Martian Greenhouse 3.0 Request for Proposal (Sample RFP)

Overview: The Martian Greenhouse Project 3.0 team, in collaboration with AIAA (American Institute of Aeronautics and Astronautics) and the Aldrin Family Foundation, is seeking systems designed to produce food for human habitation on Mars. These prototype systems will need to be self-sufficient and fit within a relatively small space. The greenhouse will provide habitat for the growth of a variety or varieties of edible plants.

1. Design of Structure
    1. Student teams are asked to design a self-contained greenhouse module with a volume no larger than 1 meter3. This volume includes all supporting equipment.
    2. Teams will create a set of procedures and plans that may be shared that allow others to duplicate their design.

1. Growth of Plants
    1. Teams will provide a rational for their selection of a crop or crops to be produced.
    2. Teams will submit procedures and a time-line for planting, maintenance and harvest of their crop(s).
    3. Teams will provide a recipe for preparation of their crop(s) as a food source.

1. Use of Water
    1. Teams will identify the amount of water that will be consumed by the system and create a water budget for their greenhouse design.
    2. Teams will address systems to limit use of water.

1. Use of Energy
    1. Teams will identify the amount of energy that will be consumed by the system and create an energy budget for their greenhouse design.
    2. Teams will account for lighting and generation of power.

1. Efficiency of the System
    1. Teams will calculate and submit a chart defining the efficiency of their system by comparing total use of energy and water to the total calories of food produced.

1. Submissions
    1. Teams have the option of submitting one of the following packages
        1. Technical drawings and a descriptive paper,
        2. Technical drawings, a descriptive paper, and a conceptual model, or
        3. Technical drawings, a descriptive paper, and a functioning prototype
    2. Teams will create and post a brief video to YouTube that describes the process, products and learning by the team.

The RFP is designed with the idea of appealing to students with a wide range of interests and to make use of management strategies. Projects will not be judged against each other. The idea is to allow everyone a chance to compete with themselves against set functional standards.

Jim Christensen, Aldrin Family Foundation, 2021

Teachers	**School**	**Mentors**
Michael Cus	Our Lady of Guadeloupe	Masha Esfandabadi & Nicole Rote
Wu, McDougall, & Itzab	Pallotti HS	Sunny Narayanan & Nutifafa Doumon
Dr. Rose & Dr. Trudi	Astra Nova	Jeffrey Umland
Peter Tlusty	St. Mary's	Pacifica Sommers
Michael Bruscia	Charlottesville Catholic School	Bryce Meyer
Melissa Sleeper	Storm Grove MS	Chad Cerutti
Christina Campos	West Oslo JH	Chetan Kulkarni
Nadine Francisco & Sonieda Teul	Georgetown Technical HS	Rhonda Ahrens & Rose Worku
Christine Girtain & Dr. Kretz	Toms River HS	Mario Maggio
Zenaida Romero & Melva Guerra	Our Lady of Guadeloupe	Dr. Emilly Matula & Grace Ford
Rick Russon	Valor Christian High School	Tamalee Basu
Arielle Christensen	Wings Aerospace Pathways	Uyen Suo
Wilson Mendoza & Guilber Mesh	Bishop Martin High School	Dan Adamo
Dr. Joe Wagner	Eads High School	Dan Adamo
Bede Adazi	Liberty Bells Schools	Nikhitha C
Uzma Mazoor	DPS Sahiwal	Prakhar Jain
Adrian Ojeda Flores	**Liceo Naval C. de N. Francisco Carrasco**	Peruvian Mentors

Our Teams are from Belize, Nigeria, Pakistan, Virginia, New Jersey, Colorado, California, and Florida.

