## **Let's equip our future house in 3D!**

### HIGH-LEVEL PROJECT SUMMARY

"Mars is the next tangible frontier for human exploration, and it’s an achievable objective," said NASA. Following those footsteps, we went through the 3D print challenge to help create concepts and tools to be used in a future Mars habitat. Plastic, Metal, Concrete, and a few combinations of them were the main elements we used for the 3D printing composite. Extensive research and collective brainstorming were carried out to ensure that our list of items covers the majority of the needed tools, furniture, and other items for a one-year mission.

### LINK TO FINAL PROJECT

<https://drive.google.com/drive/folders/13HI175lFE-0Dtf5VUt9Qvj1fI_PV--ts?usp=sharing>

### LINK TO PROJECT "DEMO"

<https://docs.google.com/presentation/d/1DCrVXSkfs2XgomcwM_xX8uqlW_JlVIq1/edit?usp=sharing&amp;ouid=101732326898209180672&amp;rtpof=true&amp;sd=true>

### DETAILED PROJECT DESCRIPTION

In response to the 3D print challenge, our project aims to design tools, furniture, and other items to assist astronauts on a one-year mission using materials that are easily accessible on Mars (like regolith), or a mixture of plastic, metal, and concrete materials, all while considering build volumes and resolutions of the different 3D printers on hand, the capabilities of the SOLIDWORKS CAD software, and the time we have at hand.

The main advantage of our list is that most items can have multiple purposes and functions. This allows us not only to save more on the printing composite but also to ensure that optimal space management is achieved. With all this in mind, here are item categories and the tools we propose:

Work and Maintenance tools:

These tools are used in situations where manual labor or a maintenance activity inside or outside the habitat is required: Hammer / Shovel / Pistol Grip Tool / Concrete workbench / Wire Saw / Multi-tasking screwdriver / Adjustable wrench / Vise / Glove holders / Pliers / Work goggles / Soldering iron / Electric wires / meter

Furniture items:

These are the items generally needed to have a comfortable daily life: Manual lifting & folding chair / Suspended bed / Wall-Mounted Swivel Storage Rack / Drawers / Support for rover wheels / Shoe rack

Replacement parts:

These parts are used as a replacement in situations where important items are broken, lost, or malfunctioning: Rover replacement wheel / Spacesuit helmet / Replacement filter for the oxygen generators / Rover engine replacement parts / Airlock / Plastic paper / Duct tape / Plastic bags / Trash can / Plumbing replacement parts

Emergency items:

These items are used in emergencies onboard or offboard the habitat: Nylon rope (or safety tether) / Medical instruments / First aid kit containing injection needles / Box of matches / Alternative to signal flares / Self-inflating liferaft / Mask / Wrist brace

Energy items:

These items are used when energy regeneration (water, electricity, gas) is needed: Saltwater to oxygen/fuel converter (electrolysis) + transporter / Solar panels / Gas tanks

Exploration items:

These items are used for essential exploration and sample collection: Portable telescope / Samples holder / Portable heating unit / Environmental analyzer

Kitchen:

These items are used in preparing meals, eating, and drinking: The Snack Attack / Cup / Scoop / Double hook for cups or mugs / Kitchen Sink Drain Strainer / Mixer / Customizable Measuring Spoons / Garbage Bag Holder / Multi-level Egg Holder / Sponge Holder for Kitchen Sink / Bottle citrus juicer/ Funnel / Stackable can dispenser

Handed Bottle Opener / Heating element / utensils / Food packets holder / Baking plate

Health & Hygiene items:

These items are used for daily health and hygiene purposes: Toothbrush / Ball that can be a water container / Weightlifter / Parachute silk / Hairbrush / Portable heating unit / Printed guitar

Entertainment items:

These items are used to have fun between missions: Notebook writing & drawing items (pencil, eraser..) / Playing cards / Chess / Props & models / Rubik's cube

Other items: Ground satellite receiver

### SPACE AGENCY DATA

Since our project's main objective is to design tools for Mars's habitat, we didn't employ any numerical or imagery data from Space Agencies. However, when it comes to 3D models referenced from Space Agencies, we got inspired by the following NASA 3D models:

* Helmet: https://nasa3d.arc.nasa.gov/search/helmet/model
* Perseverance Rover Wheel: https://nasa3d.arc.nasa.gov/detail/Mini-Perseverance-Rover-Wheel

### HACKATHON JOURNEY

This hackathon was nothing short of amazing. It allowed us to get together during the weekend and work on really cool designs for a Mars Habitat we only dreamed of.

