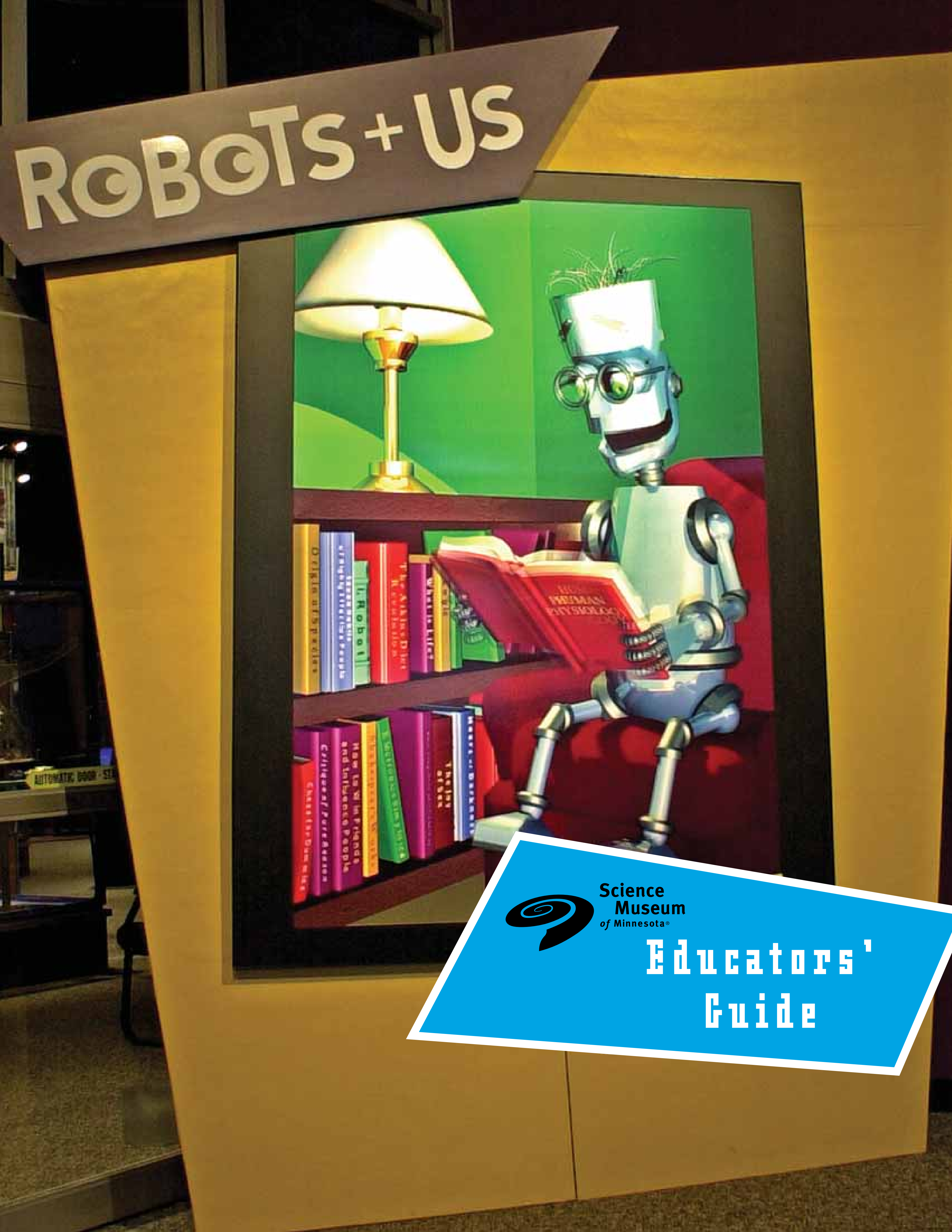


Science Museum of Minnesota

Educators' Guide

In ROBOTS+US, experience the connections between humans and machines by interacting with a variety of robotic machines, designing and building robots, watching videos of robots in action, seeing examples of robots based on insects, birds, human senses and human capabilities. Broaden your definition of "robot" and "human."

This Guide contains

The ROBOTS+US exhibition has three key themes:

- Living things have given engineers inspiration for building robots.
- Designing robots helps us analyze and appreciate the complexity of human and other biological systems.
- People have been fascinated with the idea of making life-like, animated things for a long time.

When you visit ROBOTS+US

1. Share expectations, plans and schedules for the visit with students and chaperones.
2. Do some preparation activities before your visit. Use suggestions in this guide and the resource list for more ideas. Review any activities students are expected to complete during the field trip.
3. Divide your class into small groups to work together in the exhibition.
4. Review this guide to connect ROBOTS+US to your curriculum.

Science Museum of Minnesota

The ROBOTS+US Educators' Guide was produced by the Science Museum of Minnesota with funds provided by the National Science Foundation.

NSF

ROBOTS + US encourages visitors to ask, What is a robot? Are robots "alive"? Can a machine have emotions? How do people interact with the machines in their lives?

Allow ample time for student exploration. Help students think about the impact of machines in their lives now and in the future:

- Interact and play with the exhibits
- consider other people's ideas about robots
- examine examples such as Pinocchio, characters from sci-fi movies or books, or robotic toys

The exhibition is organized into **4 major areas**. The areas are designated with overhead signs: Low-Life Labs / Moving About, Sensing the World, Thinking about Thinking and Being There.

AREA 1

LOW-LIFE LABS / MOVING ABOUT

Exhibits in this area suggest the research labs of an imaginary corporation where biology inspires technology. Robots often are based on simpler organisms, like insects or fish, because human biology and behavior is incredibly complicated to understand and replicate. Experiment with concepts shared between the animal kingdom and the latest generation of lifelike machines.

Mobot Arena

Play with small mobile robots that interact with each other and their environment. Move lights and walls in the robot's environment to see how the robots react.

Research Bots

Engineering of lifelike machines has increasingly turned to life itself for ideas. As a group, these robots have out performed more traditional engineering designs in robustness and adaptability. ROBOTS + US includes robots based on roaches, grasshoppers, flamingos, and dinosaurs with video demonstrations.

Jitterbugs

Assemble mechanical creatures from simple materials while exploring how the physics of bodies and environments shape behavior.

Leg Lab

Assemble a walking machine. Test different configurations of legs and gait patterns at the activity station to explore the dynamics of walking.

Mobot Arena

Screen Life

Construct, play, and experiment with simulated creatures demonstrating locomotion in a simple, screen-based environment.

