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NARRATED BY LEONARDO DiCAPRIO
WARNER BROS. PICTURES AND IMAX FILMED ENTERTAINMENT PRESENT "HUBBLE" IN COOPERATION WITH THE NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
NARRATED BY LEONARDO DiCAPRIO DIRECTOR OF PHOTOGRAPHY AND ASTRONAUT TRAINING JAMES NEIHOUSE MUSIC BY MICKY ERBE AND MARIBETH SOLOMON ASSOCIATE PRODUCER JUDY CARROLL EXECUTIVE PRODUCER GRAEME FERGUSON PRODUCED AND DIRECTED BY TONI MYERS
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EDUCATOR'S RESOURCE GUIDE GRADES 3-5

DEAR TEACHER:
DO YOU WANT TO TAKE YOUR STUDENTS ON AN AWE-INSPIRING JOURNEY THROUGH DISTANT GALAXIES AND ENABLE THEM TO ACCOMPANY SPACEWALKING ASTRONAUTS ON ONE OF THE MOST IMPORTANT MISSIONS IN NASA'S HISTORY?

If the answer is "yes," we invite you and your students to blast off with the new IMAX film *Hubble 3D*. Book a field trip to your local IMAX theatre to give your students an out-of-this-world learning experience. The engaging classroom activities on this poster, inspired by the film, will also enhance your students' understanding of the importance of the Hubble Space Telescope's mission. Visit **www.imax.com/hubble for additional activities and vocabulary** for grades 3-5 and, for grades 6-8. Enjoy the show!

	Build a Robotic Arm	Communication Station	Images from Hubble Simulation
Objectives	Students will use teamwork to design and build their robotic arm to model the Space Shuttle arm used by astronauts.	Students will model the roles of astronauts, engineers, and scientists as they employ effective communication skills to complete a task.	Students will model how satellites send back information to Earth in the form of numbers using binary code (a series of 1's and 0's). Students will create a mission patch to symbolize what they have learned about the Hubble Space Telescope.
Teacher Prep	You will need: •the following choice options (or similar materials) for building the robotic arms: clothespins, brads, craft sticks, straws, paper clips, rubber bands, tape (clear or masking), twine, cardboard scraps, empty paper towel or tissue rolls, unsharpened pencils, stacking blocks (4 per team) made of cardboard, foam, or other material.	You will need: •two matching bags of materials (linking cubes or other common construction material) for each pair of students.	You will need: •2 Pencils •1 Folder •Data Sheet provided in activity
Extensions	Engage students by visiting the following website showing images and video of the robotic arm at work: http://svs.gsfc.nasa.gov/sm4	Engage students by visiting the following website and viewing images from Day 2 of Hubble Servicing Mission 4 (SM4)*: http://svs.gsfc.nasa.gov/sm4. Point out the images of team members [astronauts, scientists and engineers at Goddard Space Flight Center (GSFC) and Johnson Space Center (JSC)] communicating to accomplish their tasks. Tell students they will be using verbal communication to simulate a task while acting as astronauts and engineers. Students will develop abilities to apply to the design process.	Engage students by showing them an image captured by Hubble at the following site: http://svs.gsfc.nasa.gov/sm4. Ask students if they've ever wondered how we "get" these images from so far away. Extend the lesson by having students repeat the activity using colors. (Instead of just 1's and 0's for black and white, also assign numbers to different colors i.e. 2 = blue, 3 = green, etc.)

Lessons address **NSES standards** (Understanding About Science and Technology; Science as a Human Endeavor; Nature of Scientific Knowledge) and **ITEA standards** (Understanding the Influence of Technology on History; Understanding the Role of Troubleshooting, Research and Development, Invention and Innovation, and Experimentation in Problem Solving).

For additional educational materials that support SM4* events, visit: http://amazing-space.stsci.edu/sm4/.

Special acknowledgment and thanks to Bonnie McClain (NASA Goddard Space Flight Center Office of Education) and to Bonnie Eisenhamer (Space Telescope Science Institute HST Education Manager) for their contributions.

