CHAPTER 14

PO 240 – PARTICIPATE IN AEROSPACE ACTIVITIES

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.

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.

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.

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.

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

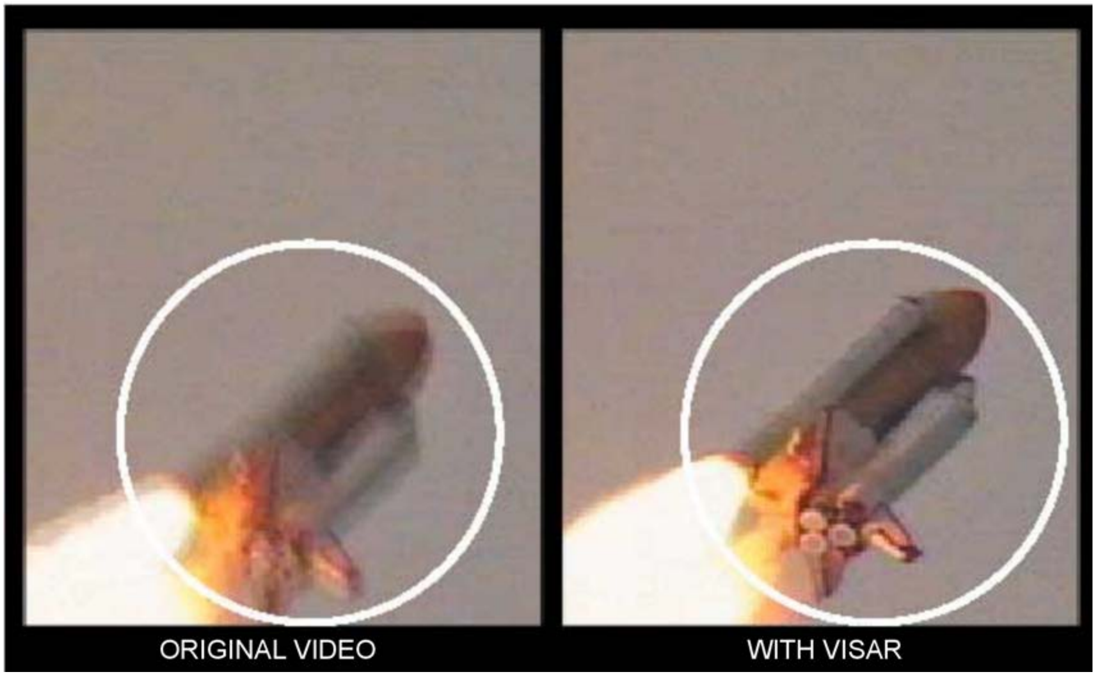
Figure A-1 Satellite Radio

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.



"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)

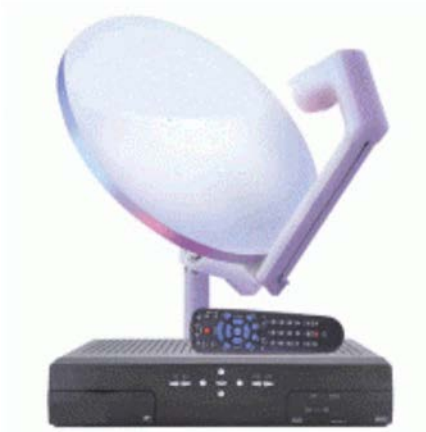
Video Image Stabilization and Registration (VISAR): Inducted into the Space Technology Hall of Fame in 2001

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.



"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

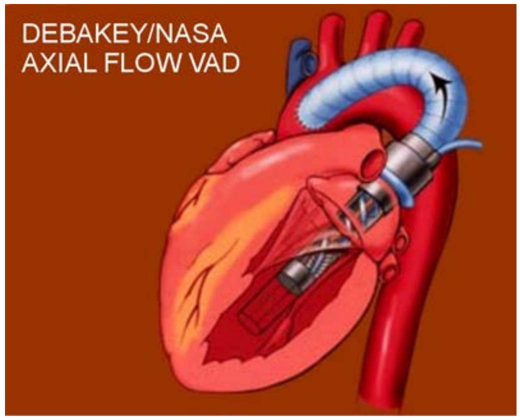
DirecTV: Inducted into the Space Technology Hall of Fame in 2000

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.



