ROYAL CANADIAN AIR CADETS

PROFICIENCY LEVEL TWO

INSTRUCTIONAL GUIDE

SECTION 1

EO M240.01 – EXPLORE CURRENT ADVANCEMENTS IN AEROSPACE TECHNOLOGY

Total Time: 30 min

PREPARATION

PRE-LESSON INSTRUCTIONS

Resources needed for the delivery of this lesson are listed in the lesson specification located in A-CR-CCP-802/PG-001, Chapter 4. Specific uses for said resources are identified throughout the Instructional Guide within the TP for which they are required.

Review the lesson content and become familiar with the material prior to delivering the lesson.

Research current advancements in aerospace technology and collect information for this lesson from newspapers, magazine, journals or Websites. The following Websites may be useful for this research:

- www.space.gc.ca.
- www.space.com.
- www.nasa.gov.
- www.cbc.ca.
- www.ctv.net.

The instructor is not limited to the suggested list for Website research.

Copy information cards located at Annex A.

PRE-LESSON ASSIGNMENT

On the parade night before the instruction of this EO, ask the cadets to research current advancements in aerospace technology and bring their findings to the class the following week. Encourage them to collect information from the news, magazines, journals and/or Websites.

APPROACH

An in-class activity was chosen for this lesson as it is an interactive way to present advancements in aerospace technology and stimulate an interest among cadets.

INTRODUCTION

REVIEW

N/A.

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OBJECTIVES

By the end of this lesson the cadet shall have explored current advancements in aerospace technology.

IMPORTANCE

It is important for cadets to know how aerospace technology has impacted what we observe and continue to learn about space and how this technology has aided in the development of inventions on Earth. Exploring current advancements in aerospace technology may allow cadets to further broaden their knowledge of space and future technologies.

Teaching point 1 **Conduct an Activity To Explore Current Advancements in Aerospace Technology**

Time: 25 min Method: In-Class Activity

We have all heard that technology developed for the space program has affected our lives. But ask ten people on the street what advancements in space technology have had the most impact on Earth-bound humans, and many will likely recall commercials for an orange-flavoured breakfast drink. A few more may remember other commercials for ballpoint pens that can write upside down.

You might be surprised to learn that you actually have seen commercials for more far-reaching space-based technologies or perhaps had the life of a loved-one saved by another spun-off space technology item.

You might have even received some of them as holiday gifts.



For this activity the cadets shall present their findings that they collected over the past week. Cadets may also brainstorm new advancements that they may have heard about in the media over the past year.

ACTIVITY

OBJECTIVE

The objective of this activity is to have the cadet explore current advancements in aerospace technology.

RESOURCES

Information cards.

ACTIVITY LAYOUT

N/A.

ACTIVITY INSTRUCTIONS

1. Divide cadets into groups of no more than four.



In addition to the cadets' findings see Annex A for advancements from the past or use information that was researched and brought to class.

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2. Have cadets take two minutes to share with their groups information they were able to find about current advancements in aerospace technology.

3. Each group must take five minutes to choose and review an advancement they have researched or an advancement from Annex A to present to the whole class.

4. Each group will have 3 minutes to present their advancement to the class.



After the activity, if time allows, identify additional advancements from the past using the information cards located at Annex A.

SAFETY

N/A.

CONFIRMATION OF TEACHING POINT 1

QUESTIONS

Q1. What is a current advancement in aerospace technology that has impacted Earth today?

Q2. What advancement in aerospace technology is of most interest to you and why?

Q3. What is a current technology item in use today designed by the Canadian Space Agency?

ANTICIPATED ANSWERS

A1. A current advancement in aerospace technology that has impacted Earth today is (any of the following):

- satellite radio,
- video image stabilization and registration,
- satellite TV,
- DeBakey blood pump,
- global positioning system (GPS),
- temper foam,
- advanced communications technology,
- fire-resistant aircraft seats,
- excimer angioplasty system, and
- liquid-cooled garments, etc.

A2. This response can be any advancement in aerospace technology that is of interest to the cadet.

A3. A technology item designed by the Canadian Space Agency is:

- The Canadarm,
- The Canadarm2, or
- Any other technology designed by the Canadian Space Agency.