Martian Resources

AIAA FREE HS Student Membership: LINK

Descripción del proyecto en español: **LINK**
Thank you Aurospace

Mars Facts
https://mars.nasa.gov/all-about-mars/facts/

3D Printed 'Artificial Leaves' Could Provide Sustainable Energy on Mars
https://interestingengineering.com/3d-printing-microalgae-for-sustainable-energy-on-mars

The Cultured Meat Revolution: Singapore and Israel One Step Closer to Commercializing Lab Grown Chicken
https://3dprint.com/276467/the-cultured-meat-revolution-singapore-and-israel-one-step-closer-to-commercializing-lab-grown-chicken/

Astronauts Enjoyed a Fresh Supply of Leafy Greens Grown on the International Space Station
https://scitechdaily.com/astronauts-enjoyed-a-fresh-supply-of-leafy-greens-grown-on-the-international-space-station/

Bringing Space Home: The Role of Sample Return in Space Exploration:
https://vimeo.com/537422251

This algae bioreactor can remove as much carbon dioxide as an acre of trees
https://www.inverse.com/article/59334-this-algae-bioreactor-can-sequester-carbon-dioxide

Algae Caviar, Anyone? What We'll Eat on the Journey to Mars
https://www.wired.com/story/space-food-what-will-keep-us-human/

With Bugs and Algae, One Million People Could Live in Mars Colonies
https://www.discovermagazine.com/the-sciences/with-bugs-and-algae-one-million-people-could-live-in-mars-colonies

Nasa's rover makes breathable oxygen on Mars:
https://www.bbc.com/news/science-environment-56844601

Clever space algae could be the key to getting humans to Mars
https://www.wired.co.uk/article/algae-long-term-space-missions

NASA is learning the best way to grow food in space
https://www.popsci.com/nasa-growing-food-in-space/

Terrestrial, Atmospheric, and Space Science
https://www.lanl.gov/org/ddste/aldcels/chemistry/physical-applied-spectroscopy/terrestrial-atmospheric-space-science/index.php

3D Printed Artificial Leaves Could Generate Oxygen on Mars
https://3dprint.com/281250/3d-printed-artificial-leaves-could-generate-oxygen-on-mars/

Automatic Gardening
https://www.youtube.com/watch?v=v3aTJeuTW5Y

Greenhouses for Mars
https://www.nasa.gov/vision/earth/livingthings/25feb_greenhouses.html

Roane Lab: Applied Microbial Ecology
https://roanemicrobiology.weebly.com/

Microorganisms in parched regions extract needed water from colonized rocks
https://www.sciencedaily.com/releases/2020/05/200504155203.htm

Getting Water From a Stone: How Life Survives in Extreme Environments
https://scitechdaily.com/getting-water-from-a-stone-how-life-survives-in-extreme-environments/

Space agencies are learning how to make food on Mars and the moon
https://www.cnbc.com/2021/06/20/space-agencies-are-learning-how-to-farm-on-mars-and-the-moon.html

Mars: Vast amount of water may be locked up on planet
https://www.bbc.com/news/science-environment-56400227

Sneaky New Bacteria on the ISS Could Build a Future on Mars
https://www.wired.com/story/sneaky-new-bacteria-on-the-iss-could-build-a-future-on-mars/

Nasa's rover makes breathable oxygen on Mars
https://www.bbc.com/news/science-environment-56844601

Inspirational story about a 12-year old aerospace girl
https://www.goodmorningamerica.com/amp/living/story/12-year-genius-sights-set-nasa-engineer-76923842 /
https://www.goodmorningamerica.com/living/video/12-year-child-prodigy-dreams-working-nasa-day-76983173

Decades of Mars research by CU faculty and students lays the groundwork for human astronauts|LASP|CU-Boulder

AIAA Classroom Grant Program
https://www.aiaa.org/get-involved/students-educators/aiaa-foundation-classroom-grant-program

Google Workspace
https://blog.google/products/workspace/google-workspace-everyone

Mars Science City project in Dubai
https://www.3dnatives.com/en/top-5-videos-dubais-mars-science-city-130620214/

Decades of Mars research by CU faculty and students lays the groundwork for human astronauts
https://lasp.colorado.edu/home/2021/03/05/decades-of-mars-research-by-cu-faculty-and-students-lays-the-groundwork-for-human-astronauts/

Technical Sketching
https://sites.google.com/stemk12.org/mr-rs-engineering/introduction-to-engineering/technical-sketching

Nanoracks' spinoff aims to bring food production to Earth's deserts and orbital space
https://www.space.com/nanoracks-food-agriculture-earth-deserts-orbit

