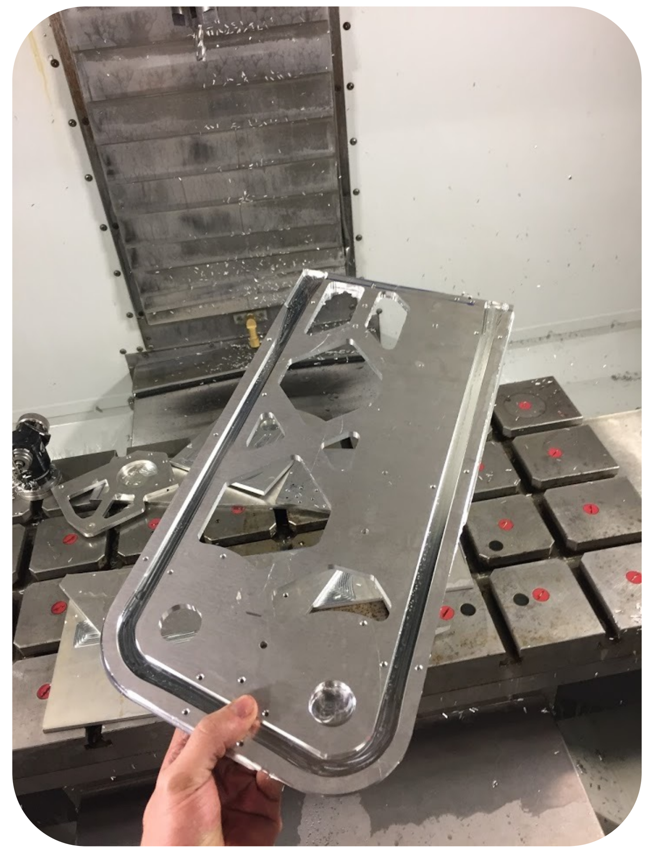
Project Goals:
Design and build robot to compete in the NASA Robotic Mining Challenge capable of in a Martian environment and collecting and depositing 100kg “icy” Regolith (crushed basalt and gravel).

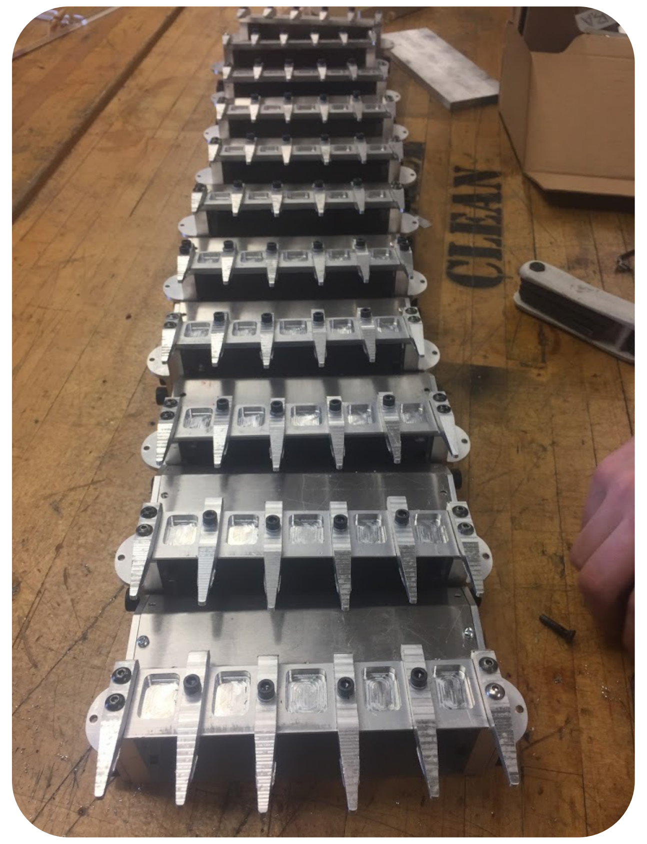
Roles:
Prototyped and experimented with new mechanism designs. Used testing results to inform design revisions. Machinist. Resource coordinator. The “glue” of the team.

