Lunar Rescue Concept for Incapacitated EVA Crew

13 Characters

Jonah Davies, Natalia Gamez, Giovanni Trujillo, Andrew Mendiola
Faculty Advisor: Dr. Kazi Rashed
San Jacinto College, Houston, TX
For more information, contact 13 Characters at 13.character@sjcdedu.onmicrosoft.com

About The Challenge

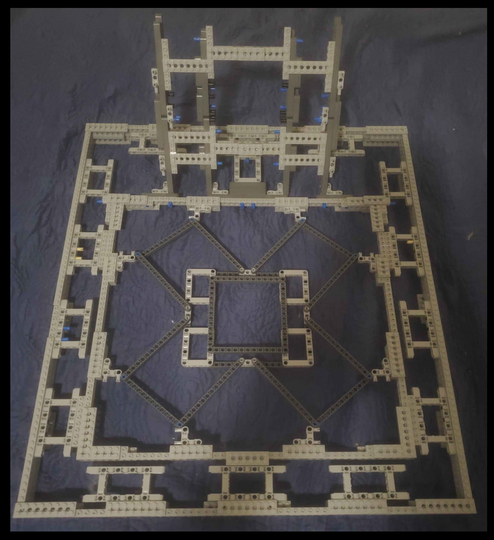
- The purpose of this challenge is to give undergraduates an opportunity to design and a ICR (Incapacitated Crew Rescue craft) that is light, manually powered, and easy to use
- During lunar missions, it is understood that astronauts could potentially be injured and require transport back to the lander

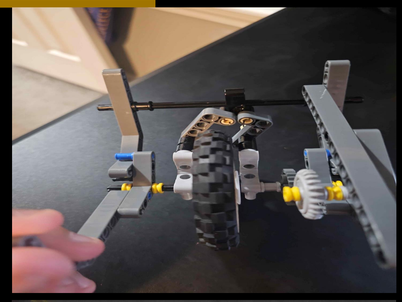
Materials

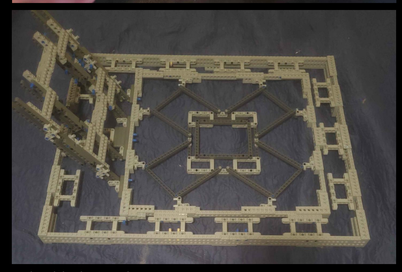
- The frame of the ICR will be constructed of Al-2219 due to its good performance across a large temperature range, strength equal to that of steel, and low density. Silicate fibers will be used to insulate against the large temperature range.

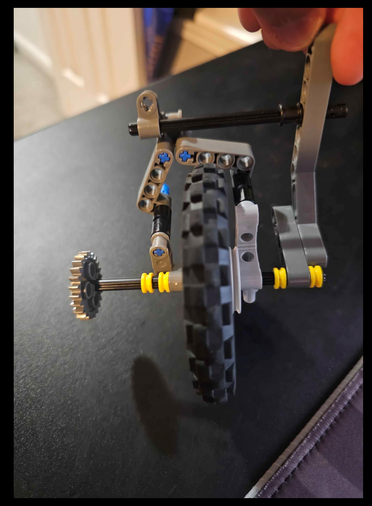
Design Overview

- 13 Characters current design iteration is a four wheeled, 6'x4'x4" cart using differential axles on a double wishbone suspension with motor assisted starts and movement
- The ICR will have science and tool storage on board which can be jettisoned in case of an emergency.
- The design will use mechanical brakes that will utilize a tension-based system so that simply pulling on a joystick will allow the crew to easily engage the brakes.