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END OF LESSON CONFIRMATION

The cadets' participation in the exploration of current advancements in aerospace technology activity will serve as the confirmation of this lesson.

CONCLUSION

HOMEWORK/READING/PRACTICE

N/A.

METHOD OF EVALUATION

N/A.

CLOSING STATEMENT

Exploring advancements in aerospace technology will familiarize the cadets with technology developed for space that has had an impact on Earth. The knowledge gained in this lesson will assist in stimulating an interest in aerospace technology in the Air Cadet Program.

INSTRUCTOR NOTES/REMARKS

N/A.

REFERENCES

C3-110 Space.com. (2006). *Space on Earth: How Technology Transfer Benefits Humanity.* Retrieved 27 February 2007, from http://www.space.com/businesstechnollogy/technology/tech_halloframe_030101-1.html.

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INFORMATION CARDS



"Google Images", CNN.net, Satellite Radio. Retrieved 14 March 2006, from http://i.a.cnn.net/cnn/2006/SHOWBIZ/Music/07/20/terrestrial.radio/story.satelitte.radio.jpg

Figure A-1 Satellite Radio

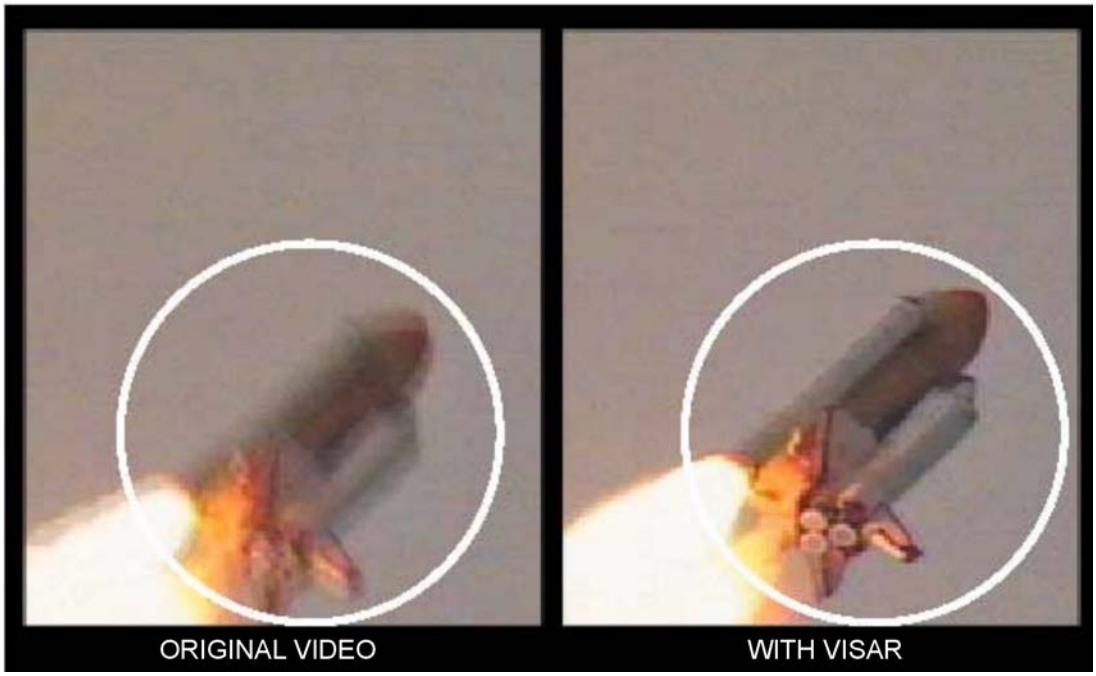
Satellite Radio: Inducted into the Space Technology Hall of Fame in 2002

In 1997, two companies launched new services to help frustrated listeners find the right radio station for them, and when we say "launched," we mean as in rockets going up.

Sirius Satellite Radio and XM Satellite Radio were two companies that launched satellites to offer improved radios service for frustrated listeners. They were the winners in a Federal Communications Commission (FCC) bandwidth auction that allowed them to lay claim to the ultimate in broadcast antenna height. Broadcasting from the Earth's orbit, the two stations' satellites provide hundreds of digital-quality channels to all of North America. This service is offered with no commercials, but you need to pay to subscribe and use their proprietary receivers.