BRING THE UNIVERSE TO YOUR STUDENTS' FINGERTIPS:

Each of the activities provides hands-on extensions connected to viewing *Hubble 3D*.
IMAX films are ideal teaching tools that:

- present new knowledge in a powerful, popular medium
- inspire thoughtful and lively classroom discussion
- motivate students for extended learning

Field trips are economical and easily arranged. To book a field trip, contact your local IMAX theatre today. Visit **www.imax.com/newsletter** to sign up for the latest news and updates on IMAX educational programs and events. For locations near you, visit **www.IMAX.com**.

Engage your students with an unforgettable learning experience.

BOOK YOUR IMAX FIELD TRIP TODAY!

Discovery Education NASA IMAX

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*Also referred to as the STS-125 mission.

Worksheet #1

NAME: ______________________ GRADE: ________

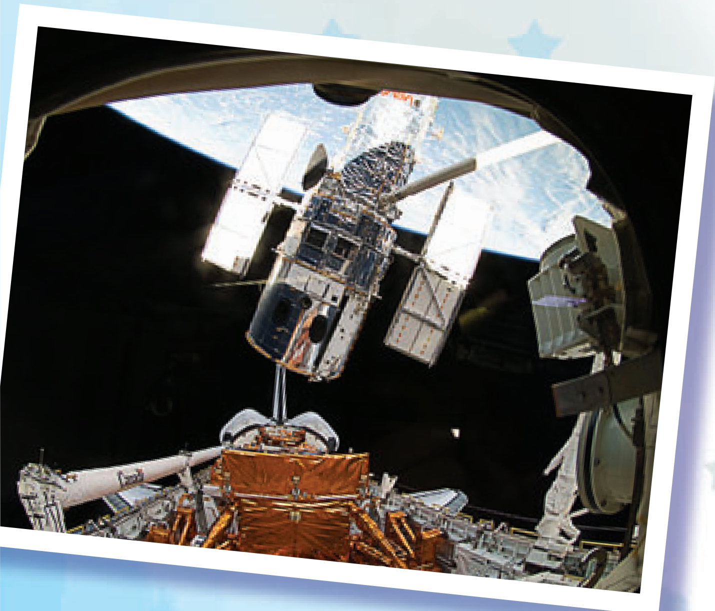
BUILD A ROBOTIC ARM

BACKGROUND:

In May 2009, NASA **astronauts** went on an important Space Shuttle mission. The **Hubble Space Telescope Servicing Mission 4 (SM4)*** gave spacewalking **astronauts** the chance to make **repairs** on **Hubble**. NASA scientists hoped these improvements would keep the Hubble working for at least five more years. To make **repairs** and upgrades, astronaut Megan McArthur used the Shuttle **robotic** arm to grab **Hubble** and pull it onto a platform for **servicing**.

YOUR MISSION:

An engineer designs tools and machines to solve practical problems. Imagine you are an engineer. How could you design a robotic arm like the one used by astronauts who upgraded and fixed the Hubble Space Telescope?
With your team of four students, design and build a robotic arm to complete a task.



YOUR TASK:

STEP 1: View the robotic arm video: http://svs.gsfc.nasa.gov/sm4.

STEP 2: Work as a team to design and build a robotic arm that will stack four blocks on top of one another. You cannot touch the blocks with your hands, only with the robotic arm.

- define your task objectives and requirements
- look at the materials your teacher has made available
- agree upon a design for the robotic arm after considering alternatives
- identify materials you will use
- draw a sketch of your team's design before you build it
- report to the mission specialist (teacher) to collect your supplies (including stacking blocks)

STEP 3: Build and test your robotic arm. Redesign as needed.

STEP 4: Demonstrate and share your robotic arm design.

STEP 5: Discuss with your team how you think this activity might compare to what engineers did when designing the Shuttle robotic arm. Fill in the chart below with the differences from your team and the NASA team.

STEP 6: Debrief. Discuss with your team.

- Did your team use all the materials provided? Why or why not?
- Which material was most important in your robotic arm design? Why?
- How did working as a team help in the design process?
- Were there any disadvantages to designing and building as a team?
- What did you learn from seeing the designs developed by other teams?
- What advice would you give to a team that was about to complete this same task?
- How would using a robotic arm on a spacewalk be even more challenging?
- Think about the roles and responsibilities of the astronauts, engineers, and scientists who keep Hubble in working order. Which role do you like best? Why?

