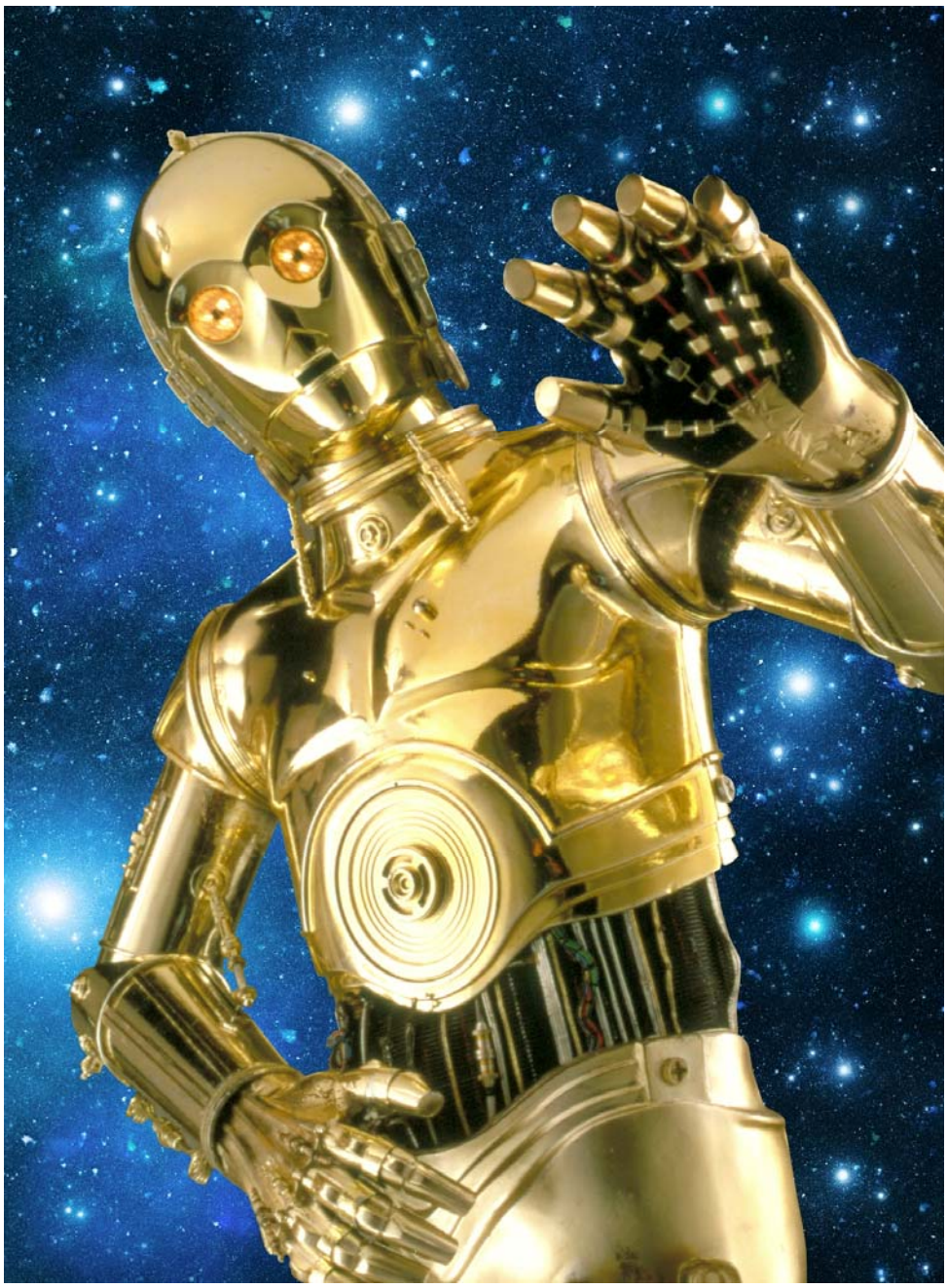
ANCHORAGE MUSEUM

EDUCATOR'S EXHIBITION GUIDE



STAR WARS: WHERE SCIENCE MEETS IMAGINATION

February 10-April 25 at the Anchorage Museum

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ABOUT THE EXHIBITION

Star Wars: Where Science Meets Imagination is an interactive science and technology exhibition that explores two major themes – *Getting Around* and *Robots and People*, as well as two minor themes – *Adapting to Environments* and *Robots and Medicine.*

The *Star Wars* exhibition combines models, props, and costumes from all six *Star Wars* films with real world technologies and video interviews with filmmakers, scientists and engineers.

Students explore prototypes, learn about new technologies, experiment with magnetic levitation and robot design in two engineering laboratories, and discover how imagination drives science and innovation.

This exhibition is on view at the Anchorage Museum February 10 through April 25, 2010. It was created by the Museum of Science, Boston, and Lucasfilm Ltd.

PLANNING YOUR VISIT

Star Wars: Where Science Meets Imagination is on view February 10 – April 25 at the Anchorage Museum, 625 C Street.

Admission for school groups is $7 per person: This price applies to students, teachers and chaperones. The discounted rate can only be obtained by school groups who book tours in advance. For more information or to schedule a school group tour, call Katie Kelley at 929-9268 or e-mail kkelley@anchoragemuseum.org.

You'll find the majority of the exhibit on the third floor of the west wing (new addition). The Robot Object Theatre and robot building lab are on the fourth floor of the west wing (new addition) and the *Millennium Falcon* experience is on the first floor of the east wing (original building).

Students may bring digital cameras or mobile phones to document their experience. Students may also use the voice recording function on their mobile phones or mp3 players.

Before Your Visit

This guide is designed to help you and your students get the most out of your visit.

1. Set clear objectives for the museum visit and discuss them with your students. This helps make the purpose of the visit clear and helps students focus and work together.

2. Help students get the most out of the *Star Wars* experience by dividing them into small groups of three or four. Create a plan to rotate the groups through different sections and interactives.