The innovation could set the standard for broadcasting in the future. Unlike satellite TV services, you do not need a stationary dish antenna aimed at a point in the sky. You can even listen in your car during long trips without ever touching the dial or fine tuning controls.

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"Space.com", VISAR. Retrieved 14 March 2007, from http://www.space.com/php/multimedia/imagedisplay/img_display.php?pic=h_visar_02,0.jpg&cap=The%20VISAR%20system%20is%20a%20revolutionary%20way%20of%20stabilizing%20and%20refining%20images

Figure A-2 Video Image Stabilization and Registration (VISAR)

Video Image Stabilization and Registration (VISAR): Inducted into the Space Technology Hall of Fame in 2001

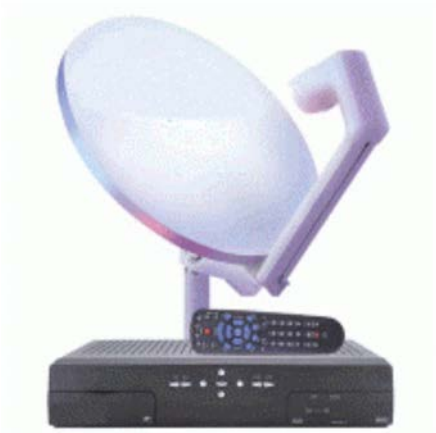
Video cameras seem to be everywhere these days. For law enforcement officers however, the recordings made on security cameras can often be a mixed blessing. Since the cameras are low-cost and often quite old, and the tapes reused repeatedly, the images can often be frustratingly muddy.

A great leap forward in solving this problem occurred in 1996 as a result of the bombing at the Olympic Games in Atlanta. At the request of the FBI, two NASA scientists, David Hathaway and Paul Meyer, took the skills they had honed studying the Sun and Earth's weather and used them to fight crime.

Their invention, called VISAR, brings order out of video chaos by correcting for a host of camera problems. A computer uses the VISAR software to "wash" the video until it is nearly free of static, blurring from camera movement, and the jagged edges of distant objects.

The software is beginning to see regular use by law enforcement and may soon be available for home computers. VISAR-equipped camcorders may be hitting the market in a few years, helping users to avoid pretending that their blurry, fuzzy vacation videos are cutting edge.

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"Google Images", CNN.net, Satellite TV. Retrieved 14 March 2006, from http://gfx.download-by.net/screen/304/304217-satellite-tv-pro.jpg

Figure A-3 Satellite TV

DirecTV: Inducted into the Space Technology Hall of Fame in 2000

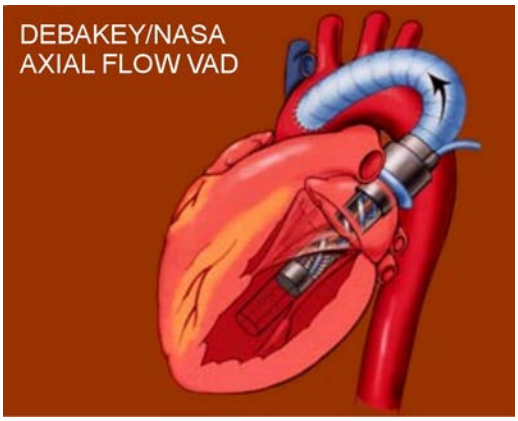
It took an effort worthy of building a Mars exploration probe to bring you HBO, Showtime and Cinemax using a dish that does not cover your backyard and block out the sun.

The idea for TV-by-satellite began percolating inside the minds of Hughes Electronics researchers back in 1984. This was a time when TV viewing options were limited to your local VHF and UHF stations, and perhaps a cable service showing selections of other towns' local stations. This was also a time when kids played Atari (the first home video game system).

After getting permission from the Federal Communications Commission (FCC), Hughes spent $750 million to launch three satellites and build a broadcast centre. But it was their "under the hood" innovations that made it possible for subscribers to receive a clear signal with a dish no bigger than a large pizza.