In an attempt to understand "Key (Driving) Requirements, I found these resources:

https://science.nasa.gov/science-red/s3fs-public/atoms/files/2019-546-Pugel-Final-WhatAreRequirements%20.pdf
https://www.nasa.gov/sites/default/files/atoms/files/nasa_systems_engineering_handbook_0.pdf

Mars Greenhouses: Concepts and Challenges. Proceedings from a 1999 Workshop:
https://ntrs.nasa.gov/citations/20050182966

KETCHUP on MARS:
https://www.floridatoday.com/story/news/2021/11/15/florida-tech-and-heinz-grow-space-tomatoes-marz-ketchup-brevard-county-space-travel-mars-red-planet/8584265002/?utm_source=floridatoday-Daily%20Briefing&utm_medium=email&utm_campaign=daily_briefing&utm_term=hero&utm_content=1028FT-E-NLETTER65

Deep Space Food Challenge - Winner
https://www.nonfiction.design/projects/deep-space-food-challenge

https://www.hortidaily.com/article/9398112/chickpea-seeds-headed-to-international-space-station-for-use-in-mini-greenhouse/

https://spacewatch.global/2022/03/interstellar-lab-announces-a-us-5-million-seed-round-to-accelerate-biopod-manufacturing/

https://nypost.com/2022/03/22/humans-on-mars-may-feast-on-gene-edited-salad-to-stop-bones-breaking/

ISS Post-Flight Crew Debrief (June 1, 2022): *They said one of their favorite experiments was the Veggie system, in part because they got to eat some good tasting produce at the end, but that wasn't the main reason. He said that he looked forward to opening up the plastic curtain and having the earthy, green smell of things growing blast him in the face as a break from the sterile plastic smell from the rest of the station. He said it was actually great for his mental health.*

https://www.nonfiction.design/projects/deep-space-food-challenge
Hydroponically grown microgreens bring a little bit of planet Earth to the tastebuds and the psychology of the astronauts. Maintaining the hydroponic garden is essentially nurturing nature. It lowers blood pressure, stress levels and brings a sense of balance to the void of space. Closed loop hydroponics can help agriculturally challenged environments on the planet as well.

micor:bits Hackathon Invitation: Kevin Simmons has invited students to this FREE event.
https://www.wolfpacksat.org/hackathon
Students will be organized into 3 person teams and given 24 hours to solve a series of open-ended problems related to growing food in space.

Careers in Aerospace:
https://www.aiaa.org/docs/default-source/uploadedfiles/education-and-careers/2020-hs-career-booklet.pdf

MAT Filtration Technologies has a system that produces food for fish based on Hybrid Autotrophic Bacteria using human feces- https://matkuling.com/news/first-aquaculture-farms-mars-space/