3. Review the *Star Wars* exhibits with students. Discuss how they will move through the exhibit and what they'll see.

4. Provide adult chaperones with a package that includes the names of the students in their group, group rotation times and other useful information.

5. Work with your students on one or more of the suggested pre-visit activities in this guide.

6. Plan on at least 90 minutes for your visit to the *Star Wars* exhibit. Arrange your travel to arrive 15 minutes before your scheduled tour time, to allow for payment, restroom breaks, etc.

During Your Visit

Please arrive early for your scheduled tour. Although the tours are self guided, your group will be met by a museum host who will introduce the exhibit. Your group may start the tour with a viewing of the Robot Object Theatre, a 15-minute animatronic and video experience.

After that, your students are encouraged to explore the exhibit within their chaperone groups. This is a time for chaperones to engage students by asking questions, encouraging observation skills, promoting small group co-operative learning, and actively reinforcing positive behavior. At the beginning of your tour, your chaperone groups will be given information on interactive exhibits and suggestions for engaging students with these activities.

After Your Visit

Through class discussion and post-visit activities, review with your students what they saw, experienced and learned while at *Star Wars:* Where Science Meets Imagination.

EXHIBITION THEME 1: GETTING AROUND

Star Wars vehicles use a fantasy technology called "repulsorlift" to get around. "Repulsorlift" is a movie fantasy, but engineers today are busy designing vehicles just as amazing. In the "getting around" area, you can explore the science behind these advancing technologies and even try building your very own floating vehicle.

Alaska State Science Standards

[3-9]SA1.1
[3-5]SA1.2
[4-5] SB4.1
[3][7][10] SB4.2
[3][5][6] SE1.1
[6] SE2.1
[6-8] SE2.2
[3-4][6] SG2.1

WHAT YOU WILL SEE

<u>*Star Wars* Vehicles</u>

***Millennium Falcon* Model**

Han Solo's famous starship from *Star Wars* Episode IV: *A New Hope*

+Audiovisual - Millennium Falcon's role as a character in the movies and special effects used

Rebel Alliance X-wing Starfighter Model

The shape of the starfighter's wings may be unusual, but many of the starship's features come straight from 20th century military aircraft.

+Audiovisual – Filmmakers describe inspiration for the starfighter's design and how it was made to fly in the movies.

<u>Future Spaceships</u>

Interstellar travel is one of the great themes of science fiction. Unfortunately, given our understanding of physics and the vast size of our galaxy, it is unlikely that we will visit the stars anytime soon. However, great imaginations combined with solid science just might be able to overcome these obstacles.

The models in this case are technologically plausible designs that scientists and engineers believe *might* allow us to reach the nearest star systems. The trips would likely take centuries, not minutes. The cost to build one of them would be greater than any project ever undertaken on Earth. In the meantime, these models show us what they might look like.

- **Daedalus Model**

Daedalus is designed to use tiny fusion reactions to propel itself. A chemical rocket typically burns 800 kilograms of fuel for every kilogram of payload it carries. A nuclear rocket like Daedalus would use only 100 kilograms of fuel per kilogram of payload.

- **Matter/Antimatter Rocket Model**

The most powerful rocket we can imagine would combine hydrogen and its opposite, antihydrogen, creating a matter/antimatter reaction. This type of reaction converts almost all its matter into energy. If we could build a vehicle to harness all this energy, it could reach almost two-thirds the speed of light.

- **Interstellar Ramjet Model**

A ramjet collects fuel as it moves through space by using a gigantic funnel to gather interstellar hydrogen. (Hydrogen atoms are scattered throughout space.) If you could scoop up enough hydrogen and feed them to a fusion reactor, you could theoretically travel forever.

- **Laser Assisted Ramjet Model**

Using a laser in Earth's orbit would provide energy to the ship to heat the hydrogen flowing into the reactor.

Landspeeders

Star Wars speeders have amazing capabilities thanks to their fantasy "repulsorlift" technology. They hover effortlessly above the ground, move through the air like a helicopter, and even fly into space. It's like having a car, helicopter, plane and spaceship all rolled into one.

We do all of these things today, but not in one vehicle. If we want to travel on the ground, we use a car. If we want to travel in the air, we use a plane or helicopter. In the future though, that might change. There may come a day that cars drive and fly!

Luke Skywalker's Landspeeder

+Audiovisual –Luke's Landspeeder in action, how speeders were brought to life on screen

Real-world Speeders

Paralleling Luke's Landspeeder is a showcase containing models of real world prototype speeders. Each of these vehicles duplicates some aspect of the *Star Wars* speeders' capabilities.

- **Moller M400 Skycar**

Model, Museum of Science Collections

The Moller Skycar uses turbofans for propulsion on the ground and in the air. It has undergone initial US FAA flight testing, but still faces regulatory hurdles.

- **Boeing Canard Rotor Wing Aircraft (CRW)**

Model, Courtesy of Boeing Corporation

On the outside, the Boeing CRW looks like an airplane, but the technology inside is very different. The Boeing CRW is able to rotate its central wing like a helicopter to generate lift. When it reaches cruising speed, the wing stops spinning, locks into place and acts like a fixed wing.

- **Scaled Composites: SpaceShipOne**

Model, Museum of Science Collections

SpaceShipOne is the first reusable commercial spaceship. It rockets into space from a launch aircraft, then glides back to Earth like the Space Shuttle. Virgin Galactic has ordered five SpaceShipTwo spaceships and plans to begin offering tourists rides into space in 2010.

+Audiovisual - See real-world speeders in action and get a glimpse at what future vehicles might look like.

INTERACTIVES FOR GETTING AROUND

Ride on a Cushion of Air

This vehicle floats over the ground on a cushion of air, like a hovercraft. Hovercrafts have been used for years, primarily as water craft. You can take our vehicle for a spin and see how it compares to a wheeled vehicle like a car. Hovercrafts, like the speeders in the *Star Wars* universe, minimize the effects of friction between a moving vehicle and its environment. Landspeeders rely on a fantasy "repulsorlift" technology, but hovercrafts ride on a cushion of air. Please note: This interactive accommodates one visitor at a time: Anticipate a line.