Demo and project presentation: Google Drive Presentation
Additional Competition info NASA

Abstract
In-situ resource utilization, or the use of the resources available in a foreign environment, is crucial to the success of manned missions to Mars; however, it is a severely underdeveloped technology. This project explores the development of a rover capable of operating in a simulated Martian environment. The rover is capable of mining large amounts of simulated ice chunks from below the surface, driving its payload to a collection station, and unloading all the collected material. This project is partially inspired by NASA’s Robotic Mining Competition which served to establish a set of guidelines around which the robot was constructed.

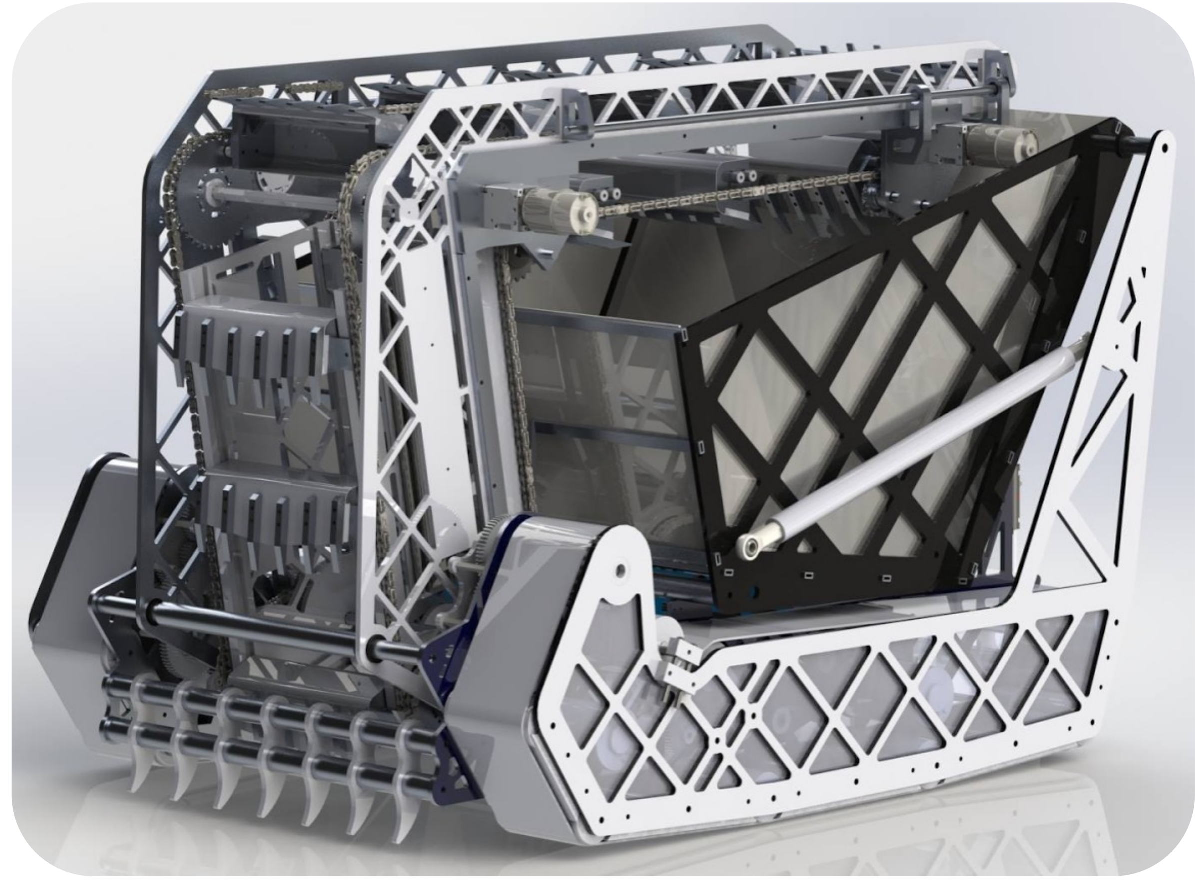
Collection System

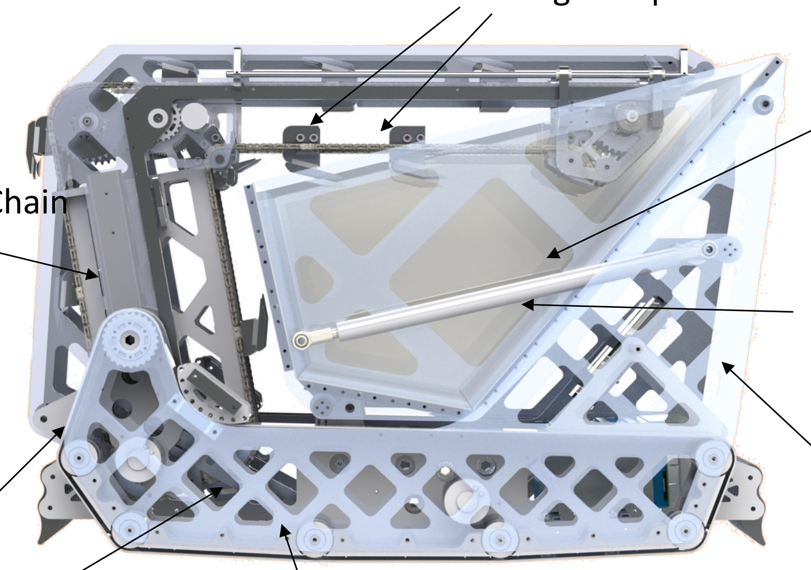


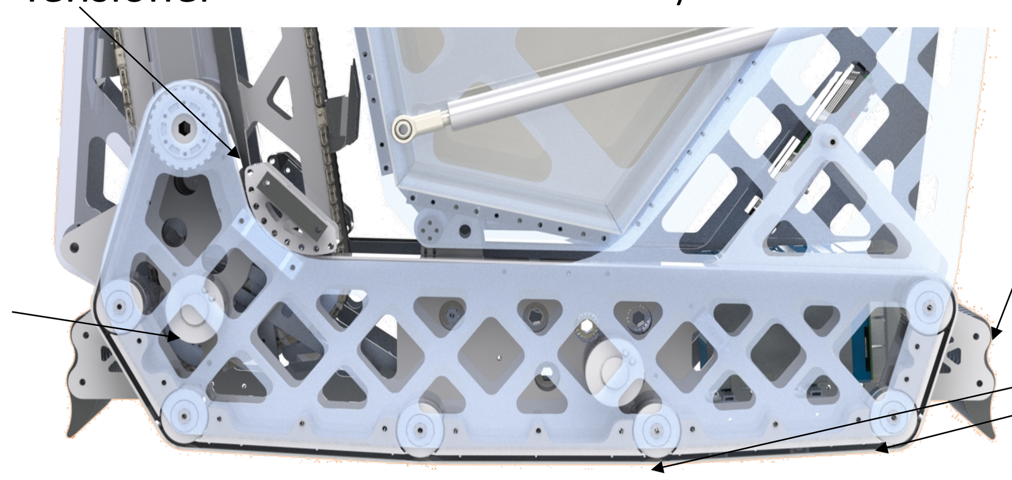


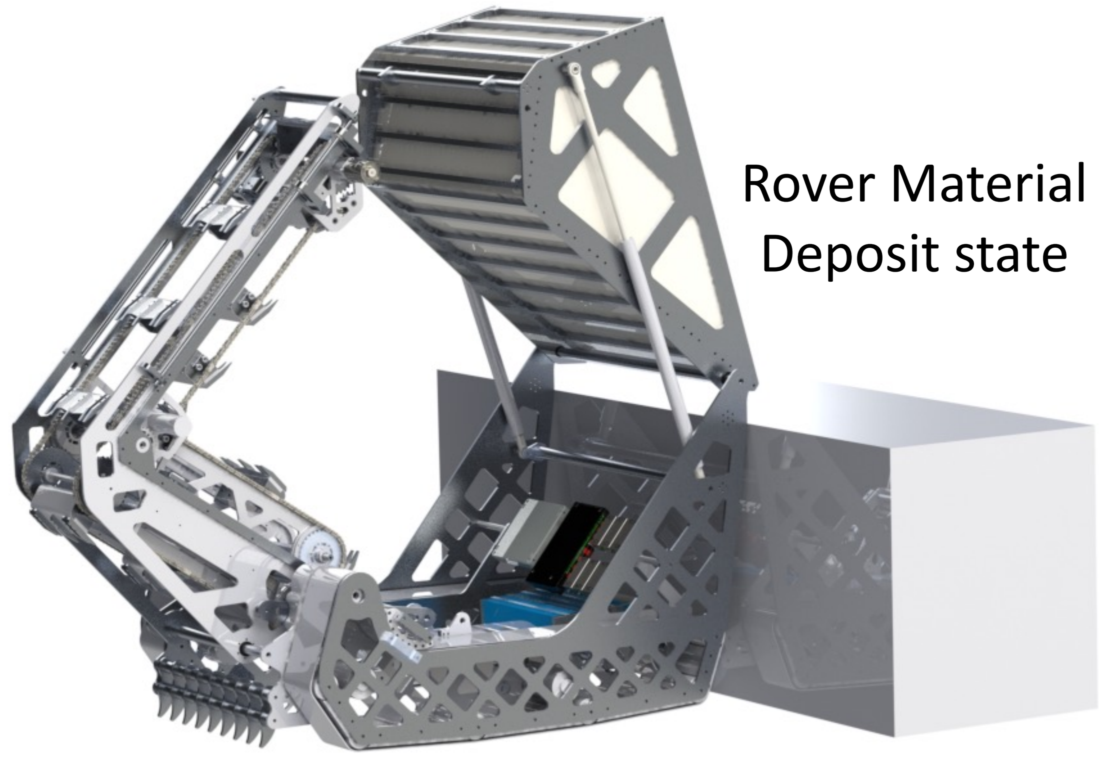
Our early collection prototypes taught us three important things. First breaking through the surface of gravel requires a lot of pressure, and the teeth on the scoops cannot be in a line. Second breaking through dirt and gravel causes a big disturbance, if the scoop is dragged through the gravel in a line after initial breakthrough then we can collect more material. Third, bucket ladder systems are very efficient at digging, however, can be fragile. Having the scoops follow a guide track transfers the digging load from the scoops to the track rather than the scoop to the chain.

When transferring material from scoops to bucket the scoops are rotated beyond 60 degrees due to the high cohesion of regolith