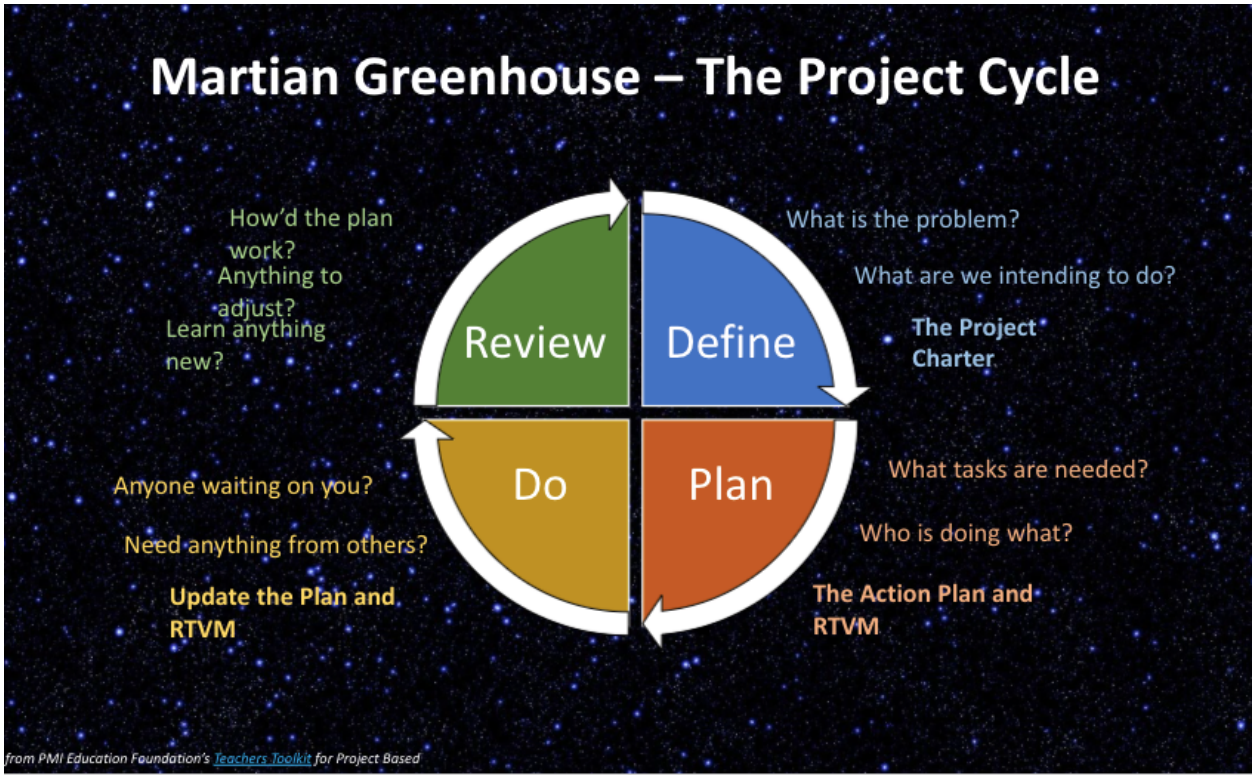
Life on Mars - SpaceGeekChannel on youtube:
https://www.youtube.com/channel/UCmw1hdlTnPFil0ZfT_C-cvw

Could the "The Martian" Really have Grown Potatoes for Food?

Examples from MG 2.0

PPT **LINK**

Descriptive Paper **LINK**



Martian Greenhouse Project Management Video Link

Martian Greenhouse

[TEAM NAME HERE]

PROJECT CHARTER

1. General Project Information

Team Name:	
Team Mentor(s):	

2. Project Team

Name	Phone	Email

3. Stakeholders (those with significant interest in the project or will be impacted by project)

4. Project Scope

Purpose (describe the need this project addresses)

Objectives (describe the measurable outcomes expected of the project)

Scope

IS (what the project deals with)	IS NOT (elements outside the project)

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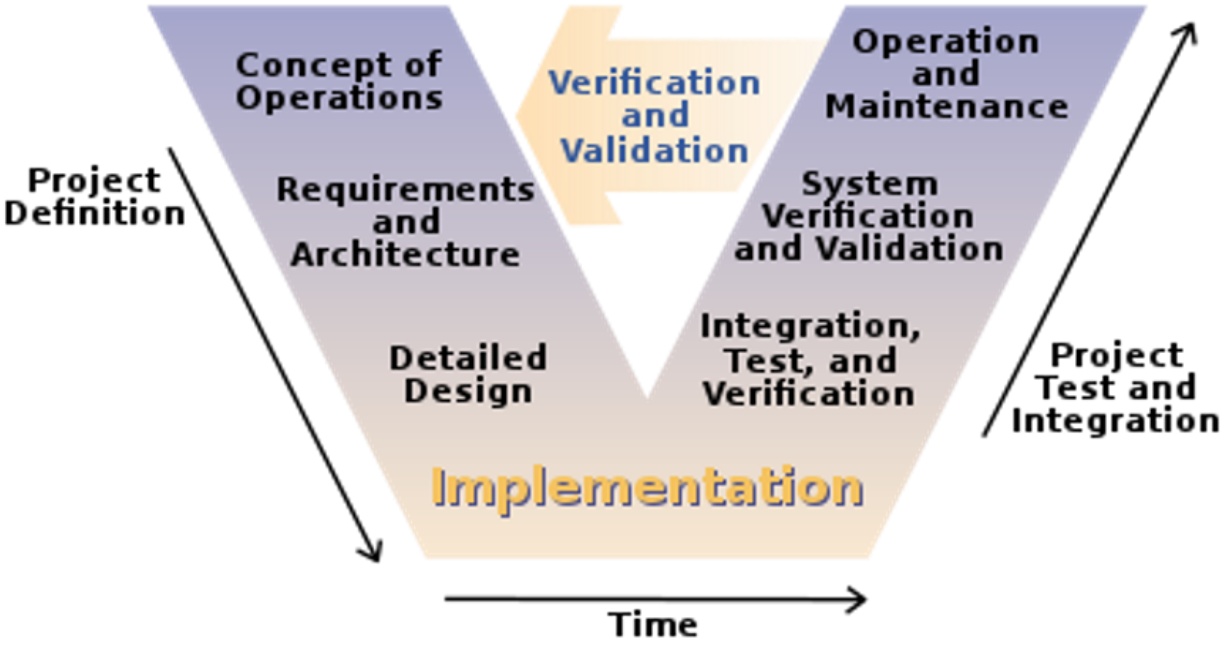
Deliverables (describe the high-level "products" to be created as part of the project)	
1.	5.
2.	6.
3.	7.
4.	8.