NOTE: Lego replicas not to scale, likely to change

Down Selection/Previous Designs

Design 1
The first design iteration was a four wheeled cart with movement assist motors, a handle for to be pulled, and a crane system for lifting an incapacitated crew member onto the craft for transportation. The design used a truck bed as its seat where the incapacitated crew would lie. They would be held in place by two clips which attach at the waist. This design was scrapped in favor of the current one due to significant higher mass and reliance on electrical power for multiple systems

Design 2
The second design's goal was to be as simple as possible and have no reliance on electrical power. It would be a two wheeled "mule cart" with a detachable ramp to assist the crew with moving the incapacitated astronaut onto the craft. On this design, there would have been a seat placed in the middle to position the crew member in a at the CG. This design was scrapped in favor of the current one due to having increased workload on the healthy crew member.

The Specifics

The Frame

The ICR's frame will be a 6'4'4" aluminum lattice with four wheels. Each wheel having its own mechanical brake; it will use a double wishbone suspension system and have two sets of differential axles to allow for easier turning. The rear wheels will have assistant motors to help initiate movement of the craft and maintain it on slopes or rough terrain. There will be a set of storage compartments for science samples and tools, so the astronauts do not have to carry them around. If a crew member is incapacitated, a ramp will be stored within the frame near the rear which can be taken out and attached to assist with lifting the incapacitated onto the frame. Once up, there will be a seat similar to those seen in military aircraft with a set of double retractor seat belts to hold them in place

The Subsystems

The Motors: The ICR will have two motors, one mounted on each rear wheel. Their sole purpose will be to assist in initiating the crafts movement and helping to maintain the movement on rough terrain or inclines so that healthy crew does not expend as much energy. Their energy will be supplied through batteries mounted near the front of the craft

The Brakes: The brakes will be mechanically operated with no electrical parts. They will use a tension-based system to engage and disengage, with a small light to indicate if the brakes are active. The brake line will connect to a lever which the driving crew member can pull back on to apply the tension, thus engaging the brake. In the event that the crew wish to park the vehicle, a "rubber band" will be available to lock the lever in the engaged position.

Issues and Solutions

Temperature: The temperature range given for this design challenge was from 99 to 238 Rankine. These extreme temperatures can cause significant thermal stress on components, leading to permanent warping on several components. To help counter this, we will use Aluminum 2219 and ablative materials such as a reflective coating on the outside of the craft to prevent heating through solar radiation and a thin silica lining encasing sensitive components to help keep a constant temperature, as well as vacuum sealing the components to halt heat transfer as much as possible.

Lunar Dust: The dust particulate on the Moon is as sharp as broken glass, because it literally is. Lunar dust is incredibly abrasive as well as sharp and can be dangerous to both the crew and the craft's sensitive systems. To reduce the amount of dust that ends up on the craft, the wheels will have flap guards as well as consisting of a wire mesh, and most frame parts will utilize a low friction finish to allow for the particulate to simply slide off or fall through the ICR.

Mass: Reducing mass is a crucial requirement for anything traveling upon a rocket, as increases in the rocket's dry mass can dramatically reduce Dv (Delta-v) for all stages that will need to move the additional mass. 13 Characters have mitigated this by using lightweight aluminum alloys for the bulk of the ICR and using a gridded structure to reduce the total volume of the craft.

Terrain: The Lunar surface is covered with erratic terrain formations that can be a serious challenge to traverse without pulling an ICR with an astronaut on it. To help reduce the effects of this on the pulling astronaut, 13 Characters have ensured the craft's mass will remain as low as possible and have opted to use electric motors to assist the crew with moving the ICR.

Conclusion

- 13 Characters current incapacitated crew rescue craft was selected though pugh chart analysis. We recognize that this design is not perfect and is missing decent amounts of information. If this design is accepted, we will flesh out the systems of the ICR to the best of our abilities

Acknowledgement

13 Characters would like to acknowledge the following and express their gratitude towards these individuals for their contributions in our project and their ongoing support

Kazi Rashed

Anne Vaughan

Márk Gamez

We would also like to thank NASA and TSGC for accepting us into this design challenge and giving us the opportunity to take part in such an amazing experience.