Maglev Engineering Design Lab

This intensive interactive area focuses on magnetic levitation propulsion – maglev. This is one of the most promising technologies for creating floating, high-speed vehicles. Its major application so far has been for trains.

The multi-station interactive allows you to engage in the design process and build your own floating vehicles while learning about magnets and magnetic levitation. The lab consists of three stations, each of which has multiple activity areas so it can accommodate up to ten groups of people at one time.

- Station 1 — Assemble and Test a Maglev Speeder (*magnetic levitation*)

The first step in designing and building a Maglev train is to get your vehicles off the ground by using the principle of magnetic repulsion. Magnetic repulsion basically means that the same poles of two magnets repel each other.

The track in this design lab consists of two long magnetic strips. The north pole of one track faces up, and the south pole of the other faces up. The car contains two magnets. The trick is to match the track-car pole north to north and south to south, because magnets with the same poles repel when they face each other.

- Station 2 — Learn How to Use Electromagnets to Propel a Maglev Speeder (*magnetic propulsion)*

At Station 1 you discovered how to use permanent magnets to make your car float (hover). At this station we have added coils of wire around the track. When an electric current flows through the wire, the coils become electromagnets. In this challenge you will use electromagnetism combined with permanent magnets to make your car move.

- Extra Challenge — Test Maglev

Put your car to the test and try to propel it along a maglev track.

+Audiovisual - Magnetic levitation, or maglev, uses powerful magnetic fields to suspend a train in the air and propel it along a guide-way at high speeds. Maglev could revolutionize train travel, because maglev trains can go much faster than traditional wheeled trains, have almost no moving parts to wear out, are more energy efficient and environmentally friendly, and in the long run could cost less than a traditional train system.

One of the reasons magnetic propulsion technology hasn't been widely adopted is because of the enormous upfront installation costs. Maglev trains can't use any of the existing (traditional railroad) infrastructures. To build a Maglev system, everything has to be built from scratch – that means the trains, tracks, stations and everything else. Even a relatively small train system could cost billions!

Safety note: This interactive includes strong magnets which may affect pacemakers.

STAR WARS REFERENCES FOR GETTING AROUND

***Millennium Falcon* Model**
- *Star Wars*: Episode IV *A New Hope*
- *Star Wars*: Episode V *The Empire Strikes Back*

***Tantive IV* Rebel Blockade Runner Model**
- *Star Wars*: Episode IV *A New Hope*

Rebel Alliance X-wing Starfighter
- *Star Wars*: Episode IV *A New Hope*
- *Star Wars*: Episode V *The Empire Strikes Back*
- *Star Wars*: Episode VI *Return of the Jedi*

Rebel Alliance Y-wing Starfighter
- *Star Wars*: Episode IV *A New Hope*
- *Star Wars*: Episode V *The Empire Strikes Back*
- *Star Wars*: Episode VI *Return of the Jedi*

Queen Amidala's Regal Nubian Starship Model
- *Star Wars*: Episode I *The Phantom Menace*

Imperial Star Destroyer Model
- *Star Wars*: Episode IV *A New Hope*
- *Star Wars*: Episode V *The Empire Strikes Back*
- *Star Wars*: Episode VI *Return of the Jedi*

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Imperial TIE Fighter Model
- *Star Wars*: Episode IV *A New Hope*
- *Star Wars*: Episode V *The Empire Strikes Back*

General Grievous' Starfighter Model
- *Star Wars*: Episode III *Revenge of the Sith*

***Invisible Hand* Trade Federation Cruiser Model**
- *Star Wars*: Episode III *Revenge of the Sith*

Luke Skywalker's Landspeeder
- *Star Wars*: Episode IV *A New Hope*

Trade Federation Armored Assault Tank (AAT) Model
- *Star Wars*: Episode I *The Phantom Menace*

Sebulba's Podracer Model
- *Star Wars*: Episode I *The Phantom Menace*

Interior view of the exhibit's Millennium Falcon simulator, a five-minute sound-and-light show that mimics lightspeed travel. Found on the first floor of the museum's west wing.

EXHIBITION THEME 2: ADAPTING TO THE ENVIRONMENT

Look at four very different *Star Wars* worlds and examine how the inhabitants of these worlds adapt to their environments: Hoth — extreme cold; Tatooine — hot and dry; Coruscant — a giant city; and Kashyyyk — a giant forest. Compare these with similar environments on Earth and consider how people adapt to or explore these sometimes extreme environments.

Alaska State Science Standards

[3-8]SA3.1
[3][6]SC1.2
[3-6] SC2.2
[3][5][9][10] SE1.1

WHAT YOU WILL SEE

Six showcases display amazing costumes and props from the *Star Wars* universe, with audiovisuals looking at how people adapt to extreme environments in the real world.

Living on Hoth — Extreme Cold

+Audiovisual - Examines the frozen world of Hoth and the creatures who live there

+Audiovisual – Analyze what it takes to live in really cold places, such as Antarctica

Living on Tatooine — Hot & Dry

+Audiovisual - Examine the different intelligent species that live on the fantasy world of Tatooine

+Audiovisual - People adapting to living in hot, dry places

Living on Coruscant - Built Environment

+Audiovisual - The world-city of Coruscant and some of its most famous inhabitants

+Audiovisual – The role of transportation in shaping the design of cities, especially mass public transit.

Living on Kashyyyk – A Forest Ecosystem

+Audiovisual – Wookiees: Their home-world of Kashyyyk and how they were designed

+Audiovisual - Eco-systems of real-world tropical forests and the techniques used by scientists to explore the forest environment.

INTERACTIVES FOR ADAPTING TO THE ENVIRONMENT

Moving Down the Skyway

What will transportation systems of the future look like? Explore and discover for yourself.

Building Communities

Surviving on a desolate planet like Tatooine isn't easy. The climate is harsh, resources are scarce, and competition for them often leads to conflict.