Milestones (major phase dates such as start, plan, design, work, deliver, review)

Constraints (any limiting conditions on resources, personnel, schedule, etc.)

5. Communications (frequency and type of communications)

6. Other Notes		

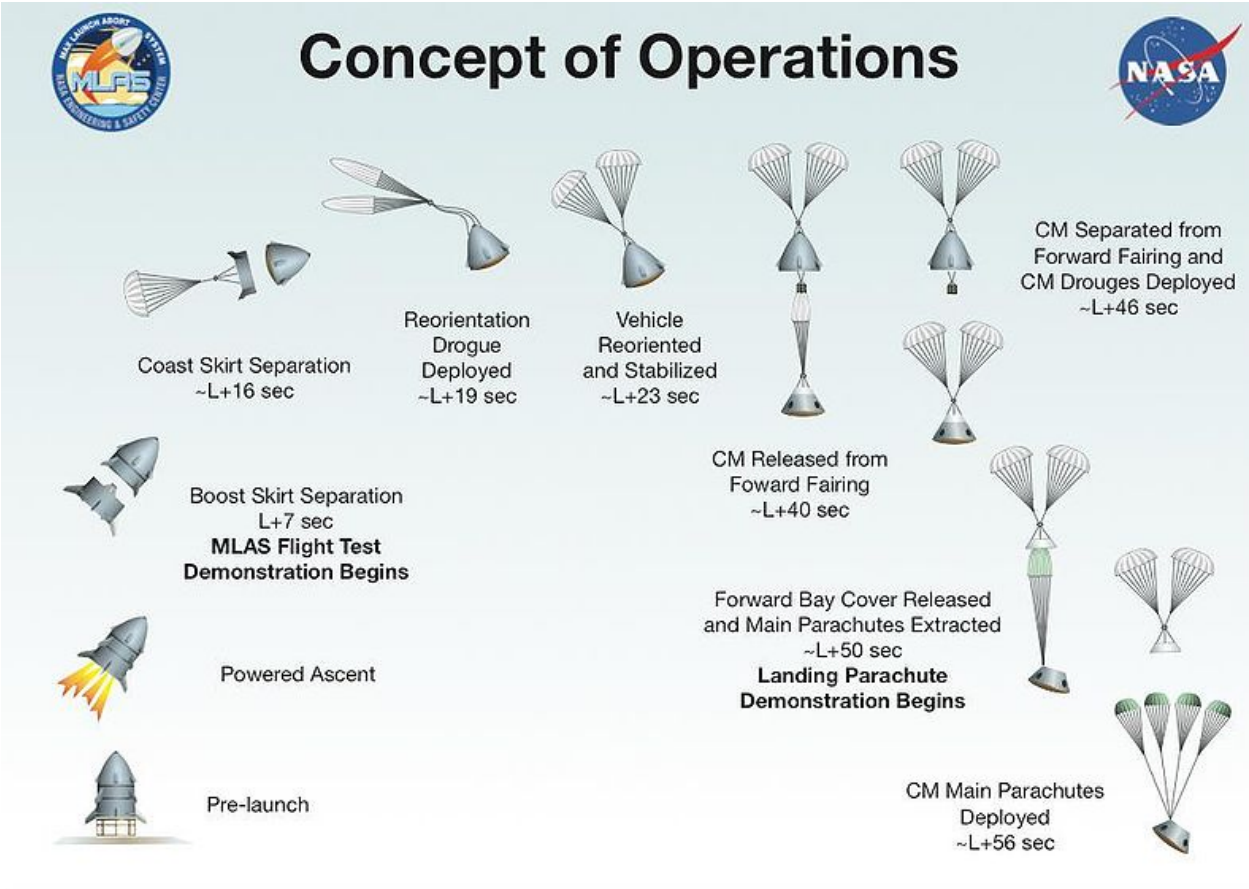


Telling the Story

ConOps (Concept of Operations)

From Dr. Matula:
These are used a lot in the aerospace industry (especially the space industry!) to describe how a system or technology is going to work during a mission. You can think of them like a story, it tells the audience how something is going to work or how it will be used during its activity.

Spaceflight Example
Below is a concept of operations of how NASA was going to test an emergency abort system for a crew capsule using parachutes.
The story it tells is:
The abort system will be loaded onto a rocket, and launched.
The abort system will separate from its launcher and the top 2 parachutes will deploy and start to slow down the abort system connected to the crew capsule.
After the crew capsule is slow enough, the abort system will release the crew capsule.
The crew capsule will start to land using its own 2 parachutes, release them, and finally land using its 4 parachutes



Everyday Example

When I am coming up with a concept of operations, I like to imagine how I would use the technology
Ex: A canvas grocery bag design

My story:

When I leave my house to go to the grocery store, I need to take something with me to carry my groceries in.
I grab my canvas grocery bag and put it in my car.
I get to the store, take my bag in with me, pick out my watermelon, and pay for the melon.

I put the melon in my bag and I walk out of the store to my car carrying the bag by its handles

Why we use ConOps

We will use ConOps to not only tell others what we are going to do, but also helps us think about what we expect our system to do, if we are forgetting anything in our design, and to make sure our design meets all our requirements.

My bag design

-Big enough to hold a melon
-Strong enough material to hold a melon
-Light enough for me to carry around in the store
-With handles for easy grabbing

