

3D

PRINTING IN SPACE

A Virtual Field Trip



TEACHER'S GUIDE GRADES 3-5



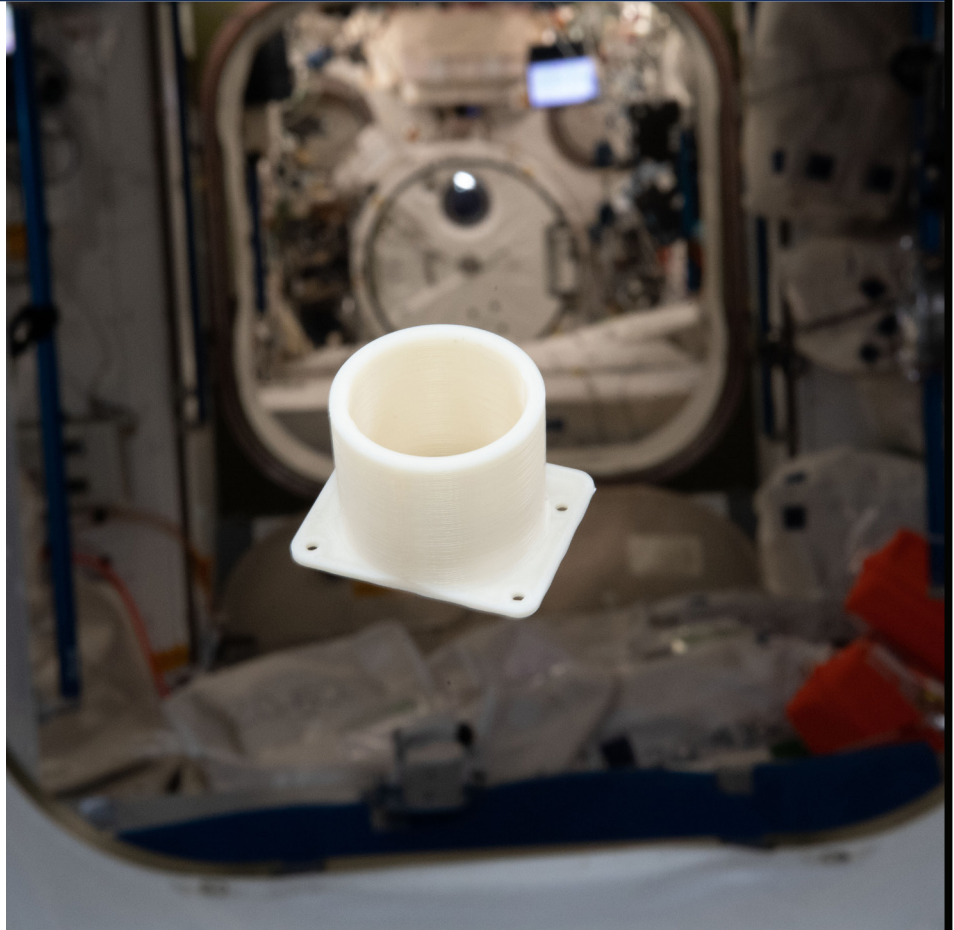
SCIENCE TEACHING GUIDE



Introduction

This virtual field trip is hosted by Austin Jordan, Vice President of Marketing and Communications at Redwire Space.

Austin will take your classroom behind the scenes with Redwire engineers to learn about the engineering processes for 3D printing, explore how 3D printing in space works, and why it's important as we continue to explore beyond our planet Earth.



Discussion questions before watching the video

Ask the class the following questions:

- ★ Who can tell me what a 3D printer does?
- ★ Why would astronauts need a 3D printer in space?
- ★ What problems can a 3D printer solve in space?
- ★ Do you think 3D printing is the same in space as it is on Earth? Why?
- ★ Do you think that gravity affects 3D printing? Why?



AFTER THE VIDEO



Key vocabulary to know

3D printing: Making an object by applying many layers of a feedstock material.

