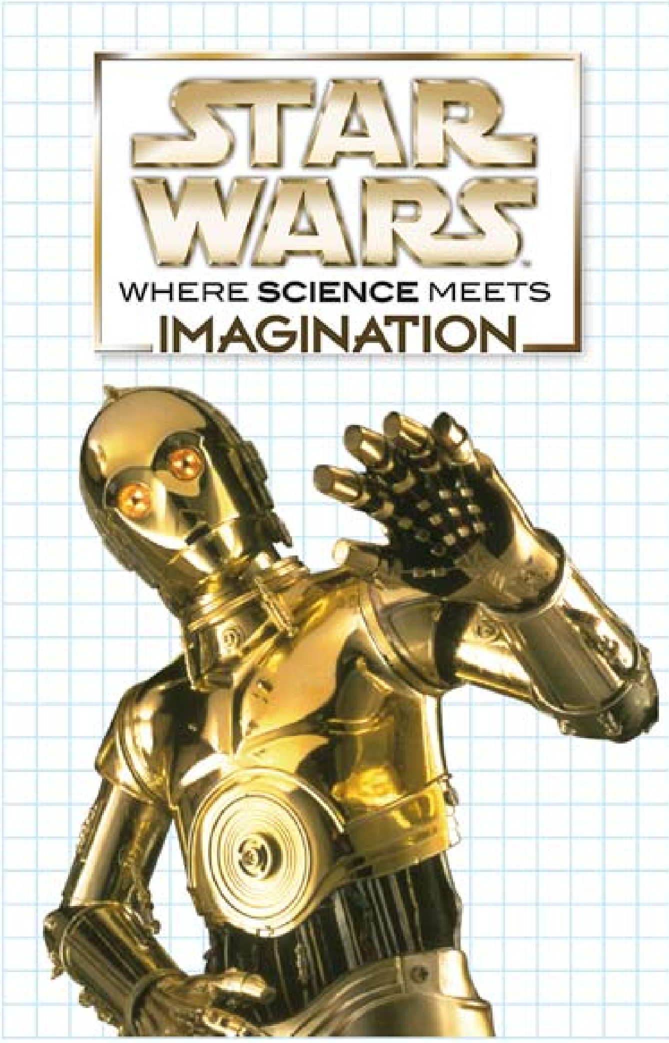

Education kit

Acknowledgements
Star Wars: Where Science Meets Imagination is presented by Bose Corporation and developed by the Museum of Science, Boston, and Lucasfilm Ltd. The exhibition is based upon work supported by a grant from the National Science Foundation, USA.

This education kit contains materials developed by Powerhouse Museum and Museum Victoria.
Rich assessment tasks by Daniel Avano, Catholic Education Office Melbourne / Museum Victoria.

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Contents

Teacher notes

Star Wars: Where Science Meets Imagination is an interactive science and technology exhibition. It combines costumes and props from all six *Star Wars* films with real-world technologies and video interviews with filmmakers, scientists and engineers. Students explore prototypes, learn about the engineers and designers who create new technologies, and compare the ways that scientists and filmmakers think.

The exhibition explores two major themes – *Getting Around* and *Robots and People*, as well as two minor themes – *Adapting to Environments* and *Robots and Medicine*. Students can meet C-3PO in the robot theatre, find out about real-world robots that sense their environment or simulate a sustainable environment on an alien planet. They can also experiment with magnetic levitation and robot design in two engineering design laboratories.

For information about the *Star Wars* season at Scienceworks:
http://museumvictoria.com.au/starwars

School groups are booked into 90 minute sessions starting at 9.30am, 11.00am or 12.30pm. Bookings are essential: telephone **03 9392 4819**.

Other Scienceworks programs: http://museumvictoria.com.au/scienceworks/Education/

Education resources
This education kit provides a range of resources to assist teachers to plan a successful class excursion to *Star Wars* at Scienceworks.

- Rich Assessment Tasks are provided to extend students' learning experiences. These multi-domain activities are relevant to a variety of themes and include pre and post visit work.
- A 'Make your own pathway' activity is provided for junior students to use in the exhibition.
- School-based activities for use before or after your visit are also provided.

Rich Assessment Tasks 1-5
The five Rich Assessment Tasks are based on ideas from the VELS domains of *Interpersonal Development*, *Personal Learning*, *Mathematics*, *Science*, *English*, *ICT* and *Thinking*. They relate well to a variety of units or themes of study including Space, Story telling, Design, Transport, Flying, Science Fiction, Living in different environments, Planets, Technology and Making films.

Rich Assessment Tasks require preparation prior to and following the visit.

Discuss with your class whether students will be working in groups, the types of exhibits they will visit, and how they will present their completed tasks. You may wish to select the VELS domain on which you will focus for your visit. You may want all students to complete the same Rich Assessment Task or allow them to choose one for themselves.

