



From Monitoring Microbes in the International Space Station to Building Houses on Mars

Monsi Roman

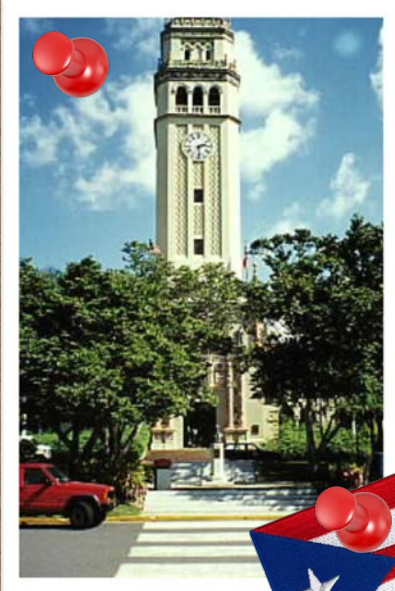
Centennial Challenges

Program Manager

NASA

www.nasa.gov/winit







6-month Missions



Astronaut Scott Kelly will drink 730 liters of recycled sweat and urine during his #YearInSpace.



Water is a precious and limited resource in space, so International Space Station crew members recycle it whenever possible, including recycling their own urine.

 #YearInSpace www.nasa.gov/oneyear



14- Day Missions



Microbiology and the International Space Station





Contamination Potential



***Preflight
contamination***



***Spacecraft are
complex***



***Astronaut
activities, such as
eating and hygiene***





Prevention - Vehicle Design

- HEPA air filters
- In-line water filters
- Contamination resistant surfaces
- Water biocides
- Water pasteurization systems
- Minimize condensation
- Contain trash and human waste





Prevention





Microbiological Monitoring on the ISS

Surfaces



Air



Water



Quantified in-flight and returned to Earth for identification

Acceptability Limits

Air

- Total bacteria
- Total fungi



1,000 CFU/m³

100 CFU/m³

Surfaces

- Total bacteria
- Total fungi

10,000 CFU/100 cm²

100 CFU/100 cm²

Water

- Heterotrophic plate count
- Total coliform bacteria

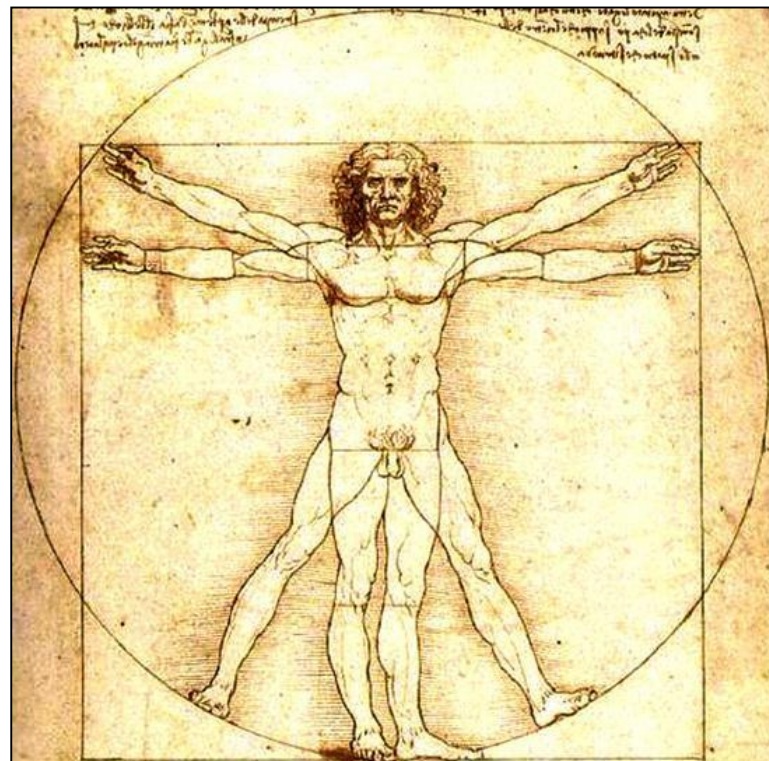
50 CFU/ml

Not detected in 100 ml



Infectious Disease during Spaceflight

- Much is based on symptomology
 - Headache
 - Rash
 - Dry hacking cough
 - Diarrhea
- Attributed to infectious disease
 - Upper respiratory infections
 - Ear infections
 - Various fungal infections
 - Herpes Zoster
 - Gastroenteritis
 - Stye
 - Allergic reactions
 - Rashes & skin disorders





Adverse Effects of Microorganisms

- Infectious Disease
- Biodegradation
- Systems failure
- Food spoilage
- Release of volatiles