Feedstock: Material, typically a plastic or polymer, used in 3D printing.

Print head: The part of a 3D printer where the feedstock comes out to create a 3D print.

Microgravity: Very weak gravity around Earth, as in an orbiting spacecraft.

International Space Station: A laboratory in microgravity (space) where astronauts live and work on science experiments.

Artemis: A NASA program to take astronauts back to the Moon.

Regolith: A type of dirt, like the dirt on the surface of the Moon.



Discussion questions

What is a Zune?

A portable music player by Microsoft.

Why did Redwire print a Zune?

If you are a fan of Marvel Studios' Guardians of the Galaxy, you may remember that the Zune is a music player gifted to Star-Lord, one of the heroes of the film. What kind of music do you like to listen to?





AFTER THE VIDEO



What is the Additive Manufacturing Facility?

The Additive Manufacturing Facility is a 3D printer on the International Space Station.

Where does the Additive Manufacturing Facility operate?

It's operated on the space station via commands from Redwire's Operations Control Room in Jacksonville, Florida.

How is 3D printing in space different from 3D printing on Earth?

The temperatures inside the 3D printer in space are different than on Earth, and the feedstock material and print beds must have proper cohesion in microgravity, so it doesn't float away and creates a proper structure.

Why is 3D printing in space important?

It allows engineers and astronauts to 3D print tools, equipment, and replacement parts that they wouldn't otherwise have onboard a spacecraft.



What are some future uses of 3D printing in space?

Future space stations and 3D printing infrastructure like roads, habitats, or rocket landing pads on the Moon or Mars.

There is also 3D bioprinting, which is the ability to 3D print human tissues. The idea is to one day be able to print human organs and cells for patients back on Earth and for future explorers in Space!

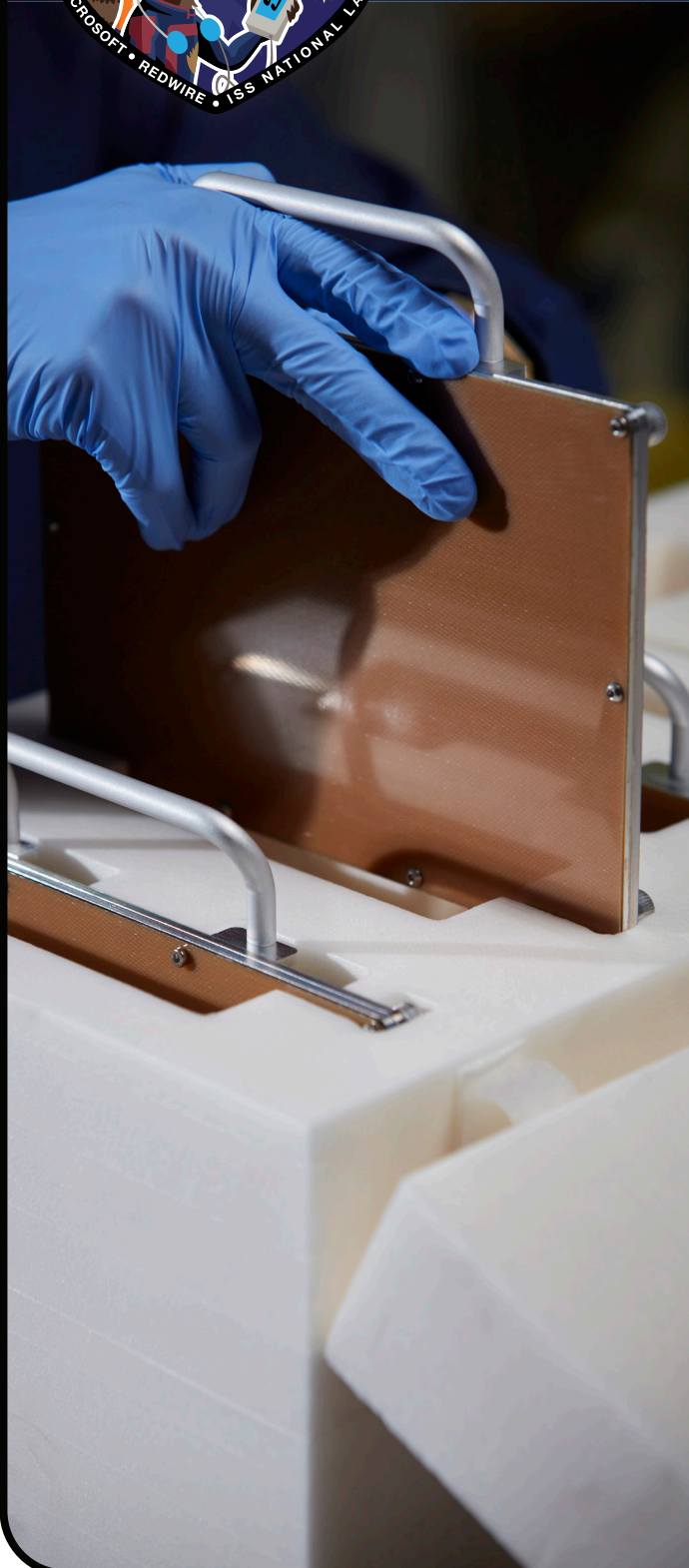
How can you become an engineer?