The Rich Assessment Task resources consist of sample assessment rubrics, 'working in teams' contracts and a work log, supplied as WORD documents. Decide which of these are relevant to your students' needs before your visit. Spend some time in class with your students discussing the requirements associated with these support materials.

Discuss how you will do the Rich Assessment Tasks with the class before the excursion. If you decide to use teams, students will need to allocate roles for each member. They will also have to decide on what types of information they will collect during their visit and how they will go about collecting it. Make sure that students keep the notes they take during their visit so that they can complete their activity back at school.

Essential preparation

'Creating interest in the subject of an exhibition is vital to a successful and enjoyable museum experience.' (Visitor Advocacy study, Museum Victoria)

Research has shown that setting clear objectives for a museum visit and discussing them with students is extremely important. It makes the purpose of the visit clear and assists students to focus and work together during the visit. Prior to your visit to Scienceworks, take some time in class to discuss your excursion and to assess your students' knowledge and understanding of the exhibition and related topics.

Before your excursion

- Please check your confirmation letter to ensure that the details of your excursion are correct. If there is a problem with your booking, please telephone Scienceworks Booking Office **03 9392 4819**.

- Photocopy the *Star Wars* floor plan in this kit and discuss the exhibits with your students. The exhibition content section of the kit contains detailed descriptions of each exhibit and the concepts that they demonstrate.

- Review the 'Rich Assessment Tasks' and 'School based activities' sections of this kit and choose one or more that are suitable for your students. You may adapt these to ensure that they are appropriate for your students.
These activities require discussion prior to your *Scienceworks* visit.
The Rich Assessment Tasks have a component to be completed during the visit, but require students to make a presentation on what they have learned back at school.

- Divide classes into groups before you arrive at Scienceworks. Groups of 3-4 students are best to avoid crowding around each exhibit. The Rich Assessment Task resources include a team agreement/contract to assist students to explore how they can work within their teams.

- Discuss with your students in advance how they will move through the exhibition and what they might see. Note that the Rich Assessment Tasks have a list of recommended exhibits for students to focus on.
Make sure that students understand that the exhibits listed on their activity sheets are very important for completing their task, so they must try to get through as many of them as possible. If an exhibit is 'busy' it is important that they try to find another one that they can visit rather than just waiting for one to become free. The order of the exhibits on the list is not important, so encourage the class to start at different places on the list.

On the day of your excursion

- Students may bring digital cameras or mobile phones so they can document their experience in the exhibition for later use. Students may also use the voice recording function on their mobile phone or mp3 player to record their observations.
Please note – tripods may not be used in Scienceworks exhibitions.

Victorian curriculum links

The exhibits and themes of *Star Wars:* Where Science Meets Imagination, together with the education materials provided, relate to Levels 1-6 of the Victorian Essential Learning Standards (VELS). The links between the Rich Assessment Tasks and Levels 3-5 of the VELS are detailed in the tables below.

Level 3

Rich Assessment Tasks

	Domain	Dimensions & Standards	1	2	3	4	5
Physical, Personal & Social Learning	Interpersonal Development	**Working in teams**					
		• cooperate with others in teams for agreed purposes, taking roles and following guidelines established within the task.	●	●	●	●	●
		• describe and evaluate their own contribution and the team's progress towards the achievement of agreed goals.	●	●	●	●	●
	Personal Learning	**Managing personal learning**					
		• students set short-term, achievable goals in relation to specific tasks.	●	●	●	●	●
		• complete short tasks by planning and allocating appropriate time and resources.	●	●	●	●	●
		• undertake some multi-step, extended tasks independently.	●	●	●	●	●
Discipline-based Learning	Mathematics	**Measurement, Chance and Data**					
		• students estimate and measure length using appropriate instruments.	●		●		●
		• recognise and use different units of measurement including informal (for example, paces), formal (for example, centimetres) and standard metric measures (for example, metre) in appropriate contexts.	●		●		●
		• read linear scales (for example, tape measure) and circular scales (for example, bathroom scales) in measurement contexts.	●				●
	English	**Reading**					
		• students read and respond to an increasing range of imaginative and informative texts with some unfamiliar ideas and information, vocabulary and textual features.	●	●	●	●	●
		• interpret the main ideas and purpose of texts.	●	●	●	●	●
		• identify how language is used to represent information, characters, people, places and events in different ways including identification of some simple symbolic meanings and stereotypes.	●		●	●	●
		• use several strategies to locate, select and record key information from texts.	●	●	●	●	●
		Writing					
		• order information and sequence events using some detail or illustrative evidence, and they express a point of view providing some information and supporting detail.	●	●	●	●	●
		• combine verbal and visual elements in the texts they produce. They meet the needs of audiences by including appropriate background information.	●	●	●	●	●
		Speaking and Listening (depending on presentation format chosen)					
		• students vary their speaking and listening for a small range of contexts, purposes and audiences.	●	●	●	●	●
		• project their voice adequately for an audience, use appropriate spoken language features, and modify spoken texts to clarify meaning and information.	●	●	●	●	●
		• listen attentively to spoken texts, including factual texts, and identify the topic, retell information accurately, ask clarifying questions, volunteer information and justify opinions.	●	●	●	●	●