- Challenge 1: Build a Moisture Farm

Moisture farmers don't really grow water. They use "*moisture vaporators*" to harvest what little water vapor is in the air. This irrigates their underground crops.

- Challenge 2: Build a Spaceport

Tatooine is a remote planet, inhabited by hardworking locals and an assortment of visitors: merchants, smugglers, thieves and bounty hunters. Spaceports provide economic opportunities for local farmers and trades-people, but they also draw criminals and troublemakers.

- Challenge 3: Build a Jawa Camp

Your clan has established a camp at the site of a rare underground water source. Use your harvesters to extract and sell water to other Jawa clans. As clan leader, you must balance your clan's interests while minimizing conflict and keeping a careful eye on your water resources.

In this interactive exhibit, visitors can use cards to build a virtual environment on a computer screen.

How an augmented reality interactive works

The Building Communities interactive exhibit combines physical objects with virtual reality to create what scientists call a "mixed" or "augmented" reality scene. In front of the screen is a small camera connected to a computer. It is constantly looking for particular patterns of light and dark that have been programmed into it. Each pattern corresponds to a virtual model of a structure.

When the computer finds a pattern, it superimposes the virtual image over the real image. This lets you combine stunning computer graphics with the ease of use of a real object you can hold. If you want to place a virtual object, you just place the card where you want, and the computer displays it.

STAR WARS REFERENCES FOR ADAPTING TO THE ENVIRONMENT

Imperial Snowtrooper Costume
- *Star Wars*: Episode V *The Empire Strikes Back*

Luke Riding a Tauntaun Model
- *Star Wars*: Episode V *The Empire Strikes Back*

Rebel Alliance Sensor Pack
- *Star Wars*: Episode V *The Empire Strikes Back*

Rebel Alliance Macrobinoculars
- *Star Wars*: Episode V *The Empire Strikes Back*

Tusken Raider Costume
- *Star Wars*: Episode IV *A New Hope*

Tusken Woman Costume
- Star Wars: Episode III: Revenge of the Sith

Young Anakin Skywalker Costume
- *Star Wars*: Episode I *The Phantom Menace*

Mos Espa Slave Housing Model
- *Star Wars*: Episode I *The Phantom Menace*

Jawa Costume
- *Star Wars*: Episode IV *A New Hope*

Tarfful Wookiee Costume
- Star Wars: Episode III: Revenge of the Sith

Salporin Wookie Costume
- Star Wars: Episode III: Revenge of the Sith

Chewbacca's Wookie Bowcaster
- Star Wars: Episode III: Revenge of the Sith

Yoda Puppet
- *Star Wars*: Episode V *The Empire Strikes Back*
- *Star Wars*: Episode VI *Return of the Jedi*

Obi-Wan Kenobi Costume
- Star Wars: Episode III: Revenge of the Sith

Anakin Skywalker Costume
- Star Wars: Episode III: Revenge of the Sith

Mace Windu Costume
- Star Wars: Episode III: Revenge of the Sith

EXHIBITION THEME 3: ROBOTS AND PEOPLE

The *Star Wars* universe teems with robots. They are everywhere, doing the dirty, dull and dangerous jobs that people tell them to do. In this area you can compare your favorite fantasy droids to real world robots.

Build your own mobile robot and discover what the robots in our future might look like. In our world, it's a huge challenge to build a robot that can do simple things like tell the difference between a person and picture of a person, or run for more than a few hours on a single battery charge. We can make all the bits and pieces, but fitting them all into one package isn't easy.

Alaska State Science Standards

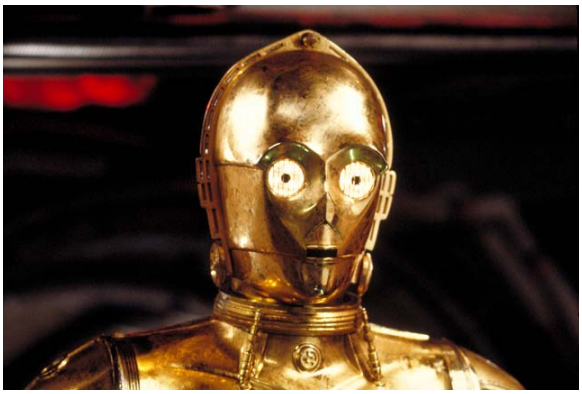
[3-8]SA1.1
[3-5]SA1.2
[3] SB4.2
[4][5] SB4.1
[3][6-8] SE3.1
[10] SG4.1

WHAT YOU WILL SEE

Robot Object Theatre

- An animatronic and video experience
- Session time 15 minutes
- Maximum number of students: 30

It's a tall order to make robots that combine the ability to move under many conditions, sense the world around them, and think. *Star Wars* droids offer imaginative examples of what robots might be some day. Join C-3P0 and MIT Roboticist Dr. Cynthia Breazeal as they debate whether R2-D2 is a good robot or not, looking at issues for modern robotics such as mobility, perception and cognition. See working models of real-world robots and meet the world's first social robot, Kismet.



Here is an excerpt from their discussion:
Dr. Cynthia Breazeal: From the human point of view, robots that are able to act on their own, and even interact with people, will be the biggest benefit to our society. For instance, humans are very emotional; they interact easily with other emotional beings.

C-3PO: Perhaps that is true. But emotion leads to unpredictability and unpredictability can be very stressful for a droid such as myself.

Cynthia: Maybe. But what we gain is creativity. At least, that's my hope. It's robots like R2-D2 that inspired me to develop a social robot, called Kismet. Would you like to meet Kismet?

C-3PO: Another socialized robot. Indeed, I should be intrigued to make its acquaintance.

Cynthia: Hello Kismet. How are you doing?

Kismet: Goobedoobedoobe.

Cynthia: I want you to meet a friend of mine, C-3PO. Come on, don't be shy. He's perfectly harmless. And I'll be right back.

