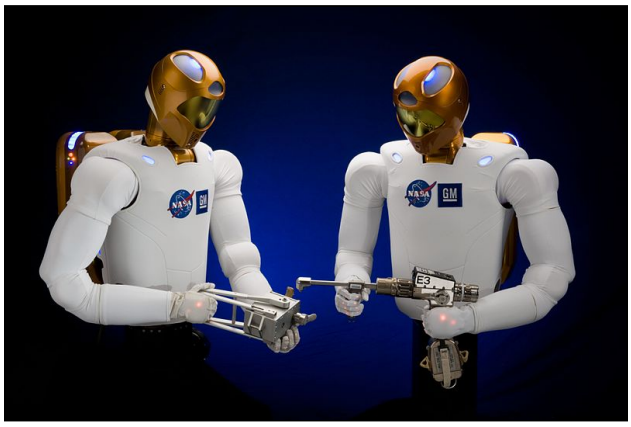
Name: _____ Class: _____

What is a Robonaut?

By NASA

In this informational text, NASA discusses the humanoid robots that will likely work alongside humans in space. As you read, take notes on how Robonauts could be useful in space.

[1] A Robonaut is a dexterous humanoid[1] robot built and designed at NASA Johnson Space Center in Houston, Texas. Our challenge is to build machines that can help humans work and explore in space. Working side by side with humans, or going where the risks are too great for people, Robonauts will expand our ability for constructions and discovery. Central to that effort is a capability we call dexterous manipulation, embodied by an ability to use one's hand to do work, and our challenge has been to build machines with dexterity that exceeds that of a suited astronaut.



"Robonaut 2 working" by NASA is in the public domain.

There are currently four Robonauts, with others in development. This allows us to study various types of mobility, control methods, and task applications. The value of a humanoid over other designs is this ability to use the same workspace and tools — not only does this improve efficiency in the types of tools, but also removes the need for specialized robotic connectors. Robonauts are essential to NASA's future as we go beyond low earth orbit and continue to explore the vast wonder that is space.

Robonaut 2 or R2, launched to the International Space Station on space shuttle Discovery as part of the STS-133 mission, it is the first dexterous humanoid robot in space, and the first U.S.-built robot at the space station. But that was just one small step for a robot and one giant leap for robot-kind.

Initially R2 will be deployed on a fixed pedestal inside the ISS.[2] Next steps include a leg for climbing through the corridors of the Space Station, upgrades for R2 to go outside into the vacuum of space, and then future lower bodies like legs and wheels to propel the R2 across Lunar and Martian terrain. A four wheeled rover[3] called Centaur 2 is being evaluated at the 2010 Desert Field Test in Arizona as an example of these future lower bodies for R2.

1. something resembling a human
2. International Space Station
3. a vehicle for driving over rough terrain, especially controlled remotely

Robonaut 2

[5] In the current iteration[4] of Robonaut, Robonaut 2, or R2, NASA and General Motors are working together with assistance from Oceaneering Space Systems engineers to accelerate development of the next generation of robots and related technologies for use in the automotive and aerospace industries. Robonaut 2 (R2) is a state of the art highly dexterous anthropomorphic[5] robot. Like its predecessor Robonaut 1 (R1), R2 is capable of handling a wide range of EVA[6] tools and interfaces, but R2 is a significant advancement over its predecessor. R2 is capable of speeds more than four times faster than R1, is more compact, is more dexterous, and includes a deeper and wider range of sensing. Advanced technology spans the entire R2 system and includes: optimized overlapping dual arm dexterous workspace, series elastic joint technology, extended finger and thumb travel, miniaturized 6-axis load cells, redundant force sensing, ultra-high speed joint controllers, extreme neck travel, and high resolution camera and IR[7] systems. The dexterity of R2 allows it to use the same tools that astronauts currently use and removes the need for specialized tools just for robots.

One advantage of a humanoid design is that Robonaut can take over simple, repetitive, or especially dangerous tasks on places such as the International Space Station. Because R2 is approaching human dexterity, tasks such as changing out an air filter can be performed without modifications to the existing design.

Another way this might be beneficial is during a robotic precursor mission. R2 would bring one set of tools for the precursor mission, such as setup and geologic investigation. Not only does this improve efficiency in the types of tools, but also removes the need for specialized robotic connectors. Future missions could then supply a new set of tools and use the existing tools already on location.

4. a new version
5. having human characteristics
6. extra-vehicular activity; activity done by an astronaut outside a spacecraft beyond Earth's atmosphere
7. InfraRed

Text-Dependent Questions

Directions: For the following questions, choose the best answer or respond in complete sentences.