	Science	**Science knowledge and understanding**					
		• use appropriate scientific vocabulary to describe and explain their observations and investigations.	●	●	●	●	●
		Science at work					
		• use a range of appropriate methods to record observations, and comment on trends.	●	●	●	●	●
		• students plan, design, conduct and report collaboratively on experiments related to their questions about living and non-living things and events.	●	●			●
		• explain how scientific knowledge is used, or could be used, to solve a social issue or problems.	●		●	●	●
		• describe aspects of the work of scientists and how this has contributed to science knowledge.	●			●	●
Interdisciplinary Learning	ICT	**ICT for creating**					
		• students follow simple plans and use tools and a range of data types to create information products designed to inform, persuade, entertain or educate particular audiences..	●	●	●	●	●
		• locate information on an intranet, and locate information from websites.	●	●	●	●	●
	Thinking	**Reasoning, processing and inquiry**					
		• collect information from a range of sources.	●	●	●	●	●
		• question the validity of sources when appropriate.	●	●	●	●	●
		• apply thinking strategies to organise information and concepts in a variety of contexts, including problem solving activities.	●	●	●	●	●
		• provide reasons for their conclusions.	●		●	●	●

Level 4

Rich Assessment Tasks

	Domain	Dimension & Standard	1	2	3	4	5
Physical, Personal and Social Learning	Interpersonal Development	**Working in teams**					
		• work effectively in different teams and take on a variety of roles to complete tasks of varying length and complexity.	●	●	●	●	●
		• work cooperatively to allocate tasks and develop timelines.	●	●	●	●	●
		• accept responsibility for their role and tasks.	●	●	●	●	●
		• provide feedback to others and evaluate their own and the team's performance.	●	●	●	●	●
	Personal Learning	**Managing personal learning**					
		• students develop and implement plans to complete short-term and long-term tasks within timeframes set by the teacher, utilising appropriate resources	●	●	●	●	●
		• undertake some set tasks independently, identifying stages for completion.	●	●	●	●	●
		• describe task progress and achievements, suggesting how outcomes may have been improved.	●	●	●	●	●
		• seek and use learning support when needed from peers, teachers and other adults.	●	●	●	●	●
		• demonstrate a positive attitude to learning within and outside the classroom.	●	●	●	●	●
Discipline-based Learning	Mathematics	**Measurement, Chance and Data**					
		• students use metric units to estimate and measure length, perimeter, area, surface area, mass, volume, capacity time and temperature.	●		●		
		• measure as accurately as needed for the purpose of the activity.	●		●		
		• convert between metric units of length, capacity and time (for example, L– mL, sec– min).	●		●		
	English	**Reading**					
		• students read, interpret and respond to a wide range of literary, everyday and media texts in print and in multimodal formats.	●	●	●	●	●
		• analyse these texts and support interpretations with evidence drawn from the text.	●	●	●	●	●
		• analyse information, imagery, characterisation, dialogue, point of view, plot and setting.	●	●	●	●	●
		Writing					
		• students produce, in print and electronic forms, a variety of texts for different purposes using structures and features of language appropriate to the purpose, audience and context of the writing.	●	●	●	●	●
		• begin to use simple figurative language and visual images.	●	●	●	●	●
		• use a range of vocabulary, a variety of sentence structures, and use punctuation accurately, including apostrophes.	●	●	●	●	●

		Speaking and Listening (depending on presentation format chosen)					
		• students plan, rehearse and make presentations for different purposes.	●	●	●	●	●
		• adjust their speaking to take account of context, purpose and audience, and vary tone, volume and pace of speech to create or emphasise meaning.	●	●	●	●	●
		• when listening to spoken texts, students identify the main idea and supporting details and summarise them for others.	●	●	●	●	●
		• when listening to others, students ask clarifying questions and build on the ideas of others.	●	●	●	●	●
		• identify key ideas and take notes.	●	●	●	●	●
	Science	**Science knowledge and understanding**					
		• qualitatively describe changes in motion in terms of the forces present.	●		●		
		• use everyday examples to illustrate the transforming and transferring of energy.	●	●	●		●
		• apply the terms *relationships*, *models* and *systems* appropriately as ways of representing complex structures.	●	●	●	●	●
		Science at work					
		• analyse a range of science-related local issues and describe the relevance of science to their own and other people's lives.	●	●	●	●	●
		• design and build simple models and write an account of the science that is central to explanation of the model.	●	●	●		●
	Humanities Geography	**Geographic knowledge and understanding**					
		• use geographic language to identify and describe the human and physical characteristics of local and global environments depicted by different kinds of maps, diagrams, photographs and satellite images.	●	●	●	●	●
Interdisciplinary Learning	ICT	**ICT for creating**					
		• students safely and independently use a range of skills, procedures, equipment and functions to process different data types and produce accurate and suitably formatted products to suit different purposes and audiences.	●	●	●	●	●
		• students design tools to represent how solutions will be produced and the layout of information products.	●	●	●	●	●
		• students modify products on an ongoing basis in order to improve meaning and judge their products against agreed criteria.	●	●	●	●	●
	Thinking	**Reasoning, processing and inquiry**					
		• use the information they collect to develop concepts, solve problems or inform decision making.	●	●	●	●	●
		• develop reasoned arguments using supporting evidence.	●	●	●	●	●