Bio-Logic; Machines at Work; Mechanical Life; Urge to Animate

A gallery of images, videos, and objects traces the long history of animated devices from puppets and 16th century toys to machines in work applications and interplanetary rovers with examples from the present day and fanciful ideas for the future.

Robot Arm

Compare your speed, precision, and judgment with that of an industrial robot arm in the assembly of a simple puzzle.

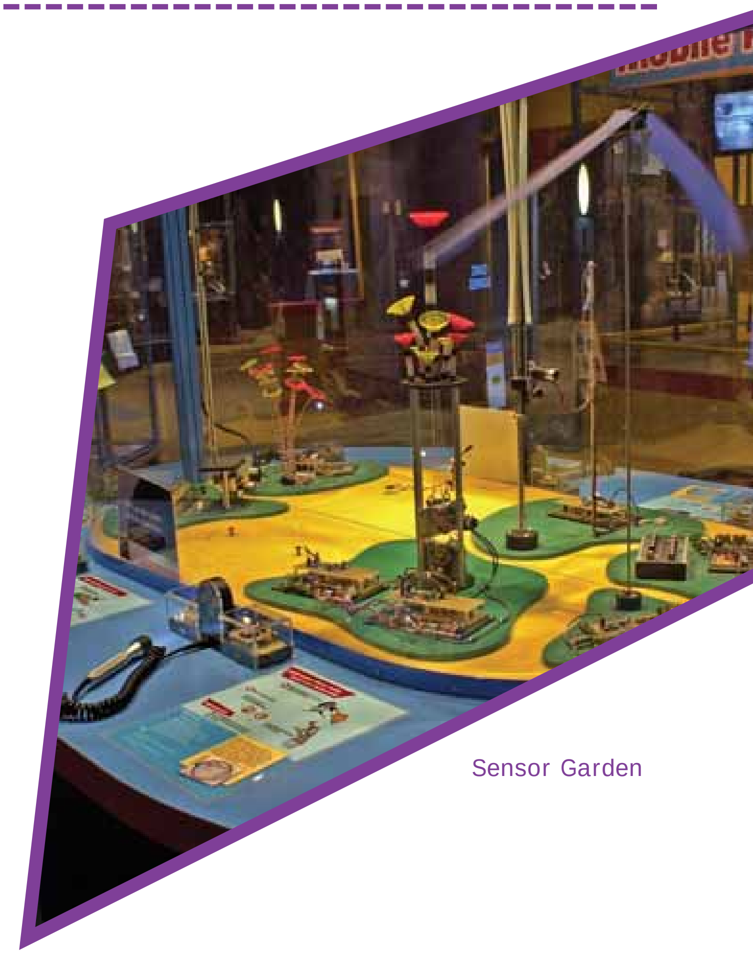
AREA 2

SENSING THE WORLD

Sensors allow machines to react to their environment directly, in contrast to human senses, which actively shape as well as receive information about the world around them. Compare ways machines and humans get information from the environment, and think about why robot sensors are an important design consideration.

Sensor Garden

Interact with sensors to generate patterns of light, sound, and movement in a "garden" with wacky kinetic devices.



Sensor Garden

Face Recognition

Recognizing faces is something humans do extremely well but remains a challenge for machines. Play with one such system. A video camera and monitor draw boxes around human faces. Try to trick the machine by putting on disguises, changing the lighting, or holding up photographs or drawn pictures.

Change-Blindness

Designers of artificial vision systems quickly learn that too much information can be as much of a problem as too little. Humans forestall information overload by seeing much less than meets our eyes. Test your change-discrimination sense by watching for changes in complex photographs.

Camouflage

A collection of games and visual illusions demonstrates human perception to be an active process that goes beyond simple receipt of information.

Artificial Ears

For people whose own sensory apparatus is damaged or missing, digital electronics provide the possibility of restoration and repair. Experience simulations of cochlear implants.

Speech Recognition

Spoken language can be very hard to understand for machines. Experiment with your intelligibility on a speech recognition machine.

AREA 3

THINKING ABOUT THINKING

Explore the nature of the mind, the problems facing designers of thinking machines, and how efforts to produce artificial intelligence can illuminate the nature of our own intelligence.

From the Minds of Ants

Observe a living ant colony that solves mazes in the course of finding food. Compare the colony to examples of swarming robots based on that model. Some people feel that the human brain may be like an ant colony – the whole more than the sum of its parts.

Learning Machines

Examine humanoid robot projects via video and example. COG is an MIT robot whose designers are aiming to replicate capabilities of a 2-year-old human.

The Game of Life

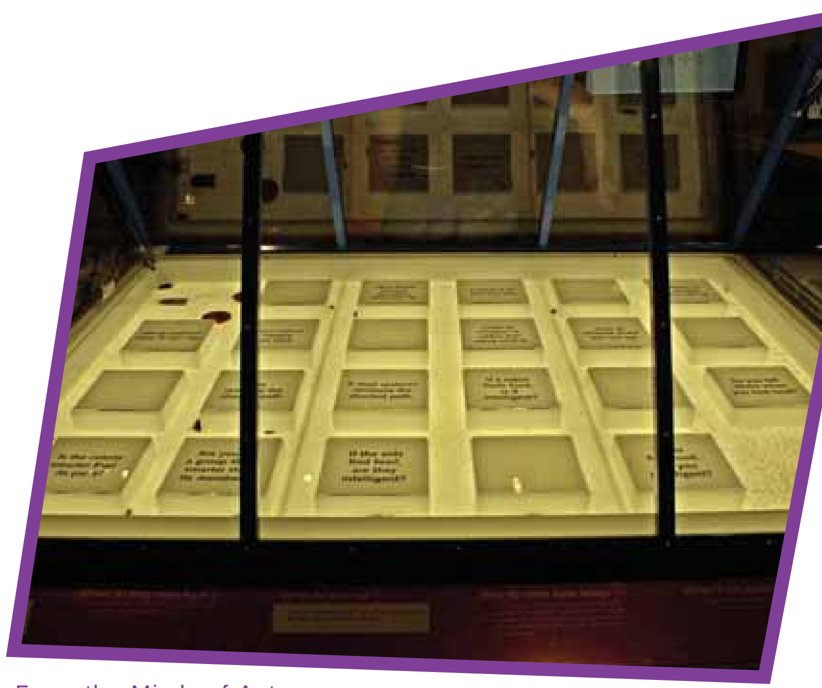
Watch moving patterns of dark squares on a gridded background, enter new patterns on the screen and watch them change according to simple rules. Mathematician John Conway's famous cellular automaton illustrates how the interaction of many parts following simple rules can produce complexity.