There was no way an old-style analog TV signal beamed from orbit could be picked up by anything less than a network affiliate's two metre dish. So Hughes' satellites were designed to be extremely high-powered, to transmit the signal digitally, and to be highly compressed.

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"Google Images", NASAexplores, Debakey Blood Pump. Retrieved 14 March 2006, from http://media.nasaexplores.com/lessons/01-005/images/heart9-12ajpg

Figure A-4 DeBakey Blood Pump

DeBakey Blood Pump: Inducted into the Space Technology Hall of Fame in 1999

Some heart patients may soon find themselves fused with space shuttle technology.

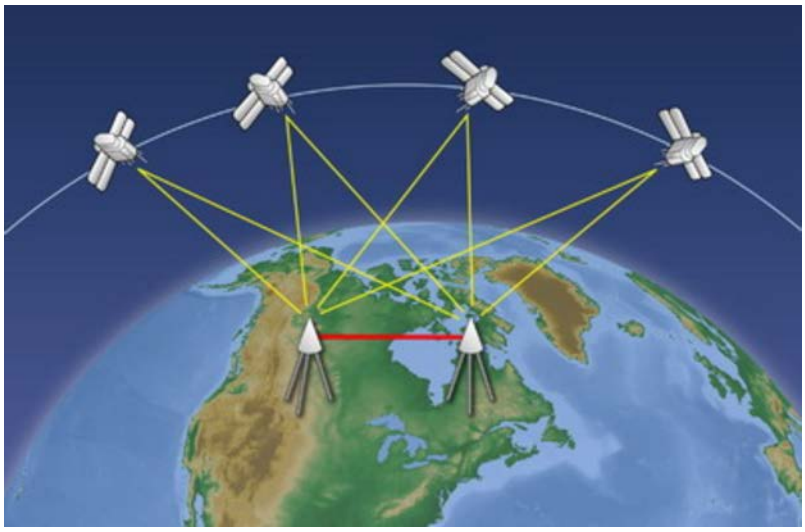
You might not think that the human heart and the monstrously powerful rocket engines that carry astronauts into orbit have much in common. However they do share a critical trait—they both depend on a steady flow of fluid to work.

While developing the shuttle's engines, NASA researchers pushed the envelope in turbo pump design. To understand and regulate the rapid gushing of millions of litres of super-cold rocket fuel through engines that needed to be reused, NASA created revolutionary software for analyzing fluid dynamics.

But it was not until a group of doctors, lead by Dr. Michael DeBakey, teamed up with NASA that these advances were applied to medicine. The results of their work resulted in a miniaturized, extremely gentle pump that could push human blood through an artery without chopping up the life-bearing blood cells.

The pump is currently entering clinical trials for use as a temporary heart for patients awaiting a transplant, and to take some of the load off a newly transplanted heart during recovery.

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"Google Images", Par Lap Top, GPS. Retrieved 14 March 2006, from http://www.parslaptop.com/images/helmer-gps.jpg