Level 5

Rich Assessment Tasks

	Domain	Dimension & Standard	1	2	3	4	5
Physical, Personal and Social Learning	Interpersonal Development	***Working in teams***					
		• accept responsibility as a team member and support other members to share information, explore the ideas of others, and work cooperatively to achieve a shared purpose within a realistic timeframe.	•	•	•	•	•
		• reflect on individual and team outcomes and act to improve their own and the team's performance.	•	•	•	•	•
	Personal Learning	**Managing personal learning**					
		• complete competing short, extended and group tasks within set timeframes, prioritising their available time, utilising appropriate resources and demonstrating motivation.	•	•	•	•	•
		• demonstrate a positive and structured approach to learning, identifying and using effective strategies that assist with study, both at school and at home.	•	•	•	•	•
		• initiate and undertake some tasks independently, within negotiated timeframes.	•	•	•	•	•
Discipline-based Learning	Mathematics	**Measurement, Chance and Data**					
		• students measure length, perimeter, area, surface area, mass, volume, capacity, angle, time and temperature using suitable units for these measurements in context.	•		•		
	English	**Reading**					
		• students read and view imaginative, informative and persuasive texts that explore ideas and information related to challenging topics, themes and issues.	•	•	•	•	•
		• identify the ideas, themes and issues explored in these texts, and provide supporting evidence to justify their interpretations.	•	•	•	•	•
		Writing					
		• students produce, in print and electronic forms, texts for a variety of purposes, including speculating, hypothesising, persuading and reflecting.	•	•	•	•	•
		• write arguments that state and justify a personal viewpoint; reports incorporating challenging themes and issues; personal reflections on, or evaluations of, texts presenting challenging themes and issues.	•	•	•	•	•
		Speaking and Listening (depending on presentation format chosen)					
		• students analyse critically the relationship between texts, contexts, speakers and listeners in a range of situations.	•	•	•	•	•
		• when engaged in discussion, they compare ideas, build on others' ideas, provide and justify other points of view, and reach conclusions that take account of aspects of an issue.	•	•	•	•	•
		• in their presentations, they make effective use of the structures and features of spoken language to deal with complex subject matter in a range of situations.	•	•	•	•	•
		• students draw on a range of strategies to listen to and present spoken texts, including note-taking, combining spoken and visual texts, and presenting complex issues or information imaginatively to interest an audience.	•	•	•	•	•

	Science	**Science knowledge and understanding**					
		• explain the relationships, past and present, in living and non-living systems, and human impact on these systems.	●	●	●	●	●
		• use everyday examples of machines, tools and appliances to show how the thermodynamic model describes energy and change, and force and motion.	●	●	●		●
		• distinguish ideas about the Universe that have a scientific basis from those that do not.	●	●	●	●	●
		Science at work					
		• make systematic observations and interpret recorded data appropriately, according to the aims of the study.	●	●	●	●	●
		• make and use models and images from computer software to interpret and explain observations.	●	●	●	●	●
		• identify, analyse and ask their own questions in relation to scientific ideas or issues of interest.	●	●	●	●	●
	Humanities Geography	***Geographic knowledge and understanding***					
		• use geographic language to identify and describe the human and physical characteristics of local and global environments depicted by different kinds of maps, diagrams, photographs and satellite images.		●	●		
		Geospatial skills					
		• analysis of information from a range of geographic data to form a conclusion.		●	●		
Interdisciplinary Learning	ICT	***ICT for creating***					
		• when creating information products, students prepare designs that identify the structure and layout of the products, the evaluation criteria, and the plans for managing collaborative projects.	●	●	●	●	●
		• students apply criteria to evaluate the extent to which their information products meet user needs and comply with intellectual property laws.	●	●	●	●	●
	Thinking	***Reasoning, processing and inquiry***					
		• use a range of question types, and locate and select relevant information from varied sources when undertaking investigations.	●	●	●	●	●
		• use a range of appropriate strategies of reasoning and analysis to evaluate evidence and consider their own and others' points of view.	●	●	●	●	●