Common Sense Project

Machines lack common sense, the ordinary knowledge that people in our society share. Give a machine a little of your common sense information to add to the collection of knowledge added by other visitors.

Metaphors of Mind

A gallery of images, objects, and examples shows comparisons that have been made to explain the human mind.



From the Minds of Ants

AREA 4

BEING THERE

As people study, design, and build all kinds of lifelike machines, questions arise about qualities and capabilities of what it means to be human. This section explores that sense of identity.

Jeremiah

The oversized face of Jeremiah, a friendly digital character, reacts to motion through facial expressions.

Android Café

Mathematician Alan Turing suggested that artificial intelligence would be demonstrated when humans could no longer tell the difference between a conversation with another human and one with a machine. Communicate with a computer "avatar" named Lena to help you experience the difference in communicating with a human and a machine. Learn how computers differentiate between human and computer interactions.

Making Faces

See how expertly we use our faces to communicate with one another and how that skill might be required of robots someday soon. Record facial expressions, study them in slow motion, and compare them with a database of possible expressions. Watch a video devoted to Kismet, an MIT robot that uses to facial expression to communicate with people.

Artificial Friends

View robot pets in an imaginary shopwindow. Watch a video showing people's emotional responses to these mechanical "life forms."

Visit the exhibition website:
www.robotsandus.org

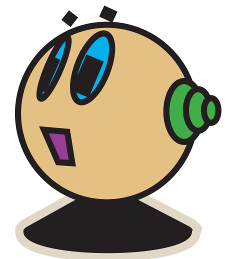
BEFORE YOUR VISIT

What is a Robot? *All grades*

Ask students to bring robot-related things to school: posters, books, comics, little robots, puppets. Use these items to initiate discussion. Print pictures of robots from this web site: *http://incolor.inebraska.com/bill_r/robotics.htm*, a virtual robot museum with pictures of all sorts of robots and links to related sites.

Discussion questions

- What is a robot? What isn't a robot? Come up with your own definition. Compare your definition to that in the dictionary.
- What kind of characters do robots portray in movies, books, comics?
- What kinds of jobs can robots do? Could a robot clean your bedroom?
- Are there machines, appliances, or toys in your classroom or your home that are robots?
- What are the advantages of a machine doing people's work?
- How do robots improve human life?
- What "senses" do robots have?
- Where do robots get their energy? Where do humans get their energy?
- How are robots similar to humans? To animals?
- Are you a machine? What is special about your brain? If you think, "I feel cold," how do you respond?
- What makes robots seem human-like or alive? Or are they more "artificial"?
- Can a machine think, learn, or feel as well as people can?



Keep a list of the students' ideas of what a robot is and what they can do. Do this as a pre-visit activity; revisit this list after your visit to the exhibition.

Many of the following could also be used after your field trip:

Test Grabbing Devices

Robots pack chocolates into boxes using delicate grabbing devices. Robots in an automotive assembly line have more robust grabbers as they pick up parts and place them. Different application, different grabbers.

Collect a variety of grabbers from the kitchen drawer and the toolbox: pliers, tweezers, wrenches, tongs, clamps. Gather a variety of items to grab: large and small items, regular and irregular shaped things, and soft and hard objects. Have students work with the grabbers and determine which grabber works best to pick up the different items. Be careful not to damage any item. Challenge students to design and build grabbers to grasp an egg, a cup, or a shoe.

Contact a robot club in your community. Invite them to your classroom to show and talk about the robots they have built.

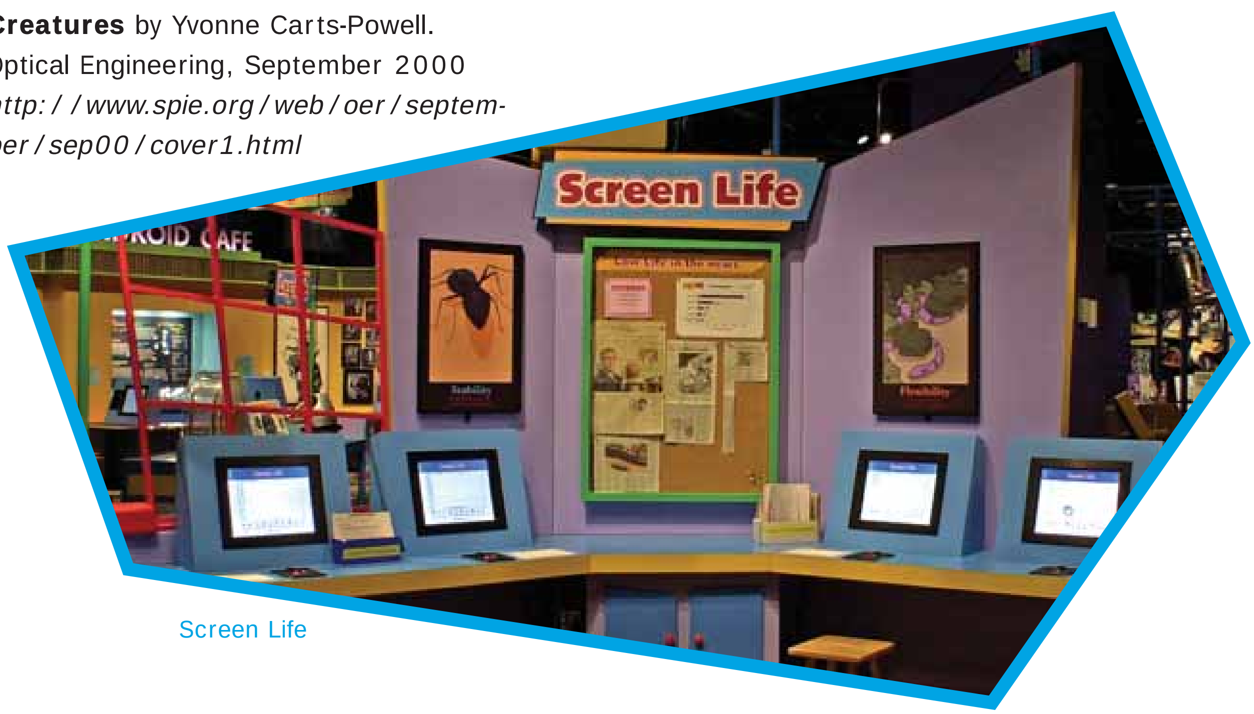
Contact someone who works with robots. What is it like to work in an environment with robots?