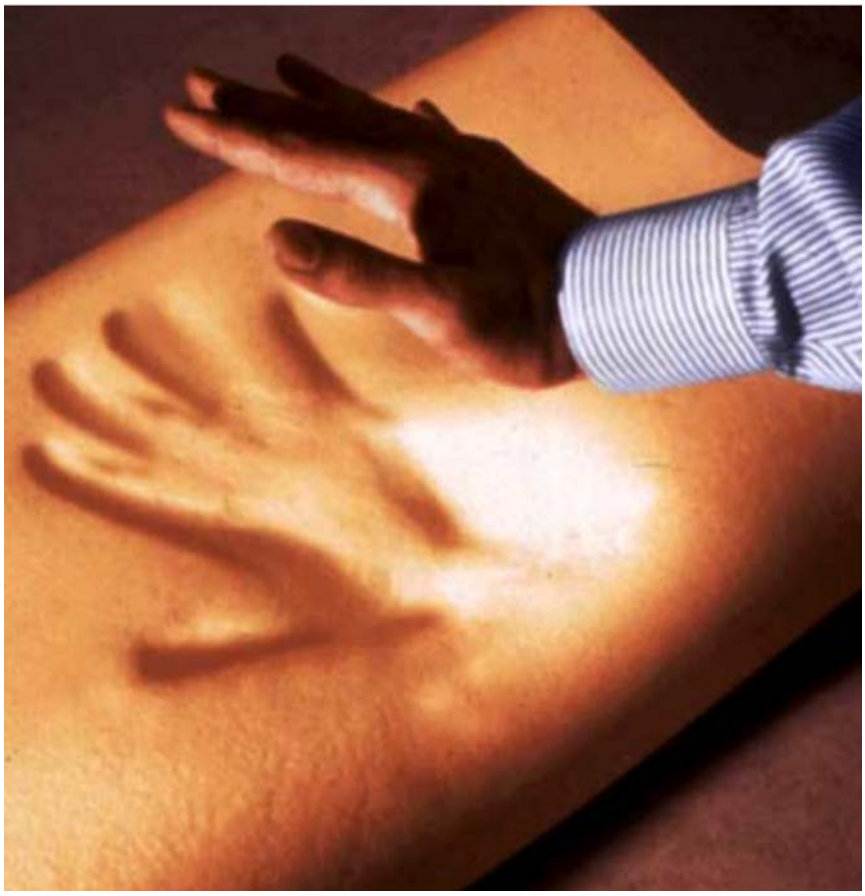
Figure A-5 Global Positioning System (GPS)

Global Positioning System (GPS): Inducted into the Space Technology Hall of Fame in 1998

Originally developed to help the military to track things like ships at sea and the locations of groups of soldiers, it is now regularly used to track things as simple as lost pets.

The true genius of the GPS system is its simplicity. No matter where you are on Earth, or what time it is, there are always several GPS satellites overhead. A constellation of 24 operating satellites (along with five spares) parade in strictly specified orbits 20 200 km (10 900 miles) high. Together they beam a global "dial tone" of sorts which GPS devices use to determine their location by determining the signal lag from each detected satellite.

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"Space.com", Temper Foam. Retrieved 14 March 2007, from http://www.space.com/php/multimedia/imagedisplay/img_display.php?pic=h_temperfoam_02,0.jpg&cap=Developed%20for%20the%20space%20program,%20Temper%20Foam%20is%20being%20used%20on%20Earth%20for%20bedding%20and%20seats

Figure A-6 Temper Foam

Temper Foam: Inducted into the Space Technology Hall of Fame in 1998

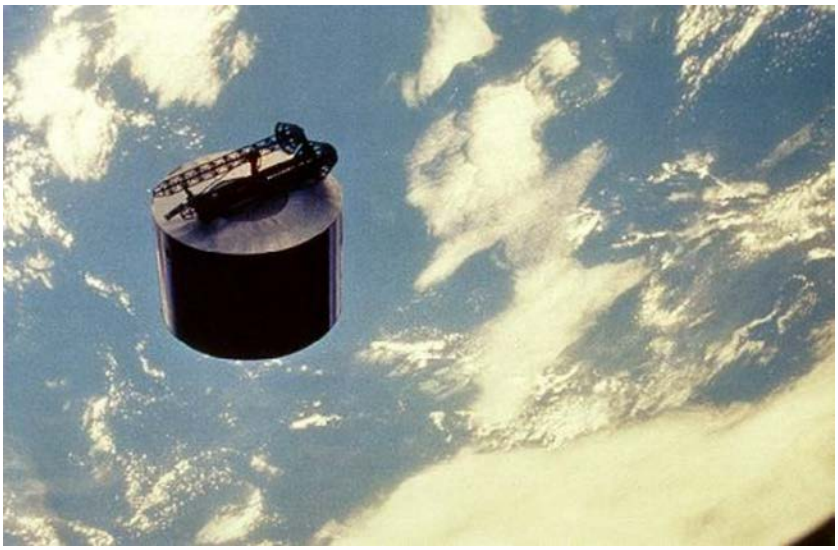
It might be hard to believe after sitting still for several hours, but the science of modern airline seats is revolutionary. Temper Foam, a NASA-developed cushioning material that is not only wonderfully shock absorbent, but also is softest where your body contacts it.

The resiliency of Temper Foam is astounding. The impact of an adult falling from a height of 3 m will be fully absorbed by a layer of Temper Foam only 7.6 cm thick. Its temperature sensitivity means it conforms to your body's contours while remaining firm at other points.