Star Wars movie references

Getting around

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

Tantive IV* and Star Destroyer *Devastator - *Star Wars*: Episode IV *A New Hope*

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*

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*

Naboo Royal Starship - *Star Wars*: Episode I *The Phantom Menace*

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

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

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

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

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

Trade Federation Armoured Assault Tank - *Star Wars*: Episode I *The Phantom Menace*

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

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

Republic All Terrain Tactical Enforcer - *Star Wars*: Episode II *Attack of the Clones*

Imperial All Terrain Armoured Transport - *Star Wars*: Episode V *The Empire Strikes Back*

Imperial All Terrain Scout Transport - *Star Wars*: Episode VI *Return of the Jedi*

Adapting to the environment

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

Luke riding a tauntaun - *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 II *Attack of the Clones*

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

Mos Espa slave housing - *Star Wars*: Episode I *The Phantom Menace*

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

Breathing equipment - *Star Wars*: Episode I *The Phantom Menace*

Miniature Wookiee tree - *Star Wars*: Episode III *Revenge of the Sith*

Robots and people

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

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

R2-D2 costume - *Star Wars*: Episode IV *A New Hope*
- *Star Wars*: Episode V *The Empire Strikes Back*
- *Star Wars*: Episode VI *Return of the Jedi*

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*

Robotics and medicine

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

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*

Internet Resources

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

Photo © 2009 Lucasfilm Ltd. & TM.

Exhibition content

Star Wars: Where Science Meets Imagination explores two major themes – *Getting Around* and *Robots and People*, as well as two minor themes – *Adapting to Environments* and *Robots and Medicine*. The exhibits within each theme area and the concepts that they demonstrate are described below.

Getting around

Star Wars vehicles use 'repulsorlift' technology to get around. The 'repulsorlift' is fantasy, but engineers here on Earth are busy creating vehicles just as amazing. In this area, you can explore the science behind these technologies. You can also try your hand at building your own floating vehicle.

New technologies change everything. For most of human history, people lived and died within walking distance of where they were born. Transportation technologies changed all that. As our ability to travel has increased, our whole world has become smaller. What would our world be like if we possessed vehicles like speeders and starships?

What you will see

• *Millennium Falcon* model
Han Solo's famous starship from *Star Wars* Episodes IV to VI.

• Luke's 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.

Today's spacecraft

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. Our closest neighbours are trillions of kilometres away. Even light takes years to make the trip.

The models in this case are technologically plausible designs that scientists and engineers have claimed *might* allow us to reach the nearest star systems. The trips would likely take centuries, not minutes. The cost to build any 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
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
The most powerful rocket we could conceivably make would use hydrogen and combine it with its opposite, antihydrogen. A matter/antimatter reaction converts almost all of its matter into energy. If all this energy could be tapped a ship like this one could reach almost two-thirds the speed of light.

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

• Laser-assisted ramjet
Some of the refinements proposed for the basic ramjet design include using a laser in Earth orbit that 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, they can move through the air like a helicopter, and can even fly into space. It's like having a car, helicopter, plane and spaceship all rolled into one.

Real world engineers have found ways to do all the same things, but not with one single technology. If you want to travel on the ground, you use a car. In the air, you use a plane, or helicopter. That is starting to change, though. In the future, your car may well be able to fly.

- **Luke Skywalker's landspeeder**

Luke's landspeeder is exhibited.
Also on display is a scale model of the landspeeder used in the movies.

Photo © 2009 Lucasfilm Ltd. & TM.

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 serious regulatory hurdles.

- **Boeing Canard Rotor/Wing (CRW) aircraft**

Model, Courtesy of Boeing Corp
On the outside, the Boeing CRW looks like an airplane, but the technology inside is very different. It 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 spaceplane**

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 SpaceShipTwos and plans to begin offering tourists rides into space in the next two years.

Interactives

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 'cars', 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 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 also 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. 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. Learn how to use electromagnets to propel them.