Grades 3 - 12
Design and Test Virtual Robot Models
Construct, play, and experiment with simulated creatures demonstrating loco-motion in a simple, screen-based environment. No software download is necessary. *http://www.sodaplay.com* Students can also explore these models at the **Screen Life** portion of the exhibition.

Dissect Chicken Wings
Like humans and animals, robot arms and legs have joints that must bend and flex. Robotics engineers looking to build robots examine animals in a mechanical manner to probe how they work. Dissect chicken wings to learn how muscles, joints, and tendons all work together. Step-by step directions for dissection:
http://www.accessexcellence.org/AE/newatg/Ekstrom.chickenwing/index.html

Read more -- **Robots Mimic Living Creatures** by Yvonne Carts-Powell. Optical Engineering, September 2000
http://www.spie.org/web/oer/september/sep00/cover1.html

Grades 5-12
Create Power Point or mini-movie ROBOTS+US Presentations
Divide students into groups to research different areas of the exhibition: history of robots, robot senses, robot movement, human interaction with robots, robot similarities with living things. Use digital cameras to photograph parts of the exhibition. Back at school, have the students create mini-movies or PowerPoint presentations about what they learned.



Screen Life

AFTER THE FIELD TRIP

Field Trip Discussion Suggestions

Discuss student pages done at the exhibition. Review the student pages with your class and use the students' experiences in the exhibition to extend the discussion.

K-4 STUDENT ACTIVITY PAGE

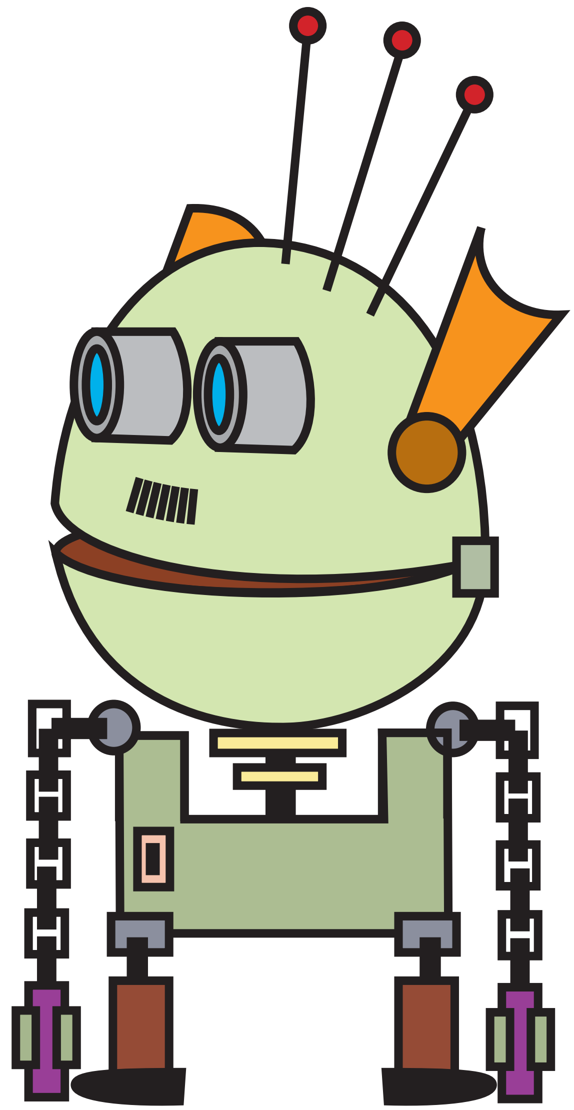
When people design new things, they may look around for new ideas or put old ideas together in new ways. Animals of all kinds (including humans!) inspired people who designed the robots in ROBOTS + US. Designers might examine human senses, or the way an animal moves or the kind of job an animal might do, and use those ideas to build a new robot.

Student pages

- What kinds of animals did the students notice at the exhibition?
- What kinds of parts would students add to their own robot designs?
- What jobs would students have robots do?

Chaperone page

- Ask students to describe the motion of robots they observed in the exhibition.
- How did students cause robots to react? Robots use sensors to notice things. What senses do humans have? Did any of robots have that sense? How are the robot senses and human senses the same? Different?



5-8 STUDENT ACTIVITY PAGES

Robot Talent

The ability for robots to sense and to move in a variety of ways is what makes the science of robotics so valuable. Discuss exhibits students chose for their checklist and ask how people might use those types of robot movements or sensing abilities. Ask students to sketch or design a robot to do one of more of the things on the list.

Like – Unlike

Discuss how robots are like or unlike living things. What characteristics do living things have? Many stories are based the theme of inanimate objects coming to life. Pinocchio, Frankenstein, AI, numerous science fiction works, and many other examples are shown in videos or photos in the exhibition.