That is why it is used in the astronauts' seats on the shuttle. During launch they experience more violent shaking than most business travellers do in an entire year.

Temper Foam is not just used in well-travelled furniture. You will find it in sports helmets, orthopaedic supports, and home furnishings.

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"Google Images", Encarta.msn.com, Advance Communication Technology (ACT). Retrieved 14 March 2006, from http://images.encarta.msn.com/xrefmedia/sharemed/targets/images/pho/t014/T014377A.jpg

Figure A-7 Advanced Communication Technology (ACT)

Advanced Communications Technology (ACT): Inducted into the Space Technology Hall of Fame in 1997

Think that the new cable modem with high bandwidth you got as a gift was high tech? Well, that is nothing compared to satellites using NASA's Advanced Communications Technology (ACT).

ACT helped pave the way for the latest generation of high-speed and high-bandwidth broadcast and communications satellites.

Most satellites broadcast in "shotgun" style, in a wide cone covering the Earth. This is wasteful if the data only needs to reach one small region.

The ACT satellite, launched in 1993, proved among other things that spot-beaming to selected areas of the Earth was possible. It also features a host of other satellite communications improvements, such as high-speed switching and gigabits of bandwidth capacity. These innovations have already been incorporated into satellite phone and TV services.

Back on Earth, another ACT innovation can even keep an antenna in a moving vehicle aimed at an appropriate satellite. So you might soon be spending those long flights watching satellite TV instead of listening to canned music.

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"Google Images", Skylink, Fire-resistant Aircraft Seats. Retrieved 14 March 2006, from http://www.skylink.co.nz/aircraft/737-200-b.jpg

Figure A-8 Fire-resistant Aircraft Seats

Fire-resistant Aircraft Seats: Inducted into the Space Technology Hall of Fame in 1996

Unfortunately, it often takes a tragedy to wake people up to new dangers and find ways to avoid them.

So it was with the fire that took the lives of the crew of Apollo 1. During the long and painstaking investigation that followed, NASA found that there were far too many flammable materials in the capsule which contributed to the blaze. One major culprit was the very seat astronauts sat in.

The cushioning was made of a flammable type of polyurethane. However there were no other materials that were as supportive and, just as importantly, lightweight.

So, to meet the exacting weight requirements without adding to the already dangerous business of space travel, NASA researchers developed a special coating for the seat cushions. The outer shell of the cushions in NASA's new seat consisted of a fire-retardant fabric that added little to the weight, yet could withstand extremely high temperatures and exposure to naked flame.

This fire-resistance system has been in use on commercial airlines for pilots and passengers since 1984 when the Federal Aviation Administration (FAA) issued new regulations regarding fire dangers on board aircraft.

So not only is your seat useful as a floatation device, it also blocks fire, and combined with Temper Foam, it can absorb a tremendous amount of impact.

That is a lot of space technology packed into the 60 cm^2 that you sit on.

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"Google Images", ALZ Eye Laser Centre Munich, Excimer Laser. Retrieved 14 March 2006, from http://www.gutsehen.de/gfx/excimer.jpg

Figure A-9 Excimer Laser Angioplasty System

Excimer Laser Angioplasty System: Inducted into the Space Technology Hall of Fame in 1994

Coronary artery disease is one of the most common medical problems. When the arteries that feed freshly oxygenated blood to the heart become congested, it can result in a fatal heart attack. Treating the condition usually involves a costly and dangerous surgery. One common treatment, called balloon angioplasty, uses a tiny balloon to open up the artery by stretching it open as the balloon inflates.

Since 1992 a much less invasive procedure has been in use that owes its existence to studies of the Earth's atmosphere.

Developed by NASA's Jet Propulsion Laboratory to study the Earth's ozone layer, the excimer laser is a concentrated beam of ultraviolet light that never rises above 18 degrees Celsius, yet can be used as a super-fine scalpel. To clear a patient's arteries, the surgeon snakes a thin tube, with a specially-designed laser emitter on the tip, up into the patient's coronary arteries. The tip spreads the laser light out in a cone, which the surgeon uses to vaporize blockages without cutting healthy tissue. The excimer laser procedure is much easier to recover from than balloon angioplasty or bypass surgery.