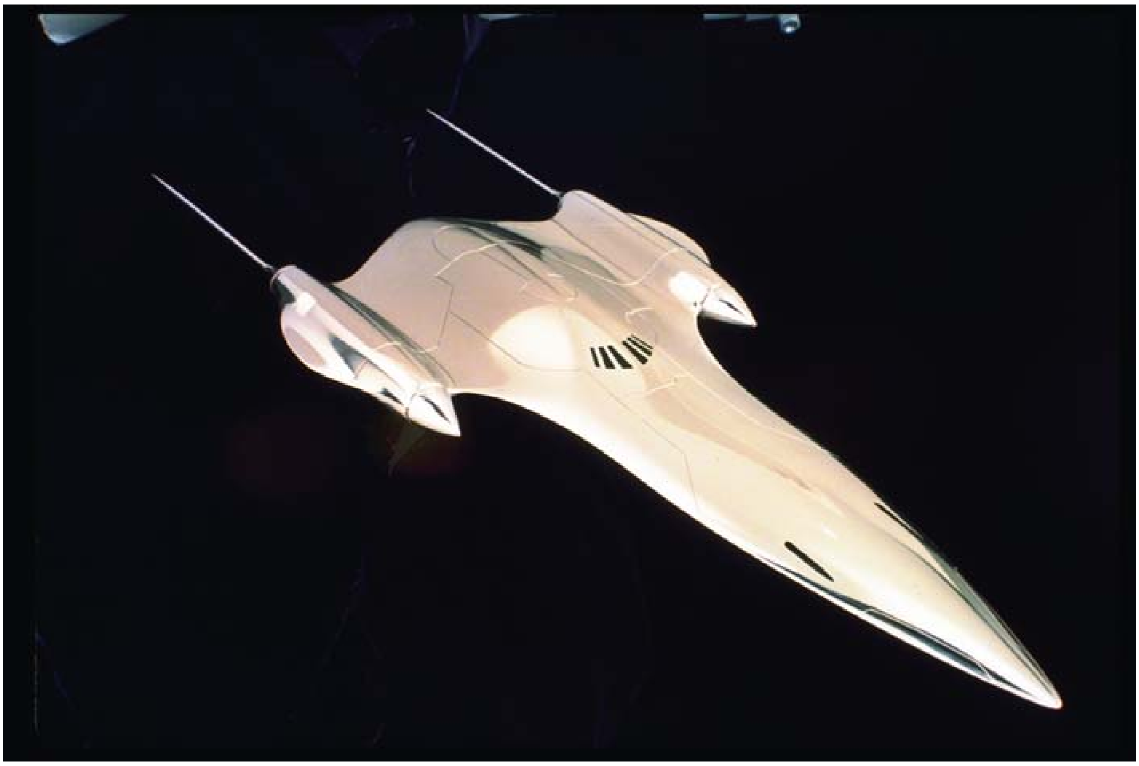
• Extra challenge — Putting Maglev to the test

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

Magnetic levitation, or Maglev, uses powerful magnetic fields to suspend a train in the air and propel it along a guideway at high speeds. Maglev could revolutionise 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.

Part of the reason why this technology hasn't been adopted is the enormous initial expense. Maglev trains can't use any of the existing infrastructure of traditional railroads, so to build a maglev system, you have to build everything from scratch — trains, tracks, stations, and everything else. Even a relatively small train system could cost billions!

NOTE: the interactive includes strong magnets which may affect pacemakers.



Adapting to the environment

'Adapting to the environment' looks at four very different *Star Wars* worlds and examines 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.
It then compares these with similar environments on Earth and considers how people adapt to, or explore these sometimes extreme environments.
A highlight of this section is the Building Communities Augmented Reality interactive where students work on three challenges focusing on adapting to different environments.

What you will see

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

• Hoth real world / Living on Hoth — extreme cold
Audiovisuals explore (1) the world of Hoth and the creatures that live on this frozen world, and (2) what it takes to live in really cold places, such as Antarctica.

• Living on Tatooine — hot and dry
Audiovisuals explore:
(1) the different intelligent species that live on the fantasy world of Tatooine and how they adapt to it, and
(2) how people adapt to living in hot, dry places on Earth — particularly Tunisia (where Episode IV was originally filmed) and Australia's own Coober Pedy.

Photo © 2009 Lucasfilm Ltd. & TM.

• Living on Coruscant — built environment
Audiovisuals explore: (1) the world-city of Coruscant and looks at some of its more famous inhabitants, and (2) the role of transportation, especially mass public transit, in shaping the design of cities.

• Living on Kashyyyk — a forest ecosystem
Audiovisuals explore (1) the Wookiees, their homeworld of Kashyyyk and how they were designed, and (2) the eco-system of real-world tropical forests and some of the techniques used by scientists to explore the forest environment.

Interactives

Interactive 1: *Building Communities*

Surviving on a desolate planet like Tatooine isn't easy. The climate is harsh, precious resources like water are scarce, and competition for them often leads to conflict. Do you think you have what it takes to survive there? Try building one of three different kinds of communities on Tatooine and see.

• Challenge 1: Build a moisture farm
Moisture farmers don't really grow water. They use moisture vaporators to harvest what little water vapour is in the air. This irrigates their underground crops, and if they're lucky, there's a little left over to sell in the bigger towns.

• 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 tradespeople, 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.

• How an augmented reality interactive works
This interactive 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.

Interactive 2
Moving down the skyway
What will the transportation of real world cities in the future look like? Be a transportation planner and design a transportation system for a city of the future.
What kinds of vehicles and systems would you choose to use in a 21st century city?