C-3PO: Hello Kismet. How fascinating to meet you. I am C-3PO.

Kismet (inquisitive, or playful): Dooboobedoobe?

C-3PO: I am programmed in 6 million forms of communication, but your sounds are completely alien to me.

Kismet (sad): Oubedoobedoobe.

Cynthia: Hello Kismet! Yes, I brought your favorite toy. Yes, I'm happy to see you too. You see, Kismet doesn't speak a real language. It babbles, but the sounds it makes are very expressive. We can tell from Kismet's expression if it's interested, frightened, or even happy to see us.

C-3PO: Yes, I can see that your droid is very expressive. But at least with R2-D2, I do always know what he's actually saying.

Cynthia: Yes, and one of the reasons we understand R2-D2 so well is that he's expressive. He's friendly. He has what we call social intelligence that allows him to interact well with humans. I hope that in time the robots in my world will be socially intelligent. Not only will it be easier to work with them, but robots and humans may end up helping each other in ways we can't even imagine. So C-3PO, do you now have a better appreciation for R2-D2?

C-3PO: Hmm. After everything you've said, perhaps I can try and appreciate his better qualities. And perhaps he will begin to appreciate mine…

Star Wars Robots

Star Wars vehicles on display in this section include an All Terrain Armored Transport and a Republic Tactical Enforcer. Robots include an Imperial probe droid, a pit droid, a battle droid, a full-size destroyer droid (Droideka), R2-D2 and a "naked" C-3P0 (without his outmost layer).

+Audiovisual – Movie clips and archival material show the development of four *Star Wars* robots: C-3PO, R2-D2, the Imperial probe droid (also called the Hoth Droid) and the Droideka.

Real-World Walking Robots

Walking robots have been a regular feature of science fiction for years. Now, walking machines are starting to appear in the real world. See some in this showcase.

- **John Deere Timberjack Model**

Courtesy of John Deere Forestry Oy, Finland

The Timberjack walking tree harvester is more maneuverable than a wheeled vehicle. It also is less damaging to the forest since it doesn't need a road and it doesn't leave deep tracks in the ground, which can lead to runoff.

- **Troody**

1996–2001, courtesy of Peter Dilworth

Troody was developed at the MIT Artificial Intelligence Lab. Its design is based on the carnivorous dinosaur *Troodon formosus*. Troody could stand up from a rest position and then walk. Troody could even sense when it was walking on an uneven surface and adjust its steps to the terrain.

- **WowWee Robosapien V2**

2005, courtesy of WowWee

Robosapien is an example of a school of robot design called BEAM. BEAM stands for Biology, Electronics, Aesthetics and Mechanics. Beam robots look to nature for inspiration and strive for minimal electronic controls, an easily-understood design, and clever mechanical design. The result is a robot that can walk, talk, see obstacles and interact with people.

+Audiovisual – Robots in action (real and *Star Wars*)

Robotics Today

- **Personal Satellite Assistant (PSA)**

1998- courtesy of NASA

The Personal Satellite Assistant is designed to be a general-purpose monitor and astronaut assistant on the International Space Station. In that weightless environment, PSA only needs tiny thrusters to get around. Sensors cover its surface to help it detect objects and monitor the environment. The screen on the front is a computer monitor that can connect to the station's network.

- **Segway RMP soccer robot**

2002- courtesy of Segway/Carnegie Mellon University

This is part of a research project at Carnegie Mellon University exploring how to create autonomous mobile robots that can navigate, learn and cooperate with other robots and people. CMU's project focuses on teaching robots how to play soccer because soccer, unlike real life, has very simple rules, a standardized playing field, and a fixed number of objects.

- **Sony AIBO**

1999–2006, courtesy of Sony Corp

The Sony AIBO (AI for Artificial Intelligence and BO for RoBOt) is designed to act like a pet. The more you play with it, the more tricks you can teach it. AIBO manages to pack sophisticated computing ability, numerous sensors that allow it to navigate and recognize speech, and a variety of programs, into a small, lightweight package durable enough to survive in a home.

- **Rectiblob**

1995–1997, courtesy of Geo Homsy

Rectiblob employed a novel method for getting around on rugged terrain. By changing shape, it could roll like a ball or drive like a tank tread. Rectiblob could also perform various acrobatics like hopping.

- **Roomba**

2002 - courtesy of iRobot

The Roomba is the most successful domestic service robot in service. It achieved this fame by doing a single job well — vacuuming houses. You can even program it to vacuum while you're out, so you never have to see it at work.

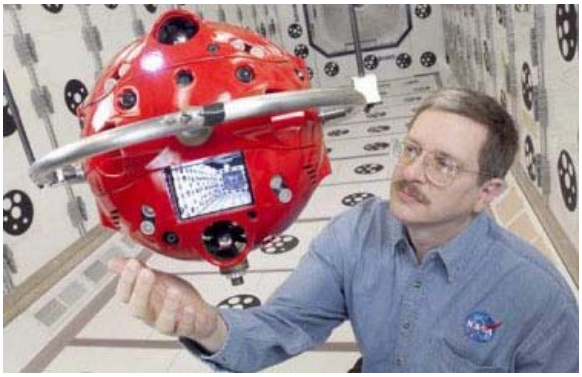
- **The Huggable Therapeutic Robot**

The Huggable robotic bear has been developed as a therapeutic aid, following research showing animal companionship is good for people's health. The Huggable can participate in active relational and touch-based interactions with a person.

- **Autom Robotic Weight Loss Coach**

Autom is a social robot created by MIT to help people lose weight. It offers feedback on diet-related behavior based on goals that have been set, such as calorie limits and amount of exercise. One of the motivations behind the project is the belief that a robot can be more engaging than a character on a screen or mobile phone.

+Audiovisual — Listen to roboticists from around the world talk about what led them to become robot designers, what they're working on now, and what kinds of robots they hope to see in the future.



A Personal Satellite Assistant being tested by NASA.