"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

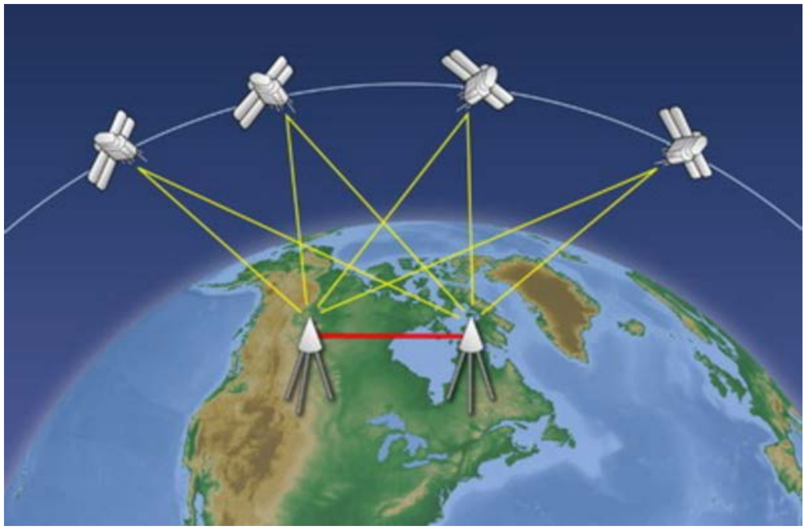
Some heart patients may soon find themselves fused with space shuttle technology.

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.



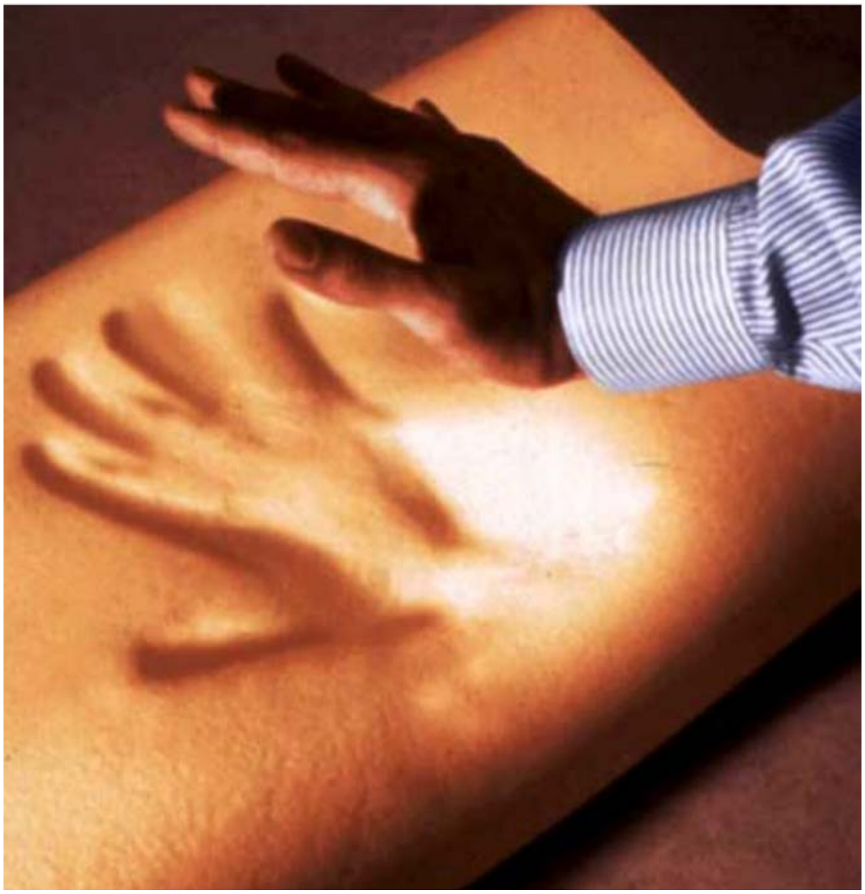
"Google Images", Par Lap Top, GPS. Retrieved 14 March 2006, from http://www.parslaptop.com/images/helmer-gps.jpg

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.