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 favourite 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, building 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 is a huge challenge. We can make all the bits and pieces, but fitting them all into one package isn't easy.

Robot Object Theatre

- Session time 15 minutes
- Maximum number of students: 30

Making robots that combine the ability to move under many conditions, sense the world around them, and think is a tall order. *Star Wars* droids offer imaginative examples of what robots might be some day. Where are we now, though?
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. Also 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 socialised robot. Indeed, I should be intrigued to make its acquaintance.
Cynthia: Hello Kismet. How are you doing?
Kismet (surprised, then content): 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 six million forms of communication, but your sounds are completely alien to me.
Kismet (sad): Oubedoobedoobe.
Cynthia: Hello Kismet! Yes, I brought your favourite 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 my counterpart 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 really 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, given all this, 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…

Robot engineering design lab

Here your challenge is to design and build a robot that has three of the important qualities that R2-D2 has — 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, cognition, and perception.

- **Station 1: Mobility**

Pick the right 'feet' for the job.

- **Station 2: Programming**

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.

What you will see

Star Wars vehicles and robots

Star Wars vehicles on display in this section include an All Terrain Armoured 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.

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 manoeuvrable 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, leading 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.

- **Wow Wee Robosapien V2**

2005, Courtesy of Wow Wee
Robosapien is an example of a school of robot design called BEAM. BEAM stands for Biology, Electronics, Aesthetics, 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.

Real world robots

• 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 standardised 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 recognise speech, and a variety of programs, into a small, lightweight package that is durable enough to survive in a typical 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 conform to rough terrain, and could also perform various feats of acrobatics like hopping.

• iRobot Roomba
2002–, courtesy of iRobot
The Roomba is the most successful domestic service robot in service. It's 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
The Huggable robotic bear has been developed as a therapeutic aid, following research that shows that animal companionship is good for people's health. The Huggable can participate in active relational and touch-based interactions with a person.

• Autom Weight Loss Coach
Autom is a social robot created by MIT to help people lose weight. It offers feedback on diet-related behaviour 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.

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Interactives

• ***Walking robot / Walking is not easy!***
Can you 'walk' our robot from one end of the track to the other?

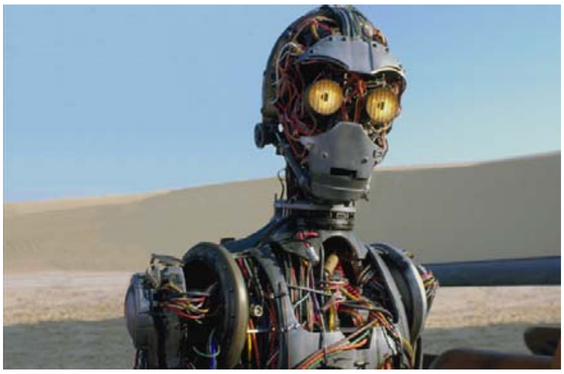
We may take it for granted, but walking is a complicated process, involving lots of different muscles and sensors. This is why you don't see many robots like C-3PO. Engineers have only recently managed to make a humanoid robot that can walk without falling over. Your legs have two major groups of muscles — those that move the upper leg and those that move the lower leg. When you walk, you are contracting and relaxing these muscles in a complicated pattern.

• ***Centre of mass***
Why don't you see a lot of walking robots like C-3PO in the real world? One of the reasons is balance. In this interactive you will experiment with robot balance and make a walking robot that is stable on flat ground and on slight slopes.

An object whose centre of mass is above its base is stable. Your centre of mass is over your base (your feet). If you stand up straight, your centre of mass is slightly above your belly button and halfway between your front and back. That's why you don't fall over when you stand. If you lean over too far, when your centre of mass moves past your feet, you fall over.

• ***Robot senses***
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 recognise and read human faces just like we do.
Can you get the robot to see you?
Can you trick the robot?

• ***Responsive face***
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 it has completed a task. This exhibit lets you control the expression of a face on the computer screen.
What kinds of information can you make your robot face communicate?



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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.

What you will see

Real world medical

• Neural interfaces — the BrainGate System™
People who are paralysed or suffering from degenerative neuromuscular diseases still 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 been able to build 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. As a 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. *NB: The Cochlear implant was developed in Australia and is a very significant Australian medical invention.*

• Implantable 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 allow them to receive the insulin they need without repeated injections. These pumps mimic the natural delivery rate of insulin. This helps to significantly reduce hypoglycaemic events, and allows the wearers to lead a more normal life.

Prosthetics

• Otto Bock 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 fibre 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 is 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 Spatial 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.

• Skin and titanium
Biologists are attempting to modify human keratinocytes (the major cell type of the upper, or epidermal layer of skin) and fibroblasts (cells that give rise to connective tissue such as collagen and active in wound healing) to create cells that are compatible with metals. Engineers are developing titanium alloys with different surface textures at the microscopic scale to improve adhesion with skin cells.