INTERACTIVES FOR ROBOTS AND PEOPLE

Robot Engineering Design Lab

Here your challenge is to design and build a robot that has three of the important qualities of R2-D2: mobility (he can navigate easily through the human world), perception (he can sense his environment and react to it accordingly), and cognition (he can understand what people are doing and telling him).

The robot lab will break down the enormous problem of robot design into three activities focused on mobility, perception and cognition.

- Station 1: Mobility

Pick the right "feet" for the job.

- Station 2: Programming (cognition)

One important difference between a robot and a vehicle is that instead of a human driver who makes decisions, robots navigate using computers that send a series of instructions to various motors.

Your robot has a short set of directions. Real world robots can need millions of lines of code to make them operate. If a robot's computer fails, it is in trouble, even if its mechanical parts are fine.

- Station 3: Perception

The final step in designing your robot is giving it some ability to sense the world around it. Your robot can use its sensor to find its way after you have told it what to look for. As you program your robot, use one of the three sensors to get it to the goal. There is no correct path to follow.

Robot Vision

This robot has been programmed with basic vision. It's trying to find human faces and make conclusions about what it sees. If robots are to work among us, they'll need to see the world around them and recognize and read human faces just like we do. Can you get the robot to see you? Can you trick the robot?

Robot Expressions

One way to improve communication between humans and robots is to give robots faces that indicate how well they are working according to their expressions. For example, a robot might appear to frown to warn of problems. It might appear to smile when all systems are OK, or after it has completed a task. This exhibit lets you control the expression of a robot face on the computer screen. What kinds of information can you make your robot face communicate?

At the Robot Engineering Design Lab, visitors can build a small, simple robot by following step-by-step instructions.

STAR WARS REFERENCES FOR ROBOTS AND PEOPLE

Interrogator Droid
- *Star Wars*: Episode IV *A New Hope*

C-3PO Costume
- *Star Wars*: Episode III *Revenge of the Sith*

"Naked" C-3PO Puppet
- *Star Wars* Episode I *The Phantom Menace*

R2-D2 Costume
- Star Wars: Episode III: Revenge of the Sith

Trade Federation Battle Droid
- *Star Wars* Episode I *The Phantom Menace*

Pit Droid (collapsed)
- *Star Wars*: Episode I *The Phantom Menace*

Imperial Probe Droid
- *Star Wars*: Episode V *The Empire Strikes Back*

Droideka (Destroyer Droid)
- *Star Wars*: Episode I *The Phantom Menace*
- *Star Wars*: Episode II *Attack of the Clones*

Walking robots

Republic All Terrain Tactical Enforcer (AT-TE) Model
- *Star Wars*: Episode II *Attack of the Clones*

Imperial All Terrain Armored Transport (AT-AT) Model
- *Star Wars*: Episode V *The Empire Strikes Back*

Imperial All Terrain Scout Transport (AT-ST) Model
- *Star Wars*: Episode VI *Return of the Jedi*

The Republic All Terrain Armored Transport (AT-AT) is an example of a walking robot in the *Star Wars* universe. The AT-AT is an intimidating armored assault vehicle.

EXHIBITION THEME 4: ROBOTICS AND MEDICINE

This section looks at the use of prosthetics and medical implants in the *Star Wars* universe and in the real world. Many of the technologies useful to the development of robotics also have applications for the artificial replacement of damaged or diseased limbs and organs. This section explores the question of whether the use of prostheses and implants blurs the line between human and robot, using Darth Vader as an example.

Alaska State Science Standards

[3-8]] SE3.1

WHAT YOU WILL SEE

Real-world Implants

- **Neural interfaces: The BrainGate System™**

People who are paralyzed or suffer from degenerative neuromuscular diseases generate neural control signals, even though their nervous system is unable to transmit those signals to the muscles. BrainGate reads those signals and transmits them to devices outside the patient's body.

- **The AbioCor™ Replacement Heart**

Making a mechanical heart that can perform like the real thing is no easy task. Your heart beats about 100,000 times in a day and 2.5 billion times in an average lifetime. Engineers have only recently built a heart that can withstand that kind of use and fit inside the human body.

- **Artificial Retinas**

This system consists of a tiny video camera that transmits signals wirelessly to an array of electrodes implanted in the patient's retina. This version of the retinal implant has only sixteen electrodes in a 4x4 pattern, so wearers see an array of sixteen lights. By comparison, each eye normally contains 100 million photoreceptors.

- **Cochlear implants**

Cochlear implants work by sending electrical signals derived from sounds to the brain via surgically implanted electrodes. This device enables people who are profoundly deaf or severely hard of hearing to have a sense of sound.

- **Paradigm Insulin Pump**

Until recently, people with diabetes mellitus needed daily insulin injections or a bulky external insulin pump to survive. A new generation of insulin pumps allows them to receive the insulin they need without repeated injections. These pumps mimic the natural delivery rate of insulin. This helps to significantly reduce hypoglycemic events, and allows the wearers to lead a more normal life.

Real-world Prosthetics

- **C-Leg® Microprocessor Knee**

Advances in electronics and microprocessors have transformed prosthetic knees from hinged mechanical joints to dynamically responsive systems that can be custom-tuned to a user's gait and activity level. The C-Leg System consists of a carbon fiber frame, a hydraulic piston, a rechargeable lithium battery, and a microprocessor that anticipates a patient's movement.

- **Boston Digital Arm™**

The Boston Digital Arm is a state-of-the-art "intelligent" prosthesis. It is both mechanically strong and sensitive to the nerve and muscle signals of the patient who controls it. The arm is controlled by myoelectric signals, small voltage fluctuations that are generated in muscles when the brain tells them to contract.

- **Taylor External Fixator Frame**

The Taylor External Fixator Frame corrects up to six axes of deformity and can help repair severe fractures. It uses Internet-based software to assist the surgeon with precise anatomical correction of deformities.

- **BION® implants: Wireless Muscle Stimulators**

BIONs are injectable electronic devices that can be used to stimulate paralyzed muscles to prevent atrophy and even restore functional movement. Once in place, a radio frequency coil outside the body sends power and commands to each implant to control electrical pulses that activate muscles to contract.