Make a ConOps diagram that either describes

-How your greenhouse will be built/deployed
-How astronauts will plant, tend, harvest plants using your greenhouse systems
-How one of the systems in your greenhouse will operate/interact with the other systems in the greenhouse

Good luck and we look forward to having you share your ConOps diagrams with the other teams.

Great CONOPS Resources
CONOPS Diagrams
PDF for the **GOES-R progra**

Presenting Tips for Slides

(from Eric Wilson - The SLIDE master!)

Identify the key message(s) on each slide

1. Each slide should have 3-4 key points at most. If it's an important element of your project – like your greenhouse drawing/model – I'd say just that one key point on a slide is great.
2. A key message can have supporting bullet points below it. But those shouldn't be read to the audience. They can read faster than you can talk so just touch on the header key points on the slide then move on.
3. If the slide is strictly pictures or graphics, make sure to have your speaker notes handy. Doesn't need to be a script you read – you'll come across as a better presenter with more natural speaking. But keeping your 2-3 key bullet points on a note you can see during the presentation will help keep you focused and moving through the content.

Look for ways to combine slides

1. If there are commonalities in key points on three slides, can the supporting text be deleted? Pictures combined?
2. While you can certainly leave the three slides in place and talk to each one for 20 seconds, it is often more effective to make one slide and talk for 45 seconds. Just saved 15 seconds!

Practice presentation timing

1. Create the slide deck, use 1 minute per slide as guidance.
2. When you practice the speaking portion, target 30-45s per slide. if you find yourself going over that by a lot, look for ways to delete content. You practice at less than your planned minute per slide because most times you'll be excited during the live session and will talk more.

Words of Wisdom from Design Team Member Jim Christensen

Spit Shine 90 Seconds of Wisdom from Jim Christensen

Martian Greenhouse: Jim's Reflection