• BION® implants: wireless muscle stimulators
BION®s 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.

Star Wars medical

Star Wars objects on display include a General Grievous bust, 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.

Interactive

• 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.

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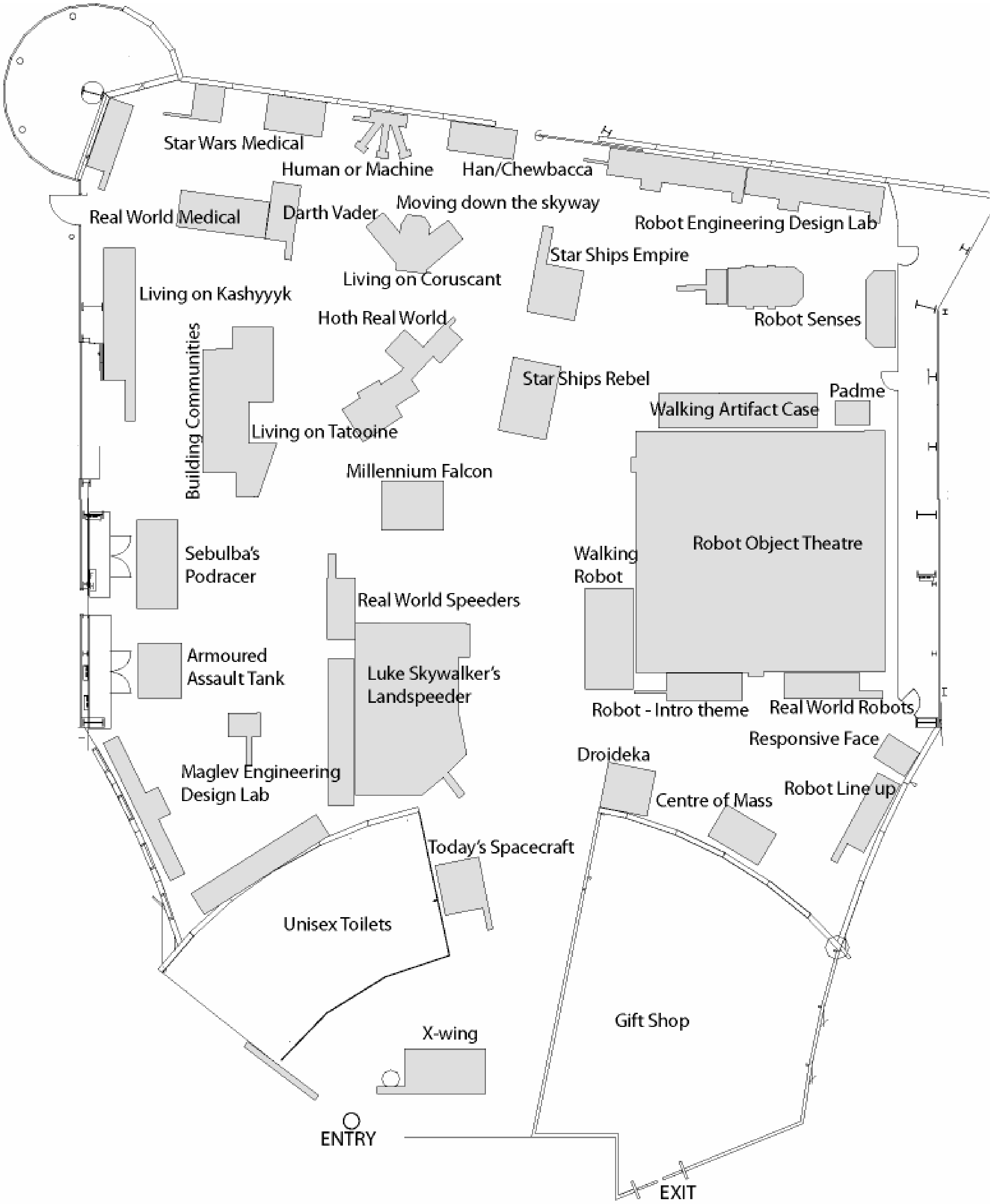
Exhibition floor plan



My favourite exhibit

Teachers:

1. Please allow the children to spend the first 20 minutes of their visit having a good look at all the exhibits in *Star Wars: Where Science Meets Imagination.*
2. Ask the children to choose one or several favourite exhibits and to record their ideas on photocopies of this page (one page per exhibit). They may work individually or with a partner or group supervisor. Some children may need help reading labels and interpreting information.

Write your name here: ____________________________________

What is the name of your favourite exhibit? ____________________

____

Describe or draw the exhibit.

Is the exhibit something used in the real world, or is it make-believe?

____

Write down three interesting facts about this exhibit:

1. ____
2. ____
3. ____