U. S. Potable Water Dispenser

- Provides “hot” and “ambient” potable water
- Processing includes:
 - Catalytic oxidizer
 - Iodine disinfection
 - In-line filter (0.2 micron)
- Common isolates
 - *Ralstonia pickettii*
 - *Burkholderia multivorans*
 - *Sphingomonas sanguinis*
 - *Cupriavidas metallidurans*



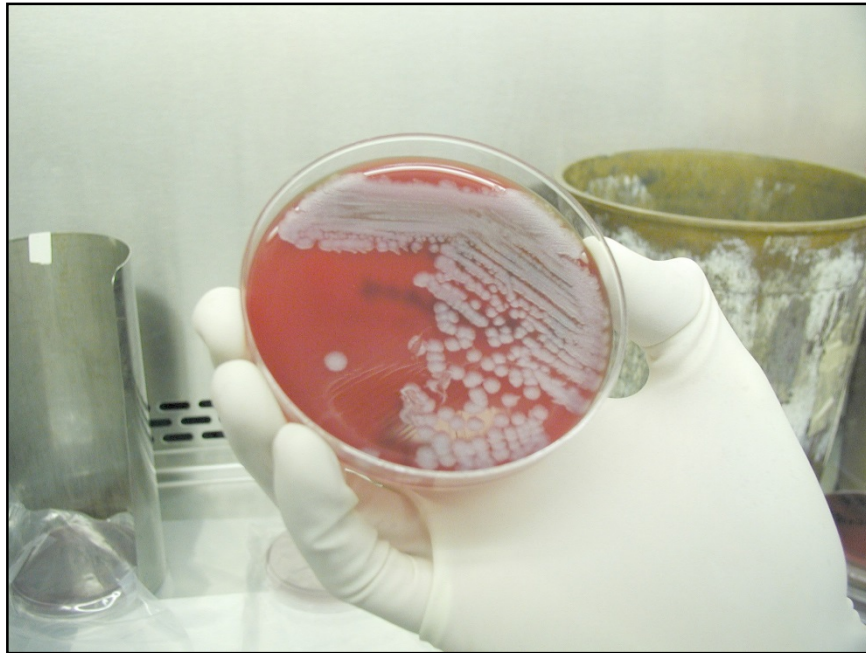


Microbiological Monitoring of Water





Microbiology – How We Monitor



Media based technology
[Colony Forming Units (CFUs)]



DNA based technology



Microbial Monitoring during Spaceflight

- Safety concerns
- Minimal
 - Power
 - Weight
 - Volume
 - Crew Time
- No phase separation