- **Apligraf® Living Skin Substitute**

A remarkable biomedical breakthrough, Apligraf is a manufactured living skin substitute that can be used to close chronic wounds. This is the first living, cell-based product ever to be approved by the U.S. Food and Drug Administration (FDA). Use of skin substitutes can speed up wound closure dramatically. Product application takes only about 15 minutes.

+Audiovisual – Looks at *Star Wars* characters like Darth Vader and Grievous and highlights recent developments in prosthetics and implantable technologies

***Star Wars* Medicine**

Star Wars objects on display include a General Grievous maquette, 2-1B medical droid, FX-7 medical droid and Luke and Anakin's prosthetic hands. There is also a separate showcase displaying Darth Vader's costume, helmet and collar.

INTERACTIVES FOR ROBOTS AND MEDICINE

Human or Machine?

We use technology to overcome physical limitations all the time. People wear glasses and hearing aids, use false teeth, and replace missing limbs with artificial ones. New technologies promise to radically change what we can do. Will they change the way we view ourselves?

You and two other visitors can explore what life might be like in a world where people can — and do — augment themselves with technological aids. How would it feel? What would you do? Pick one of the three stations and press the round button to begin.

The AbioCor Replacement Heart is made primarily of titanium and a proprietary polyether-based polyurethane plastic.

STAR WARS REFERENCES FOR ROBOTS AND MEDICINE

Is Darth Vader human? Or android?

Darth Vader Costume

- *Star Wars*: Episode IV *A New Hope*
- *Star Wars*: Episode V *The Empire Strikes Back*
- *Star Wars*: Episode VI *Return of the Jedi*

Darth Vader Helmet

- *Star Wars*: Episode III *Revenge of the Sith*

Darth Vader Mask

- *Star Wars*: Episode III *Revenge of the Sith*

Darth Vader Collar

- *Star Wars*: Episode III *Revenge of the Sith*

General Grievous maquette

- *Star Wars*: Episode III *Revenge of the Sith*

Interrogator Droid

- *Star Wars*: Episode IV *A New Hope*

2-1B Medical Droid

- *Star Wars*: Episode V *The Empire Strikes Back*

FX-7 Medical Droid

- *Star Wars*: Episodes V *The Empire Strikes Back*

Anakin's Prosthetic Hand

- *Star Wars*: Episode II *Attack of the Clones*

Lobot's Headgear - *Star Wars*: Episode V *The Empire Strikes Back*

Luke's Prosthetic Hand

- *Star Wars*: Episode V *The Empire Strikes Back*

PRE-VISIT ACTIVITIES

The following classroom activities introduce some of the concepts students will experience in the *Star Wars* exhibit. These activities are designed for grades 3-8.

MYSTERY BOXES: USING YOUR SENSORS

Materials

- Assorted mystery objects such as marbles, shells, a fork, beanbags, feathers, toys or tools, Velcro, aluminum foil, sponges … any object with an interesting shape, texture, smell or sound works well — use your imagination!
- Opaque boxes with lids
- Heavy cloth bags
- Film canisters or other small containers
- Paper and pencil or white board and markers

There are many ways to set up this activity. Here are some examples:

- Put several marbles, pennies or paper clips inside a shoebox. Boxes don't allow you to feel the specific outline of an object; however, you can shake the box to learn more. Is it one object or many? Does it roll or thump? Is it made of wood, metal, plastic, cloth, etc.? How heavy is it?
- Place items in cloth bags. Have students feel the outline of items like a spatula or toy car.
- Try something with a strong scent, like wrapped peppermint candies, chocolates or a pine branch.
- Create closed boxes with a slot cut out on the side, so students can reach in and feel an object without fully seeing it. These are great to use for textured natural history objects such as feathers, shells or rocks.

Procedure

1. Offer students a mystery object.
2. Use your senses of touch, hearing, and smell to investigate the mystery object, but don't open the container.
3. Share your ideas and observations.
4. Open the boxes!
5. Variation: Introduce one mystery box at the start of a class. Post a large piece of paper nearby. Students can investigate the mystery box (or boxes) at various times throughout the lesson and write their guesses on the paper. At the end of the class, gather everyone together, review the list and open the box.
6. Variation: Have a collection of mystery objects with two or more of each object. For example, create two containers with pencils, with playing cards, etc. Give each student a mystery object and challenge them to find another student with a matching object.

Discussion Questions

- How would a robot investigate a mystery box?
- If you were building a robot, what sensors would you want it to have?
- How does using multiple senses give you more information?
- What might confuse a robot trying to sense its environment?
- What tools might help humans and robots learn more about the objects around them?

ROBOT PROGRAMMING

It's as easy as 1, 2, 3

Materials

- A large robe or jacket

Procedure

1. Ask for one volunteer who will be a robot (consider asking an adult to volunteer). The robot can only do exactly as it is instructed. Ask the robot to temporarily leave the room so she does not hear you explain the task to the other people. (This way the robot cannot unconsciously help with the instructions.)
2. Explain to the group that you want the robot to do a very simple task: Successfully put on a robe. Place the robe on the floor and invite the robot back in.
3. Ask one volunteer to suggest the first step. For example, a person says, "Put your arm in." The robot should do exactly this: Place her arm out in the air.
4. Ask a second person for another suggestion. For example the next person says, "Pick up the robe." The robot should pick up the robe, regardless of orientation.
5. Continue asking for suggestions. Each time, the robot should do exactly as she is instructed. If an instruction is too vague, such as "Put the robe on," the robot can ask for another, more specific instruction (or hold up an error message). Remind people to speak one at a time and encourage lots of different people to participate. Eventually, with trial and error (and giggles) the robot should end up successfully robed.
6. Try again with a different robot and a different task, such as putting the robe on inside out, making a peanut butter and jelly sandwich, or walking over to and answering the telephone.