At first, before NASA Space Apps began, we were hesitating between pursuing this challenge or the "Exploring Venus Together" one. We thought about the different aspects of both, from the expertise required to succeed, all the way to the amount of fun to be had, and in every argument, both choices traded blows. In addition, every one of us always dreamed sometime in our life to be in the shoes of Mark Watney from "The Martian" movie. To be given the slightest chance to experience what he virtually did is cool on its own. In the end, it came down to the high creativity and brainstorming factor of the first challenge.

We learned a lot throughout this hackathon. Not only did every one of us brush up on their previous SOLIDWORKS skills, but we also did learn a lot of new features in this CAD software that we didn't think were even there. Do you know what it's like going from only using the bare minimum of features to design a shape to understanding all those buttons and dials on the screen and knowing when to use each one of them? It's like unlocking a whole new dimension.

The primary approach we deployed throughout this challenge is to prioritize the most useful and important items. From the start, we researched the types of things astronauts would take on a mission to an exoplanet (Mars, Moon, etc), and the different kinds of issues and troubles humans could face on Mars. We then extracted the categories out of each item's context and completed them with other important categories. To fill in the gaps, we then teamed up to do extensive research on the items typically found in Earth habitats and filtered out the ones that could be combined with other things.

All in all, we got a very good list of tools to start. But here comes a problem: we can't possibly design all items within the hackathon timeframe. To solve this problem, we gave each item a score from 1-5 (the higher, the better) in 3 criteria: usefulness, importance, and ease of design. Then we summed up the scores and got a total for each tool. After that, we proceeded to rank the items based on their respective total score from best to worst. Finally, we decided to start designing the things that have a score equal to or above 11 and go down from there if the time allows. This whole approach made it possible to quickly produce a full list of the items needed and divide the design work among different team members.

We want to thank NASA for organizing this program and all the experts who helped us on Discord. We also want to thank the amazing community for engaging and being so helpful. Thank you all!

### REFERENCES

All references are organized here: https://docs.google.com/spreadsheets/d/1HRf62JvbhokmnjHwrtGACixIOpUN-ArR39CpkCOi80s/edit?usp=sharing

Work and maintenance tools:

Hammer: <https://www.youtube.com/watch?v=VlFDcZ7NVR4&t=512s&ab_channel=CADTUTORIAL>

Shovel: <https://grabcad.com/library/garden-shovel-1>

Wire saw: <https://media.discordapp.net/attachments/1025593449740779540/1025859705995800646/unknown.png>

Pliers: <https://www.youtube.com/watch?v=EJpzv0peR58>

Work goggles: <https://grabcad.com/library/safety-glasses--3>

Furniture items:

Manual lifting and folding chair: <https://grabcad.com/library/safety-glasses--3>

Suspended bed: <https://grabcad.com/library/sofa-bed-12>

Replacement parts:

Rover replacement wheel: <https://grabcad.com/library/wheel-nasa-jpl-curiosity-rover-wheel-1>

Airlock: <https://sketchfab.com/3d-models/tharsis-facility-air-lock-232f4478d23445f7a50c516cc9fcc980>

Emergency:

Nylon rope (or safety tether): <https://youtu.be/c-VeTkanXs0>

First aid kit containing injection needles: <https://www.thingiverse.com/thing:2671239>

Wrist brace: <https://www.thingiverse.com/thing:403001>

Exploration:

Portable telescope: <https://www.thingiverse.com/thing:403001>

Samples holder: <https://www.canstockphoto.com/empty-test-tubes-19381210.html>

Kitchen

The Snack Attack: <https://www.thingiverse.com/thing:723912>Cup/Scoop<https://free3d.com/3d-model/paper-cup-4162.html>

Double hook for cups or mugs: <https://www.thingiverse.com/thing:4641694>

Kitchen Sink Drain Strainer: <https://www.thingiverse.com/thing:1858532>

Customizable Measuring Spoons: <https://www.thingiverse.com/thing:51874>

Garbage Bag Holder: <https://www.thingiverse.com/thing:4941713>

Multi-level Egg Holder: <https://www.thingiverse.com/thing:3367564>

Sponge Holder for Kitchen Sink: <https://www.thingiverse.com/thing:2377774>

Bottle citrus juicer: <https://www.printables.com/fr/model/196774-screw-on-bottle-citrus-juicer>

Handed Bottle Opener: <https://grabcad.com/library/one-handed-bottle-opener>

Heating element: <https://grabcad.com/library/heating-element--2>

Health and Hygiene

A ball that can be a water container: <https://grabcad.com/library/spherical-hollow-ball-1>

Weightlifter: <https://grabcad.com/library/consider-them-dumbbells-d-1>

Entertainment:

Notebook: <https://grabcad.com/library/notebook-3>

Ground satellite receiver: <https://grabcad.com/library/satking-2>

### TAGS

#nasa #mars #3d\_printing #3d\_models #outfitting #earth #astronaut #survival #science #future #habitat #energy #spaceapps #energy #furtiture #print