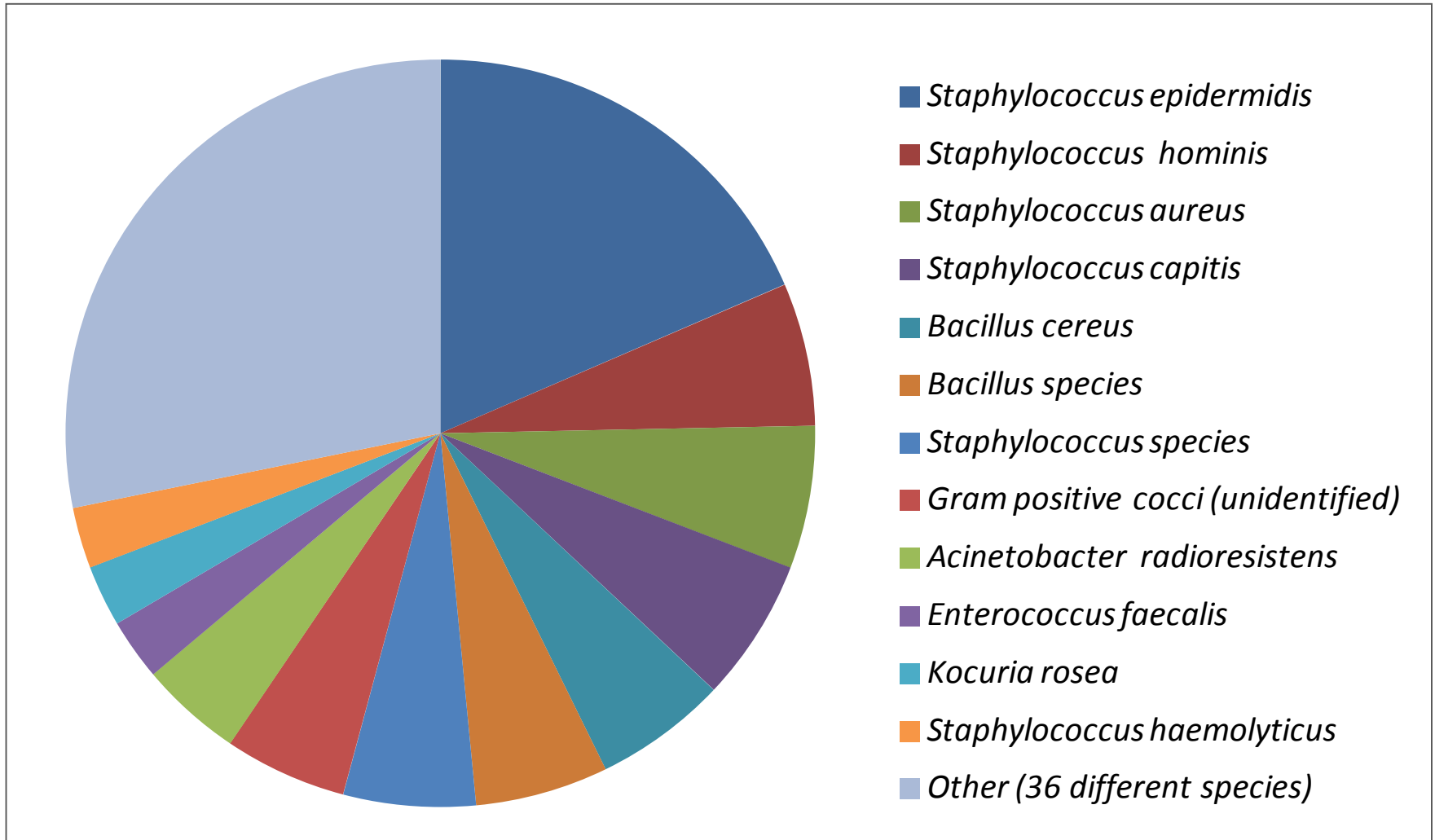
Next Generation Spaceflight Monitoring

- Spaceflight technology demonstrations
 - Razor system
 - QPCR technology – Targeted probes
 - Designed for and used by the military
 - Dry chemistry for easier sample prep
 - Limited number of sample wells
 - MinION system
 - Nanopore technology
 - Sequences all organisms in the sample
 - Requires sample prep
 - Scheduled to fly aboard SpaceX 9 (July 2016)