There are many paths to becoming an engineer, but studying science, technology, engineering and mathematics (STEM) subjects in school is the best way to start!

DISCUSSION QUESTIONS



in collaboration with



Pre-Lesson

Ask the class the following questions:

- ✦ What is gravity?
- ✦ Why do we need gravity?
- ✦ How do you think gravity affects 3D printing?
- ✦ What is the environment in space?
- ✦ What are some environmental conditions that could affect 3D printing?
- ✦ What changes can you make when in space or when on Earth?
- ✦ What are resource limitations?
- ✦ What are some resource limitations in space?
- ✦ What do you do if the printer doesn't work or prints incorrectly?
- ✦ What are some design considerations you have to make when you are printing in space?
- ✦ What are the impacts of microgravity and zero gravity on your project design in space?



DID YOU KNOW?



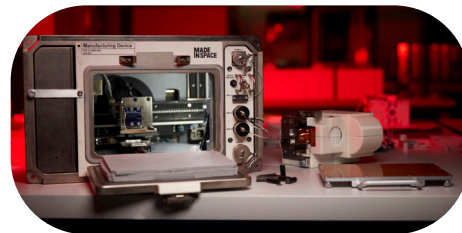
What is the difference between 3D printing on Earth versus 3D printing in space?

Gravity

On Earth, 3D printing is done under the influence of gravity, which affects the flow and deposition of materials. In space, where there is microgravity or zero gravity, the behavior of materials is different. This can result in different outcomes in terms of print quality, material properties, and structural integrity.

process and the properties of the printed objects.

Special considerations and modifications may be required for 3D printing in space to ensure successful results.



Environmental Conditions

In space, the environmental conditions are vastly different from those on Earth. This includes factors such as temperature, pressure, and radiation. These conditions can impact the 3D printing

Resource Limitations

Space missions often have limited resources, including raw materials and energy. This can affect the availability and type of materials that can be used for 3D printing. Additionally, recycling and reusing printed objects or failed prints may be more critical in space due to the scarcity of resources.

Design Considerations

Designing for 3D printing in space may require additional considerations compared to designing for Earth-based 3D printing. Factors such as weight, size, and structural strength may be more critical in space due to limitations in payload capacity and potential impacts of microgravity or zero gravity.





