To harness these resources in preparation for human habitation, the proper feedstock first needs to be acquired. But the reduced gravity on the moon, Mars, comets and asteroids poses a major challenge for digging and traction during mining operations.

Terrestrial designs for soil excavation use the significant weight of the machine to create traction and counter excavation reaction forces, but on extraterrestrial surfaces, the reduced gravity does not provide high weights. In addition, space transportation is expensive and limited in capacity. Launch costs and packaging constraints of sending traditional heavy and large excavators into space are prohibitive.

The Solution

Small, inexpensive, lightweight solutions are desirable. Kennedy’s Swamp Works is currently developing technologies to push the boundaries of space mining and resource utilization. The current mining robot is named RASSOR 2.0. RASSOR, which stands for Regolith Advanced Surface Systems Operations Robot, is a 66 kg mass micro-excavator featuring two novel counter-rotating bucket drums. RASSOR is an all-in-one solution: it can dig, load, haul, dump and trench. One day a swarm of RASSORs may operate together autonomously on the moon or Mars preparing for human presence.
**RASSOR 2.0 Features**

- Dual counter rotating bucket drums for canceling horizontal excavation forces
- 66 kg mass
- 80 kg payload capacity per excavation cycle
- 0.25 m/s driving velocity
- Obstacle detection, avoidance and traversing

**Bucket Drums**

- Designed to hold a total of 80kg of regolith
- Scoops are clocked from one another to reduce the excavation forces and to keep the drums anchored to the surface while digging
- The rake angle of the scoops was designed where the scoops would act as self-anchoring once engaged into the regolith

**Automation and Software**

- RASSOR 2.0 utilizes Robot Operating System (ROS)
  - Xsens IMU, stereo cameras and actuator feedback use sensor fusion techniques to close the loop for autonomy
  - During excavation the auto dig routine balances the excavation load on each drum by sensing torque on the drums and adjusting the height of the arm

**Potential Benefits**

For every kilogram of landed mass (hardware mass + including terrestrial propellants):

- A LOx/LCH4 ISRU system can produce 20 kg of propellant
- A LOx-only ISRU system can produce 4 kg of propellant
- Harnessing the Mars regolith water for ISRU offers a 5-times improvement over Mars ISRU atmosphere processing alone.