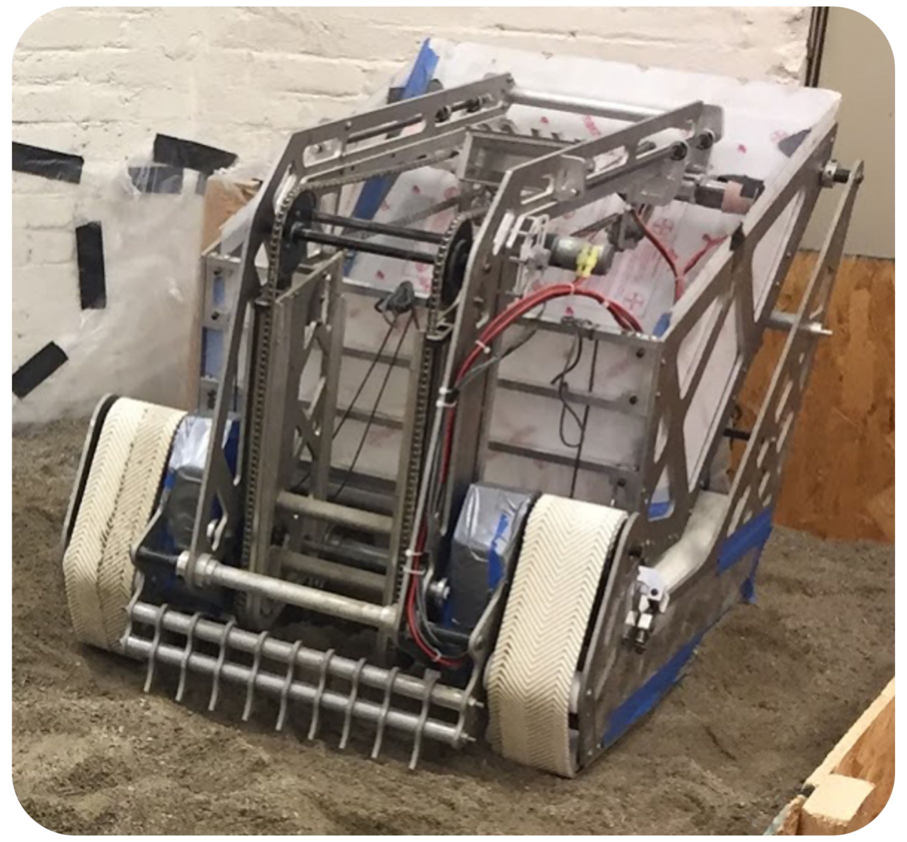






Rover Material Deposit state

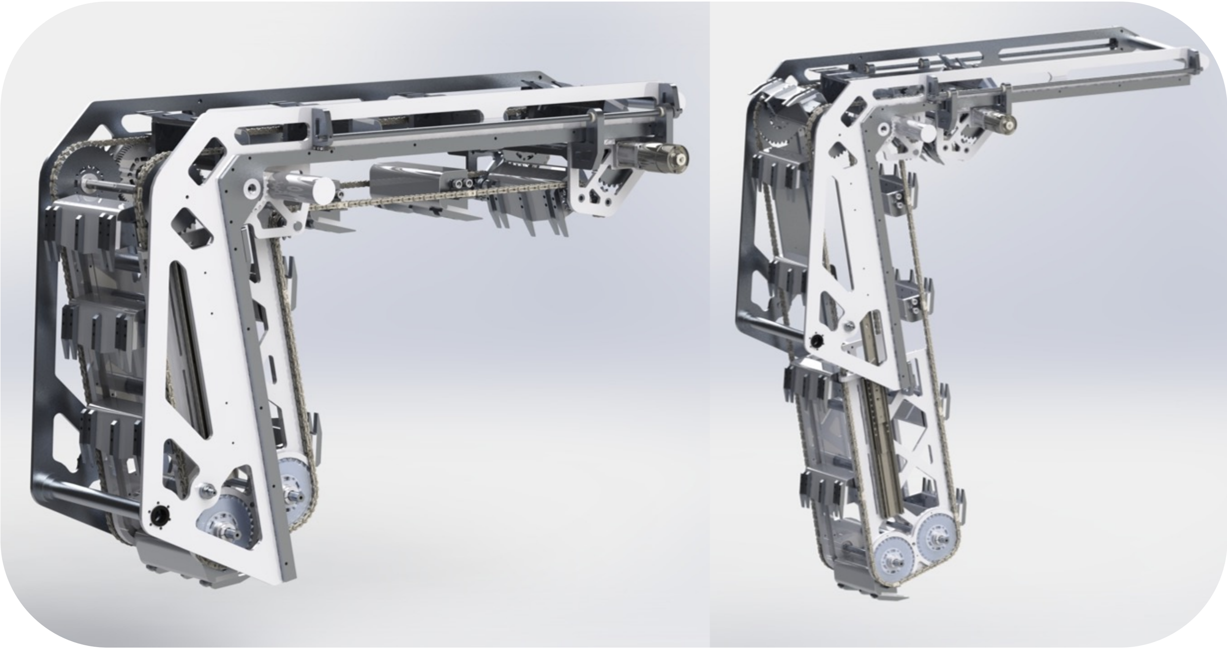
Lifting 100kg of material requires a lot of energy, and heavy, slow and expensive linear actuators. As a joke I suggested using a winch to lower the bucket lifted by a fully passive gas-shock lift system the bucket.



Markhor (front) during testing

Top: Markhor (back) at RMC
Bottom: Markhor depositing Regolith

Specifications	
Dimensions (LxWxH)	40in x 28in x 29in
Weight	80 kg (176 lbs.)
Rated Payload	100 kg (220 lbs.)
Maximum Speed	0.254 m/s (10 in/s)
Operating Time	10 min
Material Collection Rate	0.4 kg/s (14 oz/s)
Collection Depth	0.4 m (16 in)



Dynamic Chain collection system, compressed and extended state

Negotiated interdepartmental cooperation to convert Professor Bergstrom’s office into simulated Mars test facility with two tons of sand.