WORD SEARCH



A Q W E R T Y A S D F G Z X C V B N
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ENGINEER

EARTH

ZUNE

COSMO

ASTRONAUT

MARS

FEEDSTOCK

MOON

MICROGRAVITY

REGOLITH

ARTEMIS

ROCKET

GUARDIANS

WORD SEARCH ANSWERS



A	Q	W	E	R	T	Y	A	S	D	F	G	Z	X	C	V	B	N
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M	V	U	L	P	U	T	A	T	E	R	I	O	U	S	A	C	P
X	A	R	T	E	M	I	S	D	D	B	N	C	U	Y	W	R	E
K	L	Z	X	C	V	B	T	M	S	Y	T	K	E	W	R	E	W
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P	O	M	A	R	S	R	N	W	C	A	S	D	D	F	U	H	J
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ENGINEER

EARTH

ZUNE

COSMO

ASTRONAUT

MARS

FEEDSTOCK

MOON

MICROGRAVITY

REGOLITH

ARTEMIS

ROCKET

GUARDIANS

MISSION PATCH COLORING PAGE





3D PRINT A DOG TAG FOR COSMO



in collaboration with



IN THEATERS MAY 5

Have fun creating a 3D printed galaxy tag for the “good dog” Cosmo, a fan favorite character from Guardians of the Galaxy!

Step 1: Designing the Space Tag

- ✦ Start by brainstorming and sketching your ideas for the space tag. During this phase, you can think about the shape, size, and design that you would like for your Cosmo space tag or any other space element you would like to include.
- ✦ Use a computer-aided design (CAD) software that is suitable for kids, such as Tinkercad, to create a 3D model of your space tag. Follow the software's tutorials or guides to design and customize your space tag according to your ideas and creativity.
- ✦ Once you are satisfied with your design, save the file in a format that is compatible with your 3D printer, such as STL or OBJ.

Step 2: Preparing for 3D Printing

- ✦ Open your 3D printer software.
- ✦ Load the STL or OBJ file of your space tag design.
- ✦ Adjust the printer settings based on the recommended settings for your 3D printer and the material you will be using.
- ✦ Make sure the 3D printer is properly calibrated and loaded with the appropriate material.

3D PRINT A DOG TAG FOR COSMO



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Step 3: 3D Printing the Space Tag

- ✦ Initiate the 3D printing process by sending the file to your 3D printer and starting the print job.
- ✦ Monitor the progress of the 3D print and make sure it is printing smoothly without any issues.
- ✦ Once the 3D print is complete, carefully remove the space tag from the 3D printer bed, following any safety precautions recommended by your 3D printer manufacturer.

Step 4: Post-Processing the Space Tag

- ✦ Clean up any support structures or excess material from the 3D printed space tag, using appropriate tools such as pliers or a hobby knife.

- ✦ Smooth out the surface of the space tag using sandpaper or a file to remove any rough edges or imperfections.
- ✦ Paint the space tag with appropriate colors to bring it to life, using acrylic paints or other suitable paints for 3D printed objects. You can also add additional decorative elements, such as glitter or stickers, to make your space tag even more unique.

Step 5: Finishing Touches

- ✦ Once the paint is dry, attach a keychain or a string to the space tag to make it wearable or hangable as a tag.

**Now you're ready to embark on your space
adventure with Cosmo by your side!**























































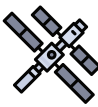
















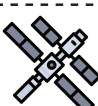








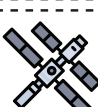




OUTER SPACE SUDOKU



Complete the empty squares with a space object without repeat it in line, column or zone.



DID YOU KNOW?



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Operational Challenges

Operating 3D printers in space may pose unique challenges, including maintenance, monitoring, and safety. Astronauts may require specialized training and equipment to operate 3D printers in space, and procedures may need to be adapted for the space environment.

- ✦ As an astronaut, what are some operational challenges that you may have operating the 3D printer in space?
- ✦ How can you fix those challenges?

Application Focus

3D printing in space is often geared towards specific applications relevant to space exploration, such as creating spare parts, tools, or habitat components. On Earth, 3D printing is used for a wide range of applications, including prototyping, manufacturing, and healthcare.

- ✦ As an astronaut, why would you use 3D printing in space?
- ✦ What would you use it for?
- ✦ How would those things help you in space?

Did you know all of this?

Now you can say that you are an expert in 3D printing both on Earth and in space!