"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.

"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.

"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.

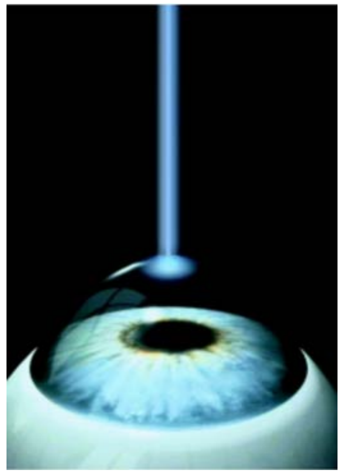
The cushioning was made of a flammable type of polyurethane. However there were no other materials that were as supportive and, just as importantly, lightweight.

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.



"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.

"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.

"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.

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.

ROYAL CANADIAN AIR CADETS

PROFICIENCY LEVEL TWO

INSTRUCTIONAL GUIDE

SECTION 2

EO M240.02 – INVENT A SPACE TECHNOLOGY ITEM

Total Time:	60 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.

PRE-LESSON ASSIGNMENT

N/A.

APPROACH

An interactive lecture was chosen for TP1 to orient the cadets to space technology and to give an overview of it.

An in-class activity was chosen for TP2 as it is an interactive way to provoke thought and stimulate an interest among cadets.

A group discussion was chosen for TP3 as it allows the cadets to interact with their peers and share their knowledge, experiences, opinions and feelings about space technology.

INTRODUCTION

REVIEW

N/A.

OBJECTIVES

By the end of this lesson and in groups of no more than four, the cadet shall have invented a space technology item.

IMPORTANCE

It is important for cadets to learn about the characteristics of space to gain an appreciation for space technology. This lesson will assist in stimulating the cadets' interest in space technology, which forms a significant part of the Canadian Space Agency, and will lead to future summer training progression opportunities in the Air Cadet Program.

Teaching Point 1	Explain That There Are Many Challenges Astronauts Encounter While in Space
Time: 5 min	Method: Interactive Lecture

Travelling to and From Space

One of the biggest challenges for astronauts is travelling to and from space. The astronaut's body and the space shuttle experience a large amount of stress through turbulence as they pass through the Earth's atmosphere. Temper Foam is a cushioning material that is shock absorbent and is also softest where the body contacts it. It is a NASA-developed technology that is used in the seats on the space shuttle to reduce the stress through turbulence that the astronauts experience during the violent shaking during launch.

Heat stress that occurs as they re-enter the Earth's atmosphere is also another challenge. Imagine a place with no air, with temperatures that vary from extreme hot to extreme cold, and where particles of dust travel at speeds that could kill you. These are just some of the situations astronauts have to cope with when they travel in space.

The Living Environment

The strangest condition in space is the lack of gravity. Gravity is a force that makes objects move toward each other. The Earth's gravity keeps your feet on the ground and makes objects fall down by pulling them toward Earth. On a spaceship, there is no gravity and everything floats in the air. Velcro is used to anchor objects and prevent them from floating around. It takes time for an astronaut's body to adjust to living in space and many astronauts suffer from space sickness for the first few days or weeks of a mission.

Astronaut apparel has evolved over the decades from Mercury's aluminium foil-looking outfits to the bulky, 275-pound whites now used on space walks outside the space station. The U.S. suits are easier to work in for long periods of time but their complexity causes more maintenance. The one-size-fits-all Russian suits are used a few times and thrown away, but they are also not easy to work in.

NASA is hoping to make new suits that are both high-tech and low-maintenance.

CONFIRMATION OF TEACHING POINT 1

QUESTIONS

Q1. What is one of the biggest challenges with space technology?

Q2. What is the strangest condition an astronaut experiences in space?

Q3. What do many astronauts suffer from for the first few days or weeks in space?

ANTICIPATED ANSWERS

A1. One of the biggest challenges with space technology is travelling to and from space.