1. The word "dexterous" is used several times in the passage. What is the meaning of "dexterous" as used in the passage?
    A. skillful
    B. experienced
    C. intelligent
    D. quick

2. PART A: Paragraph 3 contains an allusion to American astronaut Neil Armstrong's statement when, as the first person ever to walk on the Moon, he said: "That's one small step for man, one giant leap for mankind." What is the author implying by the allusion to Armstrong's statement in paragraph 3?
    A. Like Armstrong's Moon landing, the launch of the first Robonaut aboard the Discovery represents a historic breakthrough in space exploration.
    B. The use of R2 aboard the International Space Station will make space exploration safer for astronauts in the future.
    C. In the future, human astronauts like Neil Armstrong will unfortunately be replaced with humanoid robots like R2.
    D. Compared to the launch of R2 aboard the space shuttle Discovery, Neil Armstrong's Moon landing was only a minor achievement.

3. PART B: What piece of evidence from the passage best supports the answer to Part A?
    A. "our challenge has been to build machines with dexterity that exceeds that of a suited astronaut." (Paragraph 1)
    B. "not only does this improve efficiency in the types of tools, but also removes the need for specialized robotic connectors." (Paragraph 2)
    C. "Next steps include a leg for climbing through the corridors of the Space Station" (Paragraph 4)
    D. "Robonaut can take over simple, repetitive, or especially dangerous tasks" (Paragraph 6)

4. PART A: Why does the author explain Robonauts' abilities in detail?
    A. to outline the history of Robonauts abilities in detail
    B. to demonstrate the benefits of using Robonauts
    C. to explain how Robonauts might be useful in everyday life
    D. to persuade readers that Robonauts' skills have applications for other types of work beyond space exploration

5. PART B: Which detail from the passage supports the answer to Part A?
    A. "Robonauts are essential to NASA's future" (Paragraph 2)
    B. "But that was just one small step for a robot" (Paragraph 3)
    C. "Centaur 2 is being evaluated… as an example of these future lower bodies" (Paragraph 4)
    D. "for use in the automotive and aerospace industries." (Paragraph 5)

6. PART A: How does paragraph 4 contribute to the topic of the passage?
    A. It explains some improvements planned for the R2 to make it more useful.
    B. It adds details about the R2 that was launched on the space shuttle.
    C. It provides a comparison between the R2 and previous models.
    D. It states conclusions about the value of having the R2 on space missions.

7. PART B: Which additional paragraph contributes to the development of the topic in a similar way?
    A. Paragraph 2
    B. Paragraph 3
    C. Paragraph 5
    D. Paragraph 6

8. PART A: Which statement from the passage is a reasoned judgment?
    A. “The value of a humanoid over other designs is the ability to use the same workspace and tools” (Paragraph 2)
    B. “it is the first dexterous humanoid robot in the space” (Paragraph 3)
    C. “NASA and General Motors are working together with assistance from Oceaneering Space Systems engineers” (Paragraph 5)
    D. “Another way this might be beneficial is during a robotic precursor mission.” (Paragraph 7)

9. PART B: Which additional statement from the passage is also a reasoned judgment?
    A. “There are currently four Robonauts, with others in development.” (Paragraph 2)
    B. “R2 is a significant advancement over its predecessor.” (Paragraph 5)
    C. “Robonaut can take over simple, repetitive, or especially dangerous tasks on places such as the International Space Station.” (Paragraph 6)
    D. “R2 would bring one set of tools for the precursor mission, such as setup and geologic investigation.” (Paragraph 7)

10. PART A: What is one central idea that is developed in the passage?
    A. Robonauts can work more efficiently than astronauts.
    B. Use of robonauts will replace astronauts in space travel.
    C. Robonauts can make more reliable decisions about spacecraft maintenance than humans.
    D. Use of robonauts will allow space exploration to exceed what humans alone can do.

11. PART B: Which detail from the passage best supports the answer to Part A?
    A. “going where the risks are too great for people” (Paragraph 1)
    B. “includes a deeper wider range of sensing.” (Paragraph 5)
    C. “allows it to use the same tools that astronauts currently use” (Paragraph 5)
    D. “tasks such as changing out an air filter can be performed without modifications to the existing design.” (Paragraph 6)

Discussion Questions

Directions: Brainstorm your answers to the following questions in the space provided. Be prepared to share your original ideas in a class discussion.

1. In the text, the author focuses on the many benefits of a Robonaut. Do you think there could be any risks of using Robonauts for missions in space? Are there some jobs in space that you think require human thought and action? If so, what are they?

2. Robonauts will eventually complete the tasks that are too dangerous for astronauts. What are other dangerous jobs humanoid robots could be useful for?