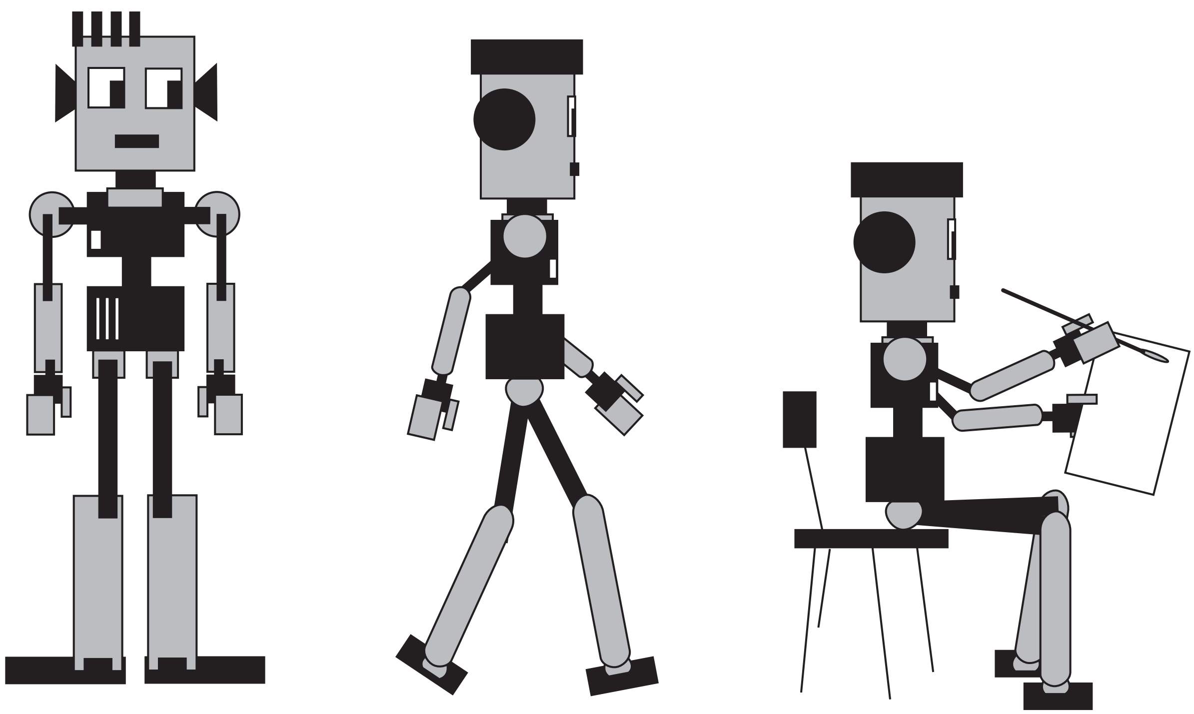
The Robotic Arm

Will robots replace all human workers? How does a robot compare with a human worker? What kinds of jobs would robots do better than humans? What kinds of jobs would humans do better?

Ask: How did you feel about the robot? Underline all of the words which describe emotional responses: happy, sad, mad, angry, annoyed, etc. Why do you think this machine could cause these kinds of feelings?

Thinking About Thinking

Research some of the learning robots in the exhibition: COG, Kismet, Common Sense Project. What are robots capable of today? What do you think robots will be able to learn in the future? What impact will those kinds of robots have?



9-12 STUDENT ACTIVITY PAGES

Robots solving problems

Robots are designed to solve problems in difficult situations or to make life easier or more comfortable, or to extend human capabilities. What problems can students suggest that might be good candidates for a robotic solution?

Making Lifelike Machines

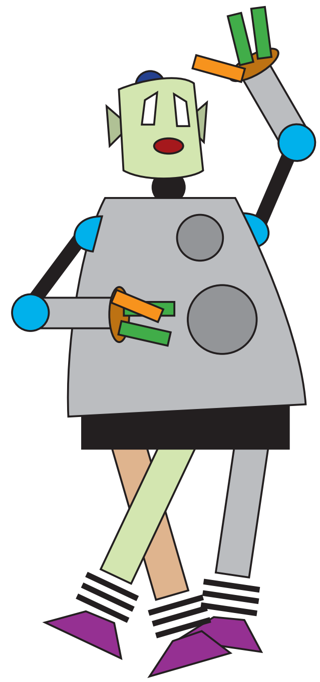
Review various student choices from page 22. Why were these animals used for inspiration? What kinds of living things would not inspire robots? Why not? Students can research these possibilities. Is anyone working on this line of thinking?

Urge to Animate

The exhibition has many historical examples of stories and designs, as well as models of artificial life. Some early examples are the Pygmalion story (800 BC), mechanical dolls (1500s, 1700s), Roman doll (200 AD), Egyptian fountain (1354)

Are Robots Alive?

Ask students to research other lists of the characteristics of living things (biology books, Internet sources). Does the list of robots still fit with these characteristics? Which ones are hardest to match to robot capabilities? Debate: Will robots ever become living things in the biological sense? Find examples in current fiction books, movies or TV shows.



How do ancient myths and fairy tales about objects magically coming to life influence our attitude about robots today? Even though characters like Pinocchio have no scientific connection to actual robots, these imaginary beings raised questions about whether an artificial person can think, learn, or feel, as well as the definition of "real" or "alive."

This Robot has Potential!

The scenario proposal on page 23 asks students to think critically about both short and long term impact of robot design decisions. The questions could also be applied to any of the activities below, as well as other design scenarios. Discuss the impact of robots and machines in human life. Can all consequences be anticipated?

DESIGN A ROBOT - *all grades*

Ask students to choose a task in your school or their home and design a robot to complete that task. What would your robot do? What "senses" would your robot need to gather information from its surroundings? What obstacles would your robot need to overcome to complete its task? Is there a job you dislike doing? Could a robot to do that job? What kind of "grabbers" would your robot need to pick up objects?

For grades 4 and up: Do some research. Are there robots in development or for sale that do the job you imagined?

BUILD A ROBOT - *all grades*

Have students bring in recycled objects to build their robots: cereal boxes, paper tubes, egg cartons, pieces of styrofoam, aluminum foil, pipe cleaners, and other doo-dads.

Provide colored masking tape for assembling the robots. If you have adult volunteers or for older students, they could run a hot glue station. Use caution with the hot glue gun.

After the robots are complete, have students draw their robot, label each part, and describe the function of the parts. Have students write a short fantasy story about their robot. Display the robots and the stories.

Doo-dads

GRADES 3-8

Write Step-by-Step Directions

Some robots must be programmed to do a job in sequence. Programming language contains detailed step-by-step directions. Write step-by-step directions for making a peanut butter and jelly sandwich or making a phone call or for a robot arm to pick up a cup of sugar and to pour it into a bowl. Remember to add specific directions that outline which arm, how far, how high, etc.

Test your "robot" by blindfolding a student; have one student read the steps and the other perform the instructions, exactly as written. Note the problems as the "robot" performs the tasks. Also be careful the "robot" does not get hurt. Rewrite the set of directions, and test the steps on another student "robot."

What does programming language look like?

There are many programming languages today. See the "find date and time" example at this web site: *http://pleac.sourceforge.net/pleac_perl/datesandtimes.html*

Grades 9-12

The Future of Robotics

"I am convinced robots today are where computers were in 1978. That's about the year that computers started to appear around us in the way that robots are cropping up today. Of course, it was another 15 years before computers truly became pervasive in our lives. I think that 15 years from now, robots will be everywhere, as e-mail and the Web are now. Robots with the vision capabilities of a two-year-old and the manipulation capabilities of a six-year-old will be more disruptive to our way of life than any robot portrayed by the governor of California. They will reorder the world labor markets that have developed over the last 50 years. They will change immigration patterns and the massive shift of labor from developed to developing countries."

http://roboticnation.blogspot.com/2004/02/robotic-predictionthe-robots-are-here.html.