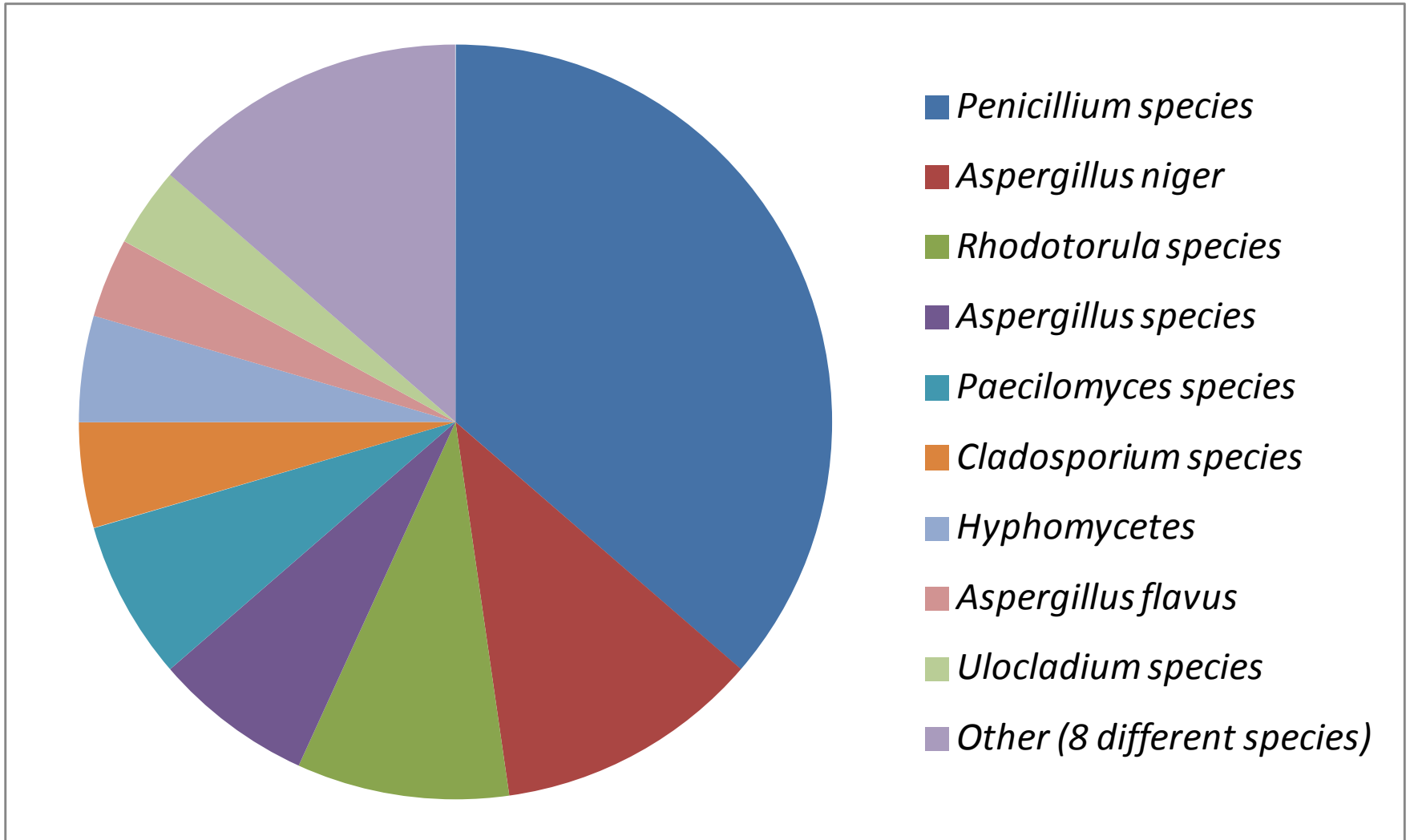


Bacterial Diversity of Surface Samples





Fungal Diversity of Surface Samples





Microbiological Spaceflight Research

- Multiple experiments over the past 50 years indicate unique microbial responses when cultured during spaceflight
- The environmental stimulus/stimuli initiating the response mechanisms are unclear
- The vast majority of microbial ecology data is based on media-based analysis
- The impact of radiation on microbial responses/mutational rates is not known





“Establish a “microbial observatory” program on the ISS”
– *National Research Council*

JOURNEY TO MARS

...A Piece of Our

Tissue Engineering

TECHNOLOGY

HUBBLE

INTERNATIONAL SPACE STATION

SPACE LAUNCH SYSTEM (SLS)