OUR TEAM	NASA TEAM

*Also referred to as the STS-125 mission.

Worksheet #2

NAME: ______________________________ **GRADE:** __________

COMMUNICATION STATION

BACKGROUND:

Good communication is very important for a space mission to be successful. The astronauts, engineers, and scientists who worked on the Hubble Space Telescope in Servicing Mission 4 all had to communicate their ideas clearly, accurately, and promptly in order to solve problems and complete their daily tasks during the mission.

Imagine you are an astronaut out in space on a mission, and you need to communicate to an engineer at the Goddard Space Flight Center. One mistake in communication could stop the mission from being successful! How could you communicate your ideas clearly and accurately?

YOUR MISSION:

Your teacher will give you and your partner each a bag of matching materials. Decide who will be the "engineer" and who will be the "astronaut." Follow the steps below to simulate what engineers at Goddard Space Flight Center experienced as they communicated with astronauts on one of the Hubble Space Telescope servicing missions.

YOUR TASK:

STEP 1: You and your partner sit back–to–back. The engineer works at his/her desk while the astronaut sits with his/her back to the engineer.

STEP 2: Engineer, use the materials to build a structure. Do not let the astronaut see the structure you have created.

STEP 3: Astronaut, open your bag of materials, but do not take the materials out.

STEP 4: Engineer, communicate with your astronaut and explain how to use the materials to re-create the structure you have built.

STEP 5: Astronaut, listen carefully to the engineer as he/she explains how to build the structure. You may ask questions as you build. Tell the engineer when you have completed the "mission."

STEP 6: Astronaut, turn around and show the engineer your completed structure. Discuss if together you successfully accomplished your goal of building the same structure.

STEP 7: Debrief. Discuss the following with your partner:

- Why did your team need each of the roles to accomplish tasks?
- Was one role more important than the other? Explain why or why not.
- How is this activity similar to what astronauts experience during spacewalks? How is it different?
- Which school subjects would be most helpful for the careers of an astronaut, astronomer, or engineer? Why?

WWW.IMAX.COM/HUBBLE

Worksheet #3

NAME: ______________________ **GRADE:** ________

IMAGES FROM HUBBLE SIMULATION

BACKGROUND:

Have you ever wondered how we get those amazing images from space? Engineers at the Space Telescope Operation Control Center (STOCC) at Goddard Space Flight Center in Greenbelt, MD communicate with the Hubble Space Telescope as it travels at 17,500 mph through space. They tell it where to point and when to send data from the light images to Earth. The Hubble then captures light and sends the data through radio waves to a satellite. Those radio waves then travel to a ground station on Earth where engineers gather all of the information and send it to astronomers at the Space Telescope Science Institute in Baltimore, MD.

YOUR MISSION:

STEP 1: Work with your team of three. Each team member will select a role to play:

- Hubble Space Telescope (HST)
- A radio signal
- An STOCC Technician

STEP 2: HST Team Member - Gather your supplies: a pencil, a folder, and a data sheet (see data sheet below). Draw an image or pattern on the data sheet by filling in blocks. Hide your pattern from your teammates.

STEP 3: STOCC Technician Team Member - Gather your supplies: a pencil and a data sheet. Sit far away from the HST.

STEP 4: HST Team Member: Begin giving the "radio waves" data to the STOCC Technician in the form of "binary code" (which means using 1's and 0's).

STEP 5: Radio Signal Team Member - you are the transmitter. You receive data from the HST Team Member and carry the data over to the STOCC Technician Team Member. *Your teacher will not give your team any direction on communication. Your team needs to decide how to transmit the data. Don't forget, you can only deliver data as 1's and 0's, no hand signals or other communication allowed.*

STEP 6: Debrief. Discuss with your team.

- Scientists and engineers find these satellite images from Hubble very useful. Can you think of other jobs people have where Hubble images could be used?

MISSION ACCOMPLISHED!

BONUS ACTIVITY:

You've learned a lot about the Hubble Space Telescope! For nearly 40 years, NASA astronauts have designated patches to symbolize their individual space missions and flight accomplishments. Now it's your turn! Design a mission patch (see example below) for your team that represents what you've learned about the Hubble Space Telescope.

DATA SHEET

	1	2	3	4	5	6
E						
D						
C						
B						
A