Excimer lasers are also now widely used for correcting vision problems.

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"Space.com", Liquid-cooled Garments. Retrieved 14 March 2007, from http://www.space.com/php/multimedia/imagedisplay/img_display.php?pic=h_sts113_spacesuit_02.jpg&cap=Astronaut% 0Michael%20E.%20Lopez-Alegria,%20STS-113%20mission%20specialist,%20works%20on%20the%20newly%20installed%20Port%20One%20(P1)%20truss%20on%20the%20International%20Space%20Station%20(ISS)%20during%20the%20mission's%20second%20scheduled%20session%20of%20extravehicular%20activity%20(EVA)%20on%20November%2028,%202002.%20The%20spacewalk%20lasted%206%20hours,%2010%20minutes

Figure A-10 Liquid-cooled Garments

Liquid-Cooled Garments: Inducted into the Space Technology Hall of Fame in 1993

Keeping astronauts cool and comfortable on the baking surface of the Moon presented NASA's designers with a formidable challenge. How do you get rid of excess heat when you are standing under an open sky with literally nothing between you and the blazing fury of the Sun? One certainly cannot open one's shirt and no matter how vigorously an astronaut waved a fan under his or her chin, there would never be a cooling breeze.

So NASA developed the liquid-cooled garment to keep the explorers as comfortable as possible on their jaunts.

Think of it like an electric blanket in reverse. A special set of long underwear in the suits contained a layer of thin water tubes that covered the astronauts literally from head-to-toe. A pump and refrigeration unit in the backpack regulated the temperature and kept the water circulating.

This technology is still in use in NASA suits today. When shuttle astronauts step outside to rescue a crippled satellite, or do construction work on the International Space Station (ISS), they are wearing the latest version of the cooling underwear first designed in the 60s.

Back on Earth, the special cooling system is worn by the likes of firefighters handling hazardous materials, race car drivers, and soldiers in the desert. People with medical conditions that make them prone to easy overheating also wear garments based on the technology, enabling them to be much more active than they would otherwise be.

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Verify against the official publication.



"Google Images", www.island.net, Canadarm. Retrieved 14 March 2006, from http://www.islandnet.com/~pacific/arm002.jpg

Figure A-11 Canadarm

Canadarm Debut on November 13, 1981

Canada's most famous robotic and technological achievement made its space debut on November 13, 1981. The design and building of the Shuttle Remote Manipulator System marked the beginning of Canada's close collaboration with NASA in manned space flight. The Canadarm project remains a sterling example of successful international space cooperation.

Canadarm firmly established Canada's international reputation for robotics innovation and know-how. Its excellent performance record has inspired several generations of scientists and engineers as they develop new technologies for industry and medicine, such as medical robotics and automated robotics in the automotive industry.

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Verify against the official publication.



Canadian Space Agency, Canadarm2. Retrieved 14 March 2006, from http:// www.space.gc.ca/asc/app/gallery/results2.asp?session=&image_id=mss_spar2

Figure A-12 Canadarm2

Canadarm2

In April 2001, Space Shuttle Endeavour delivered a package that was Canada's key contribution to the International Space Station, now being assembled about 400 kilometres above Earth.

That package was the latest generation robotic arm—Canadarm2, the Space Station Remote Manipulator System (SSRMS), installed on the Station, with the aid of Canadian astronaut Chris Hadfield.

Like Canadarm, Canadarm2 is a unique Canadian contribution–an essential tool for the construction and maintenance of the Space Station. In fact, the Station could not even be built without Canadarm2.

Robotics was identified as a strategic technology for Canada. It was a self-contained package that Canada could afford, and it was a critical component of infrastructure which gave Canada a particular role and status in building the International Space Station (ISS).

Canadarm2 will play another essential role—it gives Canadian scientists access to the Station's laboratory facilities to conduct experiments. It also entitles Canada to send an astronaut to the Station every three years for a tour of duty lasting three to four months.

Although the Canadarm2 technology has not made it to everyday technology on Earth, one can expect that this advancement in technology will one day make it to everyday life on Earth.

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