ORBITERS

LANDERS

3-D Printed Habitat

Cube Quest

SCIENCE

Space Robotics

Sample Return Robot

PHOBOS DEIMOS

Mars Ascent Vehicle

COMMERCIAL CARGO AND CREW

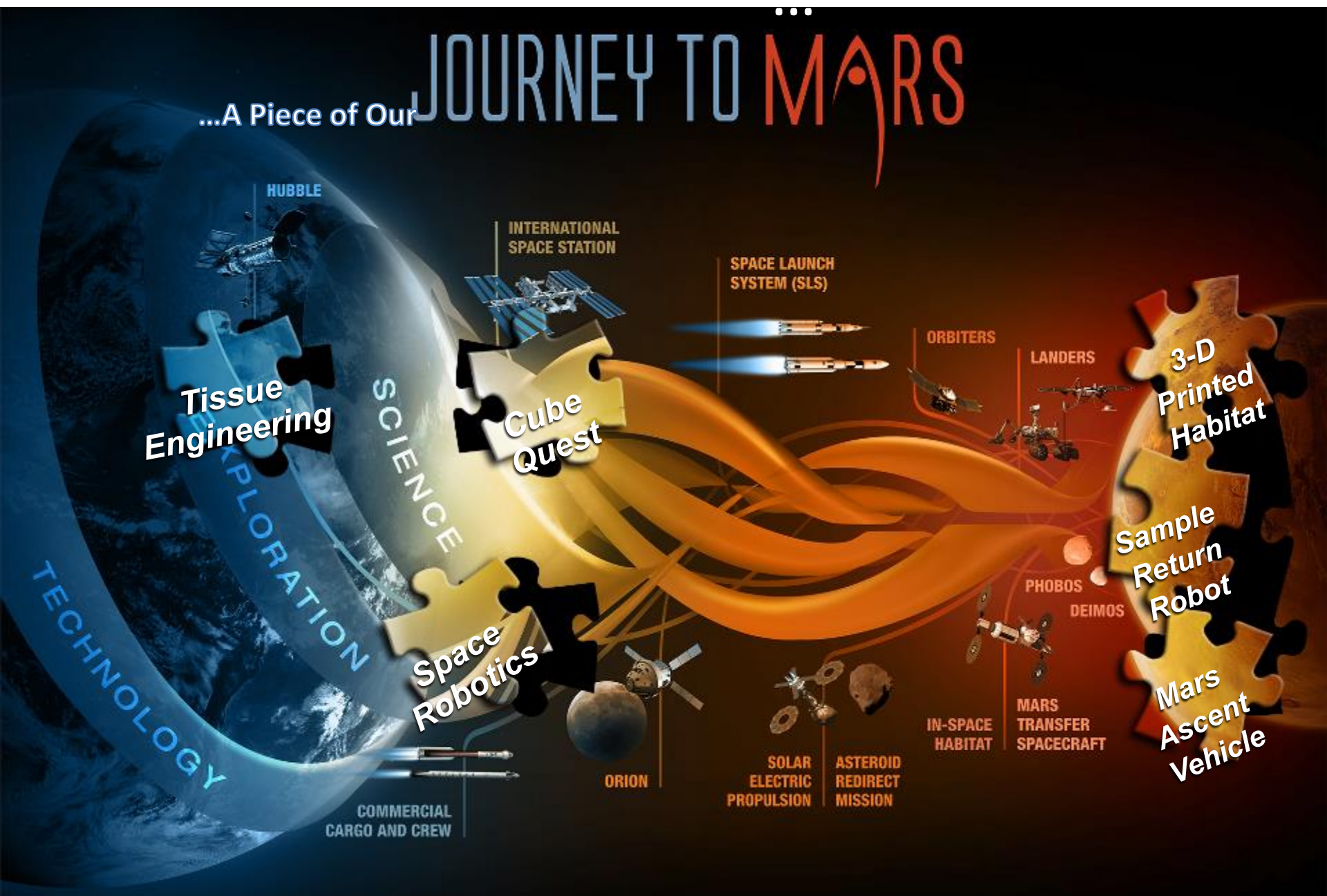
ORION

SOLAR ELECTRIC PROPULSION

ASTEROID REDIRECT MISSION

IN-SPACE HABITAT

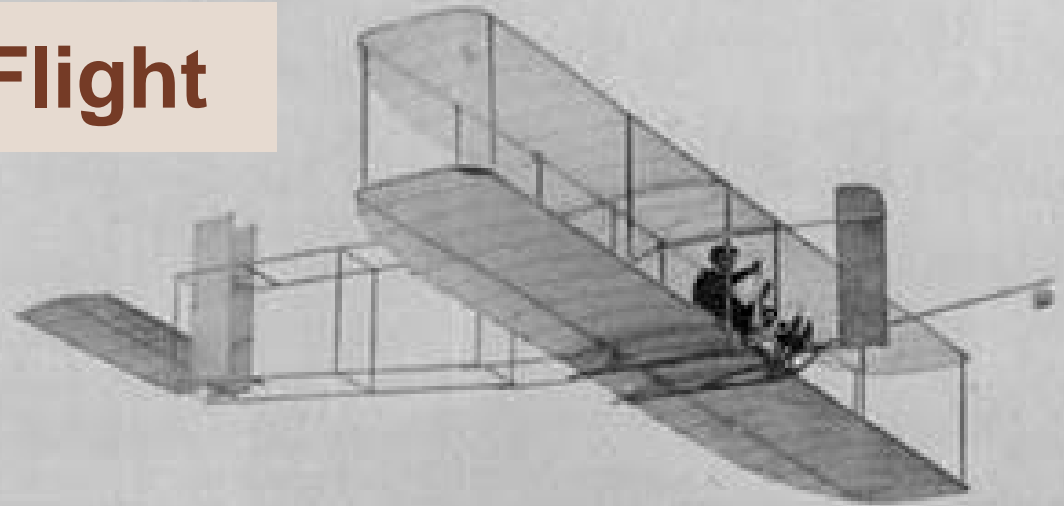
MARS TRANSFER SPACECRAFT



Why Centennial Challenges?

- The program was established to conduct prize competitions in support of the Vision for Space Exploration and ongoing NASA programs
- Although the first competition was started in 2005, development of the program started in 2003 to commemorate ...