Excerpt from *The Robots are Here*, by Rodney Brooks, director of MIT's Computer Science and Artificial Intelligence Laboratory

What do you think about Rodney Brooks' ideas of robots in the future world? Brooks predicts robots will replace human workers. How do you feel about this? Compare this robotic revolution to the Industrial Revolutions of the 1700s and the 1800s. What industries became automated then? In what ways did the workers benefit from the industrialization?

Discussion Topics

1. What are some examples highlighted in the exhibition where machines do the work of people? How have people reacted to the impact of machines in the workforce? How have people's early expectations about machines in the workforce influenced our attitudes about robots today?
2. Unlike ants, humans rely on forms of technology to learn, communicate, relax, and survive. Some examples in the exhibition include the ear implant, Stephen Hawking's speech synthesizer story, and even the use of computers as teaching tools. Does this mean ants are more "natural" than people? Does this make people more "artificial" than ants?
3. The word cyborg means an organism that is part biological and part machine. People who have medical implants could be considered cyborgs. What about someone who wears glasses? Could you live without the machines in your life: car, refrigerator, microwave, alarm clock, phone, computer, etc.? What would your life be like? Are you a cyborg?

Research Ideas – *Grades 6 and up*

The Mars Rover

http://marsrovers.jpl.nasa.gov/home/

- What information have the Martian robots gathered? How do they do this?
- What challenges did the NASA robot designers have to consider when designing the robots?
- What jobs must the robots perform?
- What scientific instruments did the robot carry?
- What "senses" do the scientific instrument emulate?
- What role do the senses of touch and seeing play for the robots on Mars? Do robots on Mars "taste"? What might the sense of "taste" tell scientists?
- Where do the robots get their energy?
- Why did NASA send robots to Mars instead of astronauts?

How would you like to be operated on by a Robot?

"Ultimately, of course, surgical robots will be designed to cooperate with surgeons, rather than replace them. [...] For example:

- minimally invasive surgery where human hands and eyes won't fit,
- surgery on a scale too small to be comfortable for unaided human hands,
- procedures such as milling hip bones that require more geometric accuracy than humans can reliably provide."

http://www.spie.org/web/oer/september/sep00/roboticsop.html
Read this article, *Robotics Transforming the Operating Room* by Yvonne Carts-Powell, then research how the technology has changed since 2000.

Artificial Intelligence

What is the best way to design a thinking machine? Top down or bottom up? Several of the exhibits in ROBOTS + US illustrate the two approaches. Which is which?
http://www.exn.ca/ai/introduction.asp

Robotics Engineering

Research the education necessary to be a robotics engineer by meeting the developers of Cog and Kismet, as well as other humanoid robots.
http://www.ai.mit.edu/projects/humanoid-robotics-group

Android Café

ROBOTS IN THE NEWS

http://marsrovers.jpl.nasa.gov/home/
News from the Mars mission from NASA, images of the Martian landscape, activities for use in the classroom like core sampling using candy bars.

http://www.pioneernet.net/johnc/newsstory.htm The home robot web site. The "News" section has up to date news and stories of robots in the news.

http://roboticnation.blogspot.com/
The Robotic Nation website contains current news and opinion pieces about the future of robots.

ALL AGES

Robots. Mark Bergin. Franklin Watts Books, 2001. ISBN: 0-531-14808-4. An introduction to robots with lots of illustrations and information on robots used in various applications: in hazardous areas, film, medicine, and space.

Robots for Kids: Exploring New Technologies for Learning. Allison Druin and James Hendler, editors. Morgan Kaufmann, 2000. ISBN: 1558605975. Designers and researchers contribute a perspective into the challenge of developing robots specifically for children.

The Robot Zoo. John Kelly.Turner Publishing, Inc.1994. ISBN:1-57036-064-2. The book looks at animals—from moles and bats to grasshoppers—as machines adapted to work in a particular environment. Wonderful illustrations. Includes a glossary that compares animal parts to their robotic equivalent.

Robots and Spaceships. Teruhisa Kitahara and Yukio Shimuzu. Tashen Books, 2001. ISBN: 3-8228-5566-0. From cover to cover, colorful pictures of toy robots and spaceships.

FOR ADULT-LEVEL READERS

I, Robot. Isaac Asimov. Bantam Books, 1950. ISBN: 0-553-29438-5. Asimov set out the Three Laws of Robotics--the principles of robot behavior. This science fiction classic has stories of robots gone mad, mind-reading robots, robots with a sense of humor, and more. A blend of science fact and science fiction.

Designing Sociable Robots. Cynthia Breazeal. MIT Press, 2002. ISBN: 0262025108. Cynthia Breazeal presents her vision of sociable robots able to understand, communicate and interact and able to learn, grow, and assist us in our daily lives. Breazeal asks what it means to be human and defines the key components of social intelligence for these machines. She blended science, engineering, and art to create Kismet, more a social creature than just a machine.

Flesh and Machines: How Robots Will Change Us. Rodney A. Brooks. Pantheon Books, 2002. ISBN: 0375420797. Explores the connection between humans and robots past, present, and future. The dream to build machines with lifelike behaviors stretches back centuries, but for the last fifteen years Rodney Brooks and his team at MIT have dreamed about potential capabilities of robots.

Robo sapiens. Peter Menzel and Faith D'Aluisio. MIT, 2000. ISBN: 0-262-13382-2. Robots are the future! Robo sapiens are "a hybrid species of human and robot with intelligence vastly superior to that of purely biological mankind." Interesting interviews with robotics engineers, lots of photographs showing robots in lots of fascinating applications, essays speculating on the future of robots.