Discussion Questions

- How does this relate to writing instructions for a robot?
- How are robots similar to humans?
- What kinds of jobs can robots do? What jobs can't they do?
- What other challenges are there when communicating with a robot?

CREATE AN ELECTROMAGNET

Part 1: Build a Simple Electromagnet

Materials

- 3 feet of insulated wire (16 – 20 gauge)
- 16 d common nail
- 1.5 volt (D cell) battery
- Battery holder
- Paper clips
- Wire strippers

Procedure

1. Take 3 feet of wire and strip 1 inch of insulation from each end.
2. Wrap the wire tightly around the long nail, leaving 6 inches free at each end. This creates a coil of wire.
3. Create a circuit by attaching the loose ends of the wire to the two opposite poles of a battery. Use a battery holder to hold the wires in place.
4. Test your electromagnet by touching the point of the nail to a paper clip and lifting the nail. The paper clip should cling to the nail. Try to pick up a string of paper clips.

Be careful: If any part of the circuit begins to get hot, break the connections and let go of the battery and wires.

Part 2: Create a Stronger Electromagnet

Additional Materials

- Nails of various sizes
- Assorted wires of various length and thickness
- Assorted objects to test the electromagnet's strength (such as nuts, bolts, screws, metal fasteners, different shapes and sizes of paper clips, or any other small metal objects)

Procedure

1. Design, test and improve various electromagnets to see how each change affects the strength of the magnet.
2. Try wrapping the wire around the nail fewer times or more times.
3. Try a thicker or thinner wire.
4. Try a different size nail.
5. Try wrapping the wire using different patterns.
6. Change any other variables you can think of.
7. You will need to come up with a concrete way to measure magnet strength, for example, by counting the number of paperclips the magnet can lift. What else can you pick up with your magnet? How many things can you pick up?
8. Change one variable at a time and record your results in a table.

Discussion Questions

- What design produced the strongest magnet?
- How could you change the designs that did not work as well to improve them?
- What are other real-world applications of electromagnets?

More questions to encourage discussion

1. **What is technology?** (manipulating the natural world/making work easier, more convenient)
Possible activities: brainstorming; drawing pictures of technology; listing examples of technology as a class group; providing examples of humorous or funny inventions; looking at the earliest examples of technology (such as primitive tools, simple machines, etc.)

2. **What is science?** (understanding of the natural world)
Possible activities: brainstorming; matching names for branches of scientific study to pictures and/or descriptions of each branch

3. **How are science and technology related?**
Possible activities: Place items or pictures of items around the room. Let students decide whether the item represents a technology that was inspired by science, or a technology that improved out of scientific understanding. Students will learn that science and technology are interrelated.

4. **What is the impact of technology on science?**
Possible activities: Look at the scientific process (basic research, applied research, development, technological advance), design a wacky invention, and explain the role scientific understanding played in the invention.

POST-VISIT ACTIVITIES

Suggestions on how to use post-visit activities/questions:

- Individual essay or journal
- Large or small group discussion
- Create posters (individually or as a small group) using drawings and/or magazine cutouts.
- Create models using clay, Legos, or other objects (individually or as a small group).
- Create PowerPoint presentations.
- Create a newspaper or newspaper report.

Getting Around

Student Inquiry Questions

1. How do humans travel today, in the 21st century?
2. How did humans travel in the 1800's?
    a. How do you think humans traveled in the 1200's?
    b. How do you think humans will travel in the 2800's?
3. What do you think our world would be like if we had vehicles like the speeders and starships in *Star Wars*?
    a. How would it be the same?
    b. How would it be different?
4. Do you think that having such vehicles would be good or bad for humans? For the world? In what way?
    a. How would such technology change or impact humans?
    b. How would it change or impact human relationships and behavior?
    c. How would it change the world?
5. If you were to design a space vehicle of the future, what would it look like?
    a. How many people would it transport?
    b. How fast would it go?
    c. What would it use for fuel?
    d. How much would it cost?
    e. How would you advertise it?
    f. What would your sales ad say?

Adapting to the Environment

Student Inquiry Questions

1. How will humans in the future live?
    a. Will we live within large or small cities?
    b. What types of food will humans of the future eat?
    c. How will humans of the future get their food?

d. Will humans colonize other planets?
    i. How will we live there?
    ii. How would we travel on those planets?
e. How will Earth be different in the future?

Robots and People

Student Inquiry Questions

1. What is happening in the world of robotics today?
    a. Who are some of the leading roboticists and/or companies making advancements in robotic technology? *(Internet / Library - RESEARCH)*
    b. What other types of careers work with robots? *(Internet / Library - RESEARCH)*
2. How do you think robots will be used in the future?
    a. What will future robots look like?
3. If you had your very own personal robot, what would it look like?
    a. What would it do for you?
    b. How would it sound?

Robots and Medicine

Student Inquiry Questions

Human or Machine? We use technology to overcome physical limitations all the time. People wear glasses, and hearing aids, use false teeth, and replace missing limbs with artificial ones. New technologies promise to radically change what we can do.

1. How do you think new medical technologies will change the way we live?
    a. Our abilities?
    b. Our size?
    c. How we eat?
2. Will they change the way we view ourselves?

INTERNET RESOURCES

Please note: The Web sites referred to in this guide were available and suitable at the time of publication. However, we advise educators to check the sites before recommending them to students.

Star Wars
http://www.lucasfilm.com/films/starwars/

Space and space travel interactives
http://www.nasa.gov/

Robots
http://www.youtube.com/watch?v=eYWQr2LoLKs
http://www.youtube.com/watch?v=Q3C5sc8b3xM&feature=related
http://www-education.rec.ri.cmu.edu/
http://en.wikipedia.org/wiki/Robot

Sustainable communities
http://www.powerhousemuseum.com/education/ecologic/ecotown/mid/

Maglev technology
http://www.howstuffworks.com/maglev-train.htm
http://www.o-keating.com/hsr/maglev.htm

Hovercraft chair

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Robot Object Theatre