The Centennial of Flight

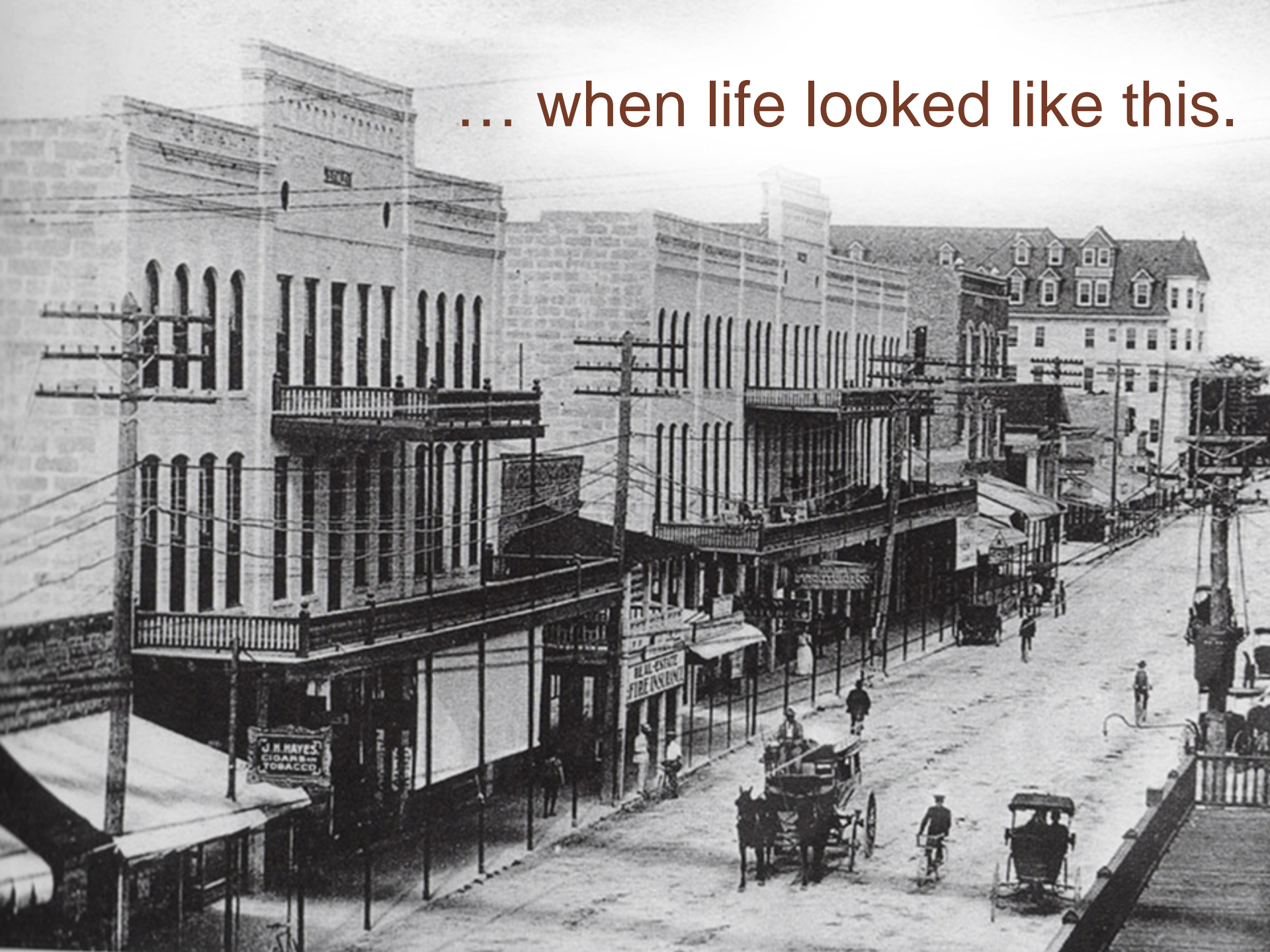


The Wright "Flyer"

An aircraft built of wood, powered by hand made propellers flew at Kitty Hawk, North Carolina, on December 17, 1903, making a 12-second flight.



... when life looked like this.