This exhibition and educator guide are most closely aligned with the following science content standards,as listed in the National Science Education Standards. For more detail about these standards, check *http://www.nap.edu/readingroom/books/nses/html/6a.html*

Physical Science
K-4 Position and Motion of Objects
Life Science
K-4 Characteristics of Organisms
5-8 Structure and Function in Living Systems; Regulation and Behavior
9-12 Behavior of Organisms

Science And Technology
K-4 Abilities to Distinguish Between Natural Objects and Objects Made by Humans; Abilities of Technological Design; Understanding about Science and Technology
5-8 Abilities of Technological Design; Understandings about Science and Technology
9-12 Abilities of technological Design; Understandings about Science and Technology

Science In Personal And Social Perspectives
K-4 Science and Technology in Local Challenges
5-8 Risks and Benefits; Science and Technology in Society
9-12 Science and Technology in Local, National, and Global challenges

History and Nature of Science
K-4 Science as a Human Endeavor
5-8 Science as a Human Endeavor; Nature of Science
9-12 Science as a Human Endeavor; Nature of Scientific Knowledge; Historical Perspectives

The American Association for the Advancement of Science has developed Benchmarks for scientific literacy in its proposals for reform of K-12 science, math and technology education, which recommend what students should know and be able to do by the time they reach certain grade levels

The *Nature of Technology* section is especially pertinent to ROBOTS+US.

- Technology and Science Grades 3-5; 6-8; 9-12
- Design and Systems K-2; 3-5; 6-8; 9-12
- Issues in Technology K-2; 3-5; 6-8; 9-12

For more specific guidelines per grade level, view the website *http://www.project 2061.org/tools/benchol/bolframe.htm*

Suggestions for chaperones

- ❑ Allow time for students to explore.
- ❑ Interact and play with the exhibits.
- ❑ Talk about other people's ideas about robots.
- ❑ Examine examples in pictures and videos such as Pinocchio, characters from sci-fi movies or books, or robotic toys.

Here are some **things to look for** and **questions to share** with your group.

Robot abilities

Find a robot that can:

- Swim
- Walk like a bird
- See light
- Feel air moving
- Watch you walk
- Move when a light shines near it
- Answer questions typed into a computer
- Walk like an insect

The Big Face (Jeremiah)

What happens when you walk by? What happens when there are 2 kids? 4? 5 or more? What is the face sensing? Does he look alive? What makes him look that way?

Ants

- *Watch the ants.* What are the ants doing?
- *Watch one ant*. What happens when it meets another ant, a wall, food?
- Do they move on their own? Where does their energy come from? (food) Where does a robot's energy come from? *Find examples of robots and think about where their energy comes from. For example, robot arm – electricity; walking legs – gravity. When you see a robot in the exhibition, ask:* Would this robot need batteries? A plug? How else could a robot get energy?

Artificial Friends

Robot toys – Which one do you like best? Why?

Sensor Garden Robot sensors

Help students read the directions on how to make each robot flower "blossom".

Find examples of different types of triggers:

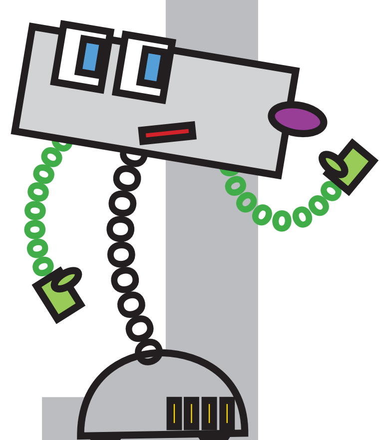
- Light
- Air
- Sound
- Force

Watch how the robot "flower" responds. Ask students to describe what happens.

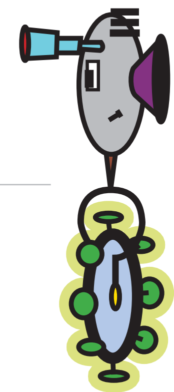
Find a robot that reminds you of an animal.

What animal is it?

DRAW THE ROBOT HERE

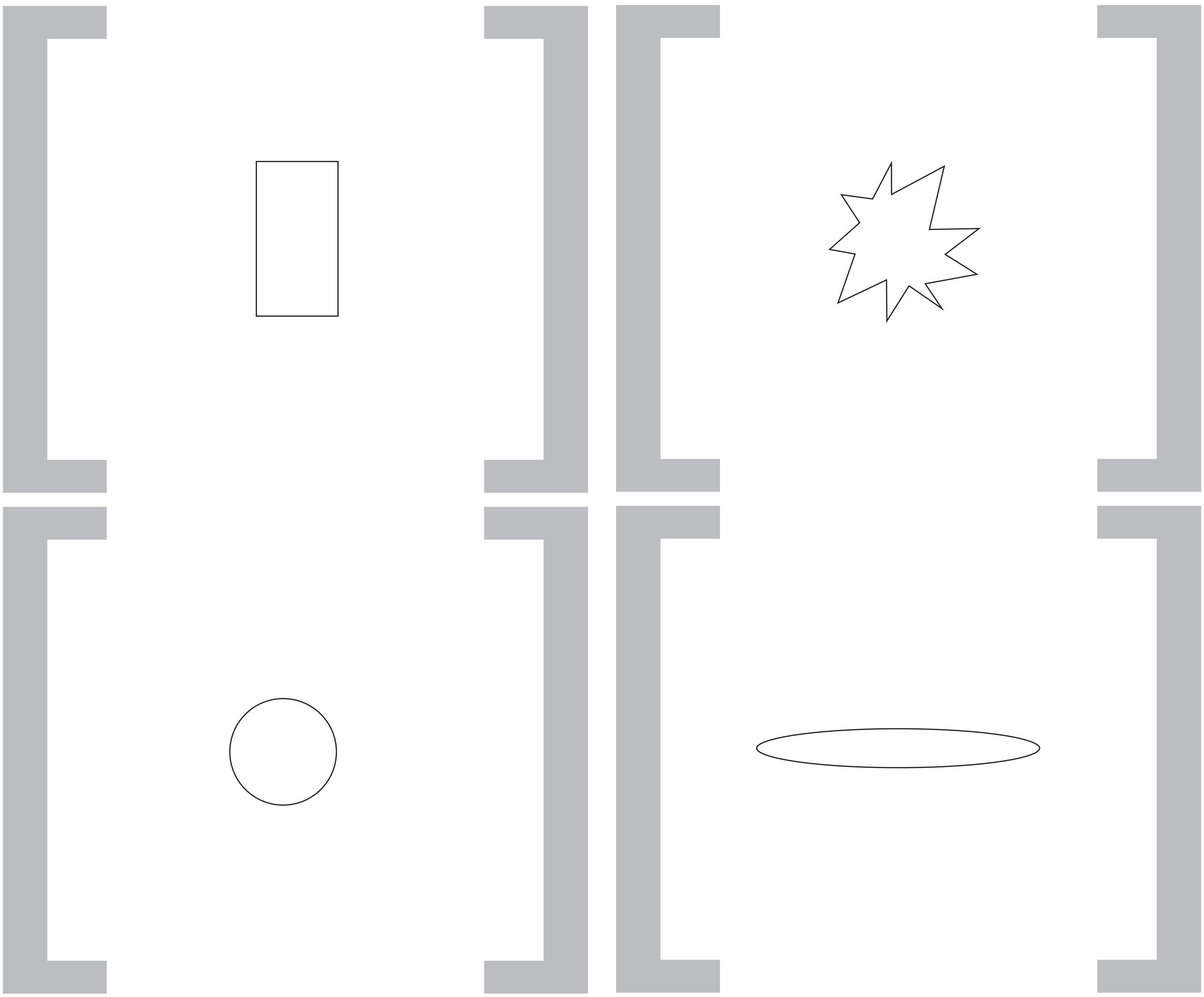


DESIGN YOUR OWN ROBOT



What job would it do?