A2. The strangest condition an astronaut experiences in space is the lack of gravity.

A3. Many astronauts suffer from space sickness for the first few days or weeks in space.

Teaching Point 2 — **Conduct an Activity Where Cadets Invent and Construct a Space Technology Item**

Time: 35 min — Method: In-Class Activity

ACTIVITY

OBJECTIVE

The objective of this activity is to have the cadets invent a space technology item that would help overcome the challenges of living in space.

RESOURCES

Consumable items for construction.

ACTIVITY LAYOUT

N/A.

ACTIVITY INSTRUCTIONS

Consumable items are items that are readily available (e.g. cereal boxes, egg cartons, milk cartons, pop cans, etc.) at no cost for construction of the space technology invention.

Cadets may draw diagrams of their space technology item as an alternative to the construction of a model.

- Divide cadets into groups of no more than four.
- Provide the groups with consumable items for construction of their invention.
- Groups will have 35 minutes to invent a space technology item using any of the consumable items provided for this activity.

SAFETY

N/A.

CONFIRMATION OF TEACHING POINT 2

The cadets' invention/construction of a space technology item will serve as the confirmation of this TP.

Teaching Point 3 — **Conduct a Group Discussion Where Cadets Share Their Space Technology Item With the Entire Group**

Time: 15 min — Method: Group Discussion

BACKGROUND KNOWLEDGE

The point of the group discussion is to discuss the cadets' space technology inventions and their applications using the tips for answering/facilitating discussion and the suggested questions provided.

GROUP DISCUSSION

TIPS FOR ANSWERING/FACILITATING DISCUSSION

- Establish ground rules for discussion, e.g. everyone should listen respectfully; don't interrupt; only one person speaks at a time; no one's ideas should be made fun of; you can disagree with ideas but not with the person; try to understand others as much as you hope they understand you; etc.
- Sit the group in a circle, making sure all cadets can be seen by everyone else.
- Ask questions that will provoke thought; in other words avoid questions with yes or no answers.
- Manage time by ensuring the cadets stay on topic.
- Listen and respond in a way that indicates you have heard and understood the cadet. This can be done by paraphrasing their ideas.
- Give the cadets time to respond to your questions.
- Ensure every cadet has an opportunity to participate. One option is to go around the group and have each cadet answer the question with a short answer. Cadets must also have the option to pass if they wish.
- Additional questions should be prepared ahead of time.

SUGGESTED QUESTIONS

Q1. What is your space technology invention?

Q2. What challenge are you trying to overcome in space?

Q3. Explain how you see it overcoming a challenge in space.

Other questions and answers will develop throughout the group discussion. The group discussion should not be limited to only those suggested.

Reinforce those answers given and comments made during the group discussion, ensuring the teaching point has been covered.

SAFETY

N/A.

CONFIRMATION OF TEACHING POINT 3

The cadets' participation in the group discussion will serve as the confirmation of this TP.

END OF LESSON CONFIRMATION

The cadets' participation in the activity in TP2 and the group discussion in TP3 will serve as the confirmation of this lesson.

CONCLUSION

HOMEWORK/READING/PRACTICE

N/A.

METHOD OF EVALUATION

N/A.

CLOSING STATEMENT

Inventing a space technology item will help the cadet learn about the characteristics of space and gain an appreciation for space technology. Stimulating the cadets' interest in space technology will lead to future summer training opportunities in the Air Cadet Program.

INSTRUCTOR NOTES/REMARKS

N/A.

REFERENCES

C3-040 (ISBN 0-7787-1140-4) Goodman, P. (2002). *Arty Facts: Space and Art Activities.* St. Catharines, ON: Crabtree Publishing.

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ROYAL CANADIAN AIR CADETS

PROFICIENCY LEVEL TWO

INSTRUCTIONAL GUIDE

SECTION 3

EO M240.03 – PARTICIPATE IN A SPACE SURVIVAL SCENARIO

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.

Photocopy the survival scenario located at Annex A for each group.

PRE-LESSON ASSIGNMENT

N/A.

APPROACH

An in-class activity was chosen for TP1 as it is an interactive way to provoke thought and to stimulate an interest in space survival among cadets.