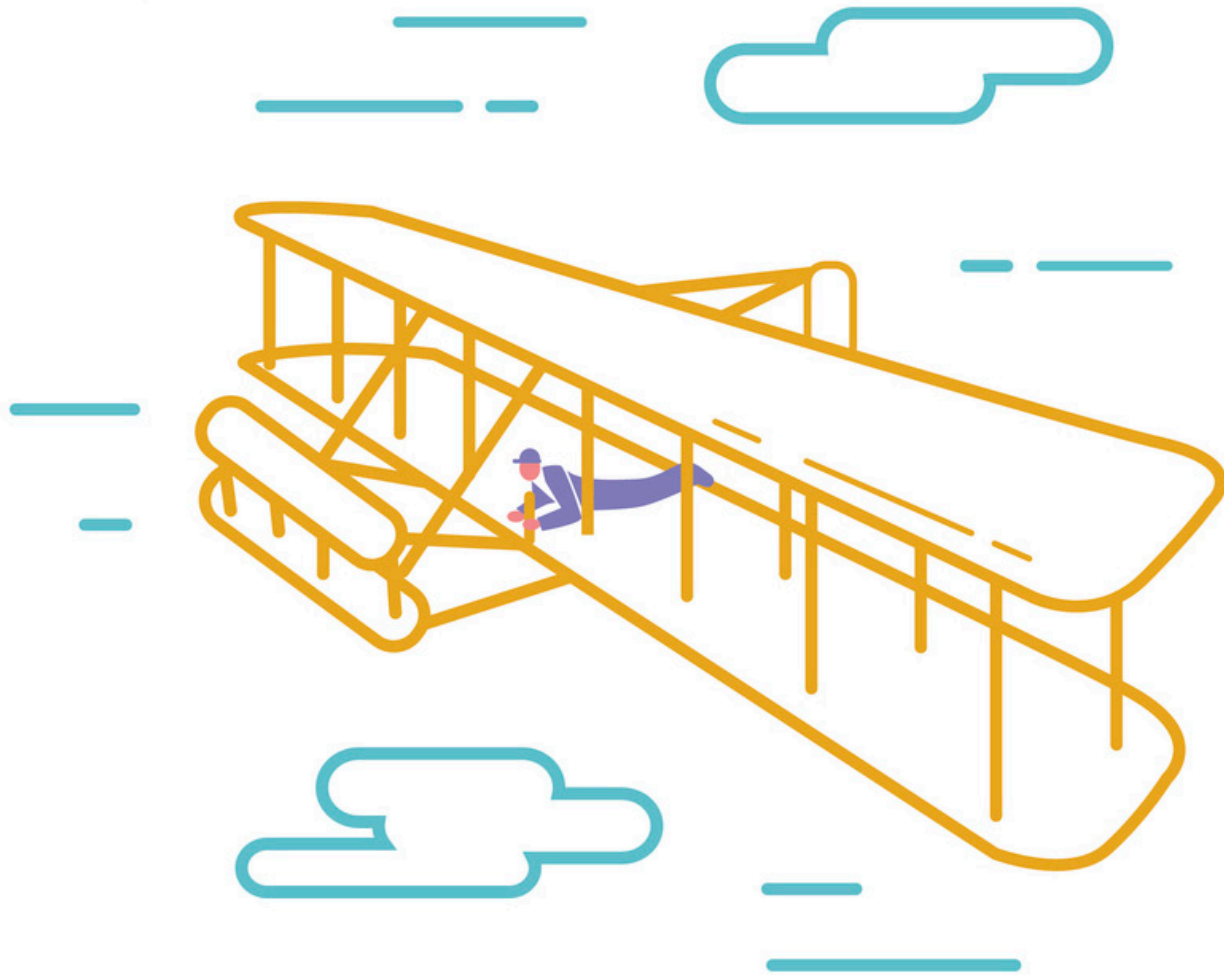


At the turn of the century, it was probably hard to imagine this ...



In the early 1900s, brothers and bicycle builders Wilbur and Orville Wright revolutionized the world with the first successful airplane.





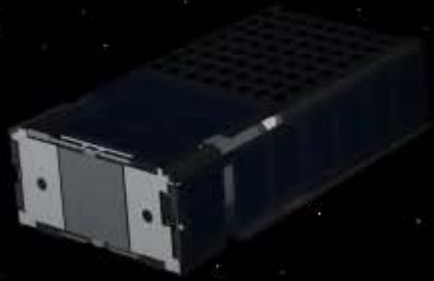
All successful airplanes since have incorporated the basic design elements of the 1903 Wright Flyer.

“ If we worked on the assumption that what is accepted as true really is true, then there would be little hope for advance. ”