Draw in the parts you would add to do this job.
Add arms, hands, legs, or anything you want.
Use the exhibits for ideas.
You can choose one shape or do all of them.



ROBOT TALENT

Robots are designed to do many things.

Find a robot that:

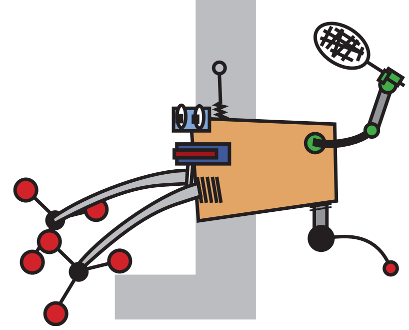
- ❑ Moves toward the light
- ❑ Moves using pulleys
- ❑ Moves on screen only
- ❑ Moves like an insect
- ❑ Moves on Mars
- ❑ Moves an arm (not a leg)
- ❑ Climbs
- ❑ Senses your movement
- ❑ Senses what you say
- ❑ Senses a human face
- ❑ Senses sound
- ❑ Senses force
- ❑ Senses light
- ❑ Senses moving air

LIKE? NOT LIKE?

Find one robot modeled on humans or an animal.
It can be a model or a picture or on a computer.

How is it like a living thing?	How is it not like a living thing?	Does it have a face?

DRAW THE ROBOT HERE

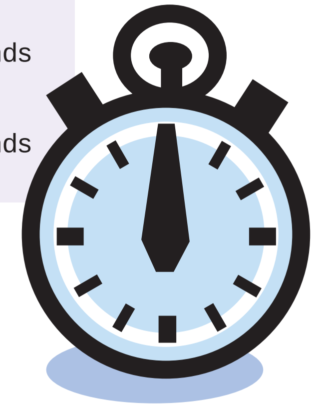


What is the robot's name? ______________________

What is one possible use for this robot? Read the information near the robot for ideas.

____

THE ROBOTIC ARM	ROBOT	HUMAN
How long does it take to do one puzzle?	______ seconds	______ seconds
Time it again using the same puzzle.	______ seconds	______ seconds
Time them one more time.	______ seconds	______ seconds



What do you notice about the times of the robot compared to the human?

How many puzzles could this robot do in one hour? ________________

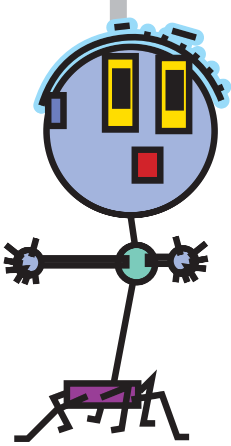
How many puzzles could a human do in one 8-hour day?

[ ] More than the robot [ ] Fewer than the robot

Explain your answer.

What other jobs could this robot do?

Describe this robot's interaction with you or another person you observed doing the puzzle. How did you feel about the robot?



THINKING ABOUT THINKING

Let the robots inspire you. Visit **Cog**. Watch the **Kismet** video.
Add your common sense to "Common Sense." Visit "Making Faces."
What do you think? Can robots learn like humans? Explain your answer.

ROBOTS SOLVING PROBLEMS

Use your creative imagination.

Identify a robot that could:

Move over the rocks on Mars ______________________________

Investigate underwater life forms ______________________________

Clean up a room ______________________________

Monitor heat changes in a factory ______________________________

Pack chocolates in a box ______________________________

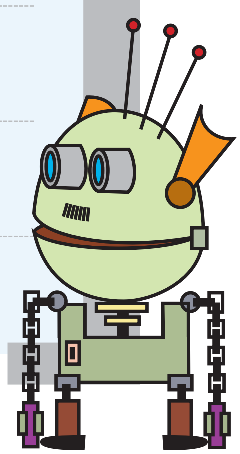
Learn to beat you at chess ______________________________

Star in a movie ______________________________

MAKING LIFELIKE MACHINES

Robot designers look to living things for ideas about how to make robots move.

	What animals have inspired robots?	Compare the inspiration with the robot. What are some similarities?
1		
2		
3		
4		



Urge to Animate

Give evidence that robot ideas have a long history. ______________________________

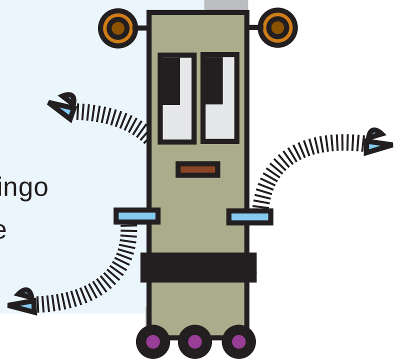
____

____

ARE ROBOTS ALIVE?

Match each characteristic of life with robots that demonstrate this characteristic.

Characteristics of life:	Exhibits:
Extract energy from the environment •	• Sensor Garden
Reproduce •	• Robo tuna
Grow •	• Screen Life
Adapt or respond to the environment •	• Cog
	• Jitterbugs
	• Spring Flamingo
	• Game of Life



What do you think? Are robots alive? *Explain your answer.*

THIS ROBOT HAS POTENTIAL!

Inspect **Cog**. Watch the **Kismet** video. Visit the **Furby**. Chat with **Lena** on screen in the Android Café.

Scenario: You are proposing that one of these robots has a practical purpose.
Choose one – circle the one you chose.

- How will the robot be used?
- What are alternatives available now to do this task?
- What are risks in using this robot for this task?
- What are the benefits?
- Who will be affected by this robot's use? How would you find out how they are affected and how they feel about it?