- Orville Wright

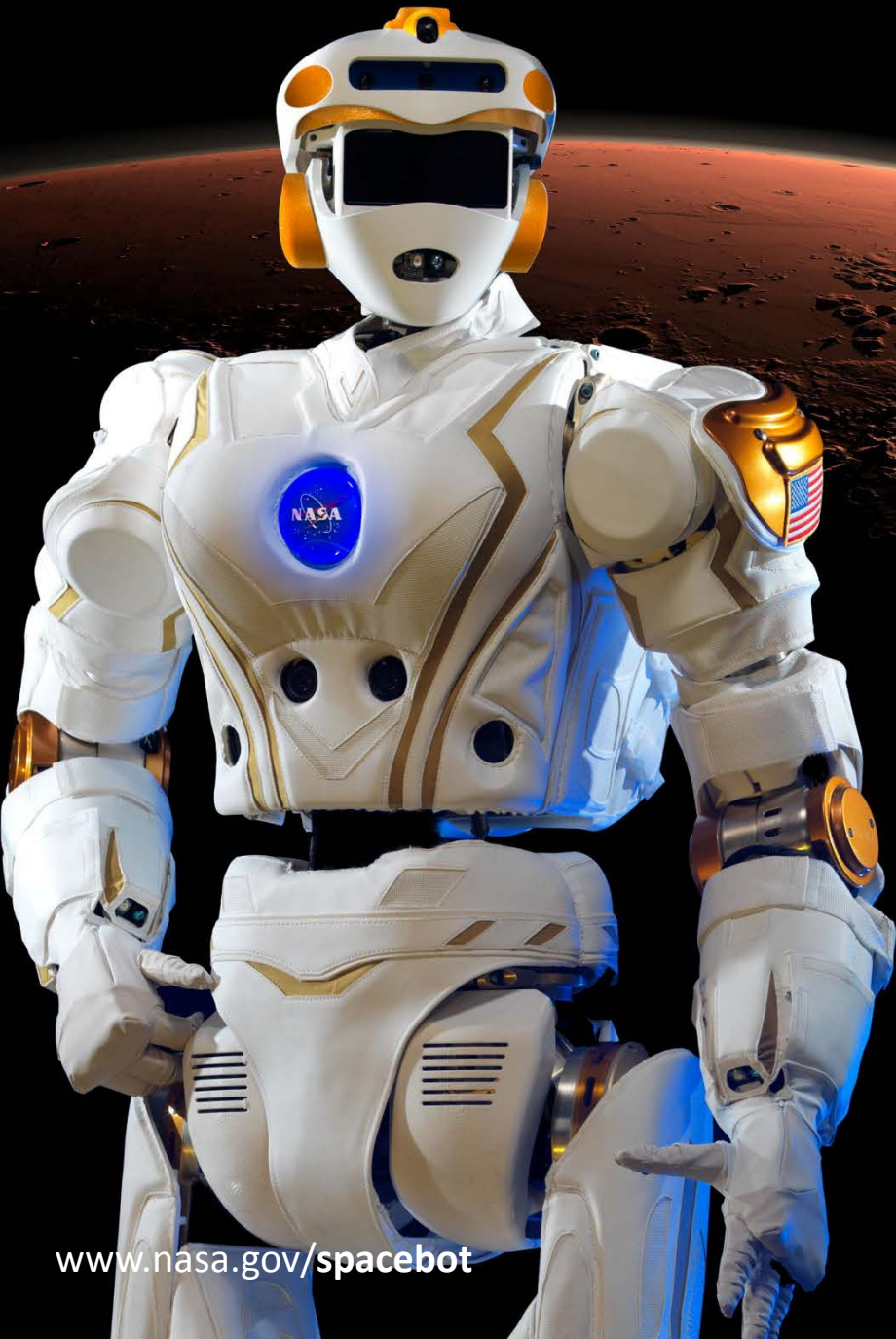


What if a
long-distance
call could
reach a
new world?





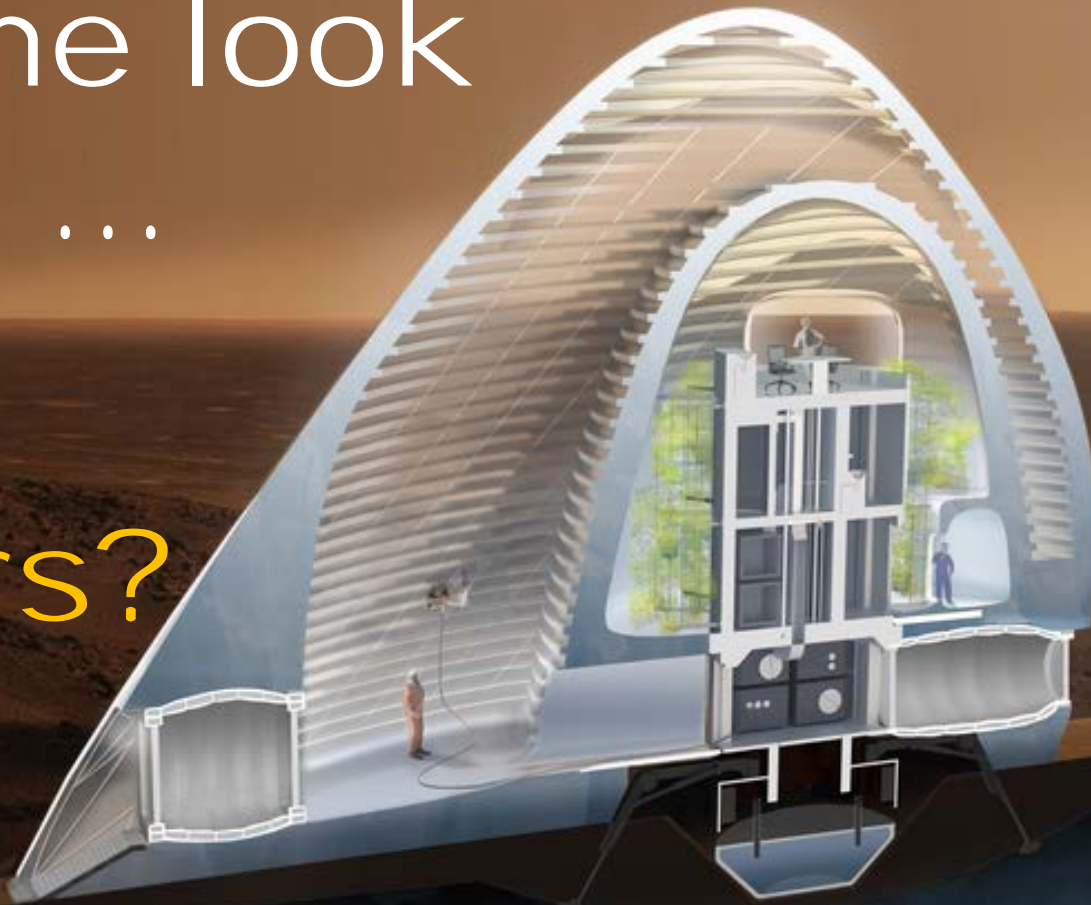
What if space
held the key to
better health?



What if your
coworkers
came with
batteries?

What will
home look
like ...

on
Mars?





WE WANT YOU



Questions?



<https://www.usajobs.gov>

Pathways



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