A group discussion was chosen for TP2 as it allows the cadets to interact with their peers and share their knowledge, experiences, opinions, and feelings about survival in space.

INTRODUCTION

REVIEW

N/A.

OBJECTIVES

By the end of this lesson and in groups of no more than four, the cadets shall have participated in a space survival scenario.

IMPORTANCE

It is important for cadets to participate in a space survival scenario to understand the challenges astronauts face while living in space. Cadets will be able to use their knowledge about space survival in future space activities in the Cadet Program.

Teaching Point 1	**Choose Five Survival Items to Survive in Space**
Time: 15 min	Method: In-Class Activity

Water on the Moon

On March 5, 1998, NASA scientists announced the discovery of water on the Moon.

Ice exists because the shadows on the moon are very frigid. The temperature in the shadow is approximately minus 140 degrees Celsius. Anywhere else on the Moon, water would be vaporized by the intense sunlight and lost to space.

Living in Space

Astronauts must learn to manage everyday activities in space. Simple hygenic tasks like brushing your teeth can prove to be a challenge in space. Everything floats in space unless it is tied down. Even the consumption of food can be a challenge. Astronauts stay away from crackers and bread because the crumbs go up their nostrils.

Astronauts are kept very busy while in space. Aside from continuing to build the International Space Station (ISS), another very important part of their mission while living in space is to perform several experiments. These experiments focus on developing technologies to improve not only life in space but also life on Earth.

ACTIVITY

OBJECTIVE

The objective of this activity is to introduce and develop the cadets' interest and understanding of living in a space environment.

RESOURCES

Survival scenario located at Annex A.

ACTIVITY LAYOUT

N/A.

ACTIVITY INSTRUCTIONS

1. Divide the cadets into groups of no more than four.
2. Provide each group with a copy of the scenario.
3. Commence the activity by reading the scenario to the cadets.
4. Inform the cadets that they have 15 minutes to complete the activity.

SAFETY

N/A.

CONFIRMATION OF TEACHING POINT 1

The cadets' participation in the activity will serve as the confirmation of this TP.

Teaching Point 2 **Have the Cadets Explain Why They Chose Their Items for Survival**

Time: 10 min Method: Group Discussion

BACKGROUND KNOWLEDGE

The point of the group discussion is to discuss the groups' reason for choosing their items to complete the survival scenario using the tips for answering/facilitating discussion and the suggested questions provided.

GROUP DISCUSSION

TIPS FOR ANSWERING/FACILITATING DISCUSSION

Establish ground rules for discussion, e.g. everyone should listen respectfully; don't interrupt; only one person speaks at a time; no one's ideas should be made fun of; you can disagree with ideas but not with the person; try to understand others as much as you hope they understand you; etc.

Sit the group in a circle, making sure all cadets can be seen by everyone else.

Ask questions that will provoke thought; in other words avoid questions with yes or no answers.

Manage time by ensuring the cadets stay on topic.

Listen and respond in a way that indicates you have heard and understood the cadet. This can be done by paraphrasing their ideas.

Give the cadets time to respond to your questions.

Ensure every cadet has an opportunity to participate. One option is to go around the group and have each cadet answer the question with a short answer. Cadets must also have the option to pass if they wish.

Additional questions should be prepared ahead of time.

SUGGESTED QUESTIONS

Q1. What were the items that your group selected to survive in space?

Q2. Why did your group select these survival items?

Q3. What was the most important item on your list and why?

Other questions and answers will develop throughout the group discussion. The group discussion should not be limited to only those suggested.

Reinforce those answers given and comments made during the group discussion, ensuring the teaching point has been covered.

SAFETY

N/A.

CONFIRMATION OF TEACHING POINT 2

The cadets' participation in the group discussion will serve as the confirmation of this TP.

END OF LESSON CONFIRMATION

The cadets' participation in the space survival scenario will serve as the confirmation of this lesson.

CONCLUSION

HOMEWORK/READING/PRACTICE

N/A.

METHOD OF EVALUATION

N/A.

CLOSING STATEMENT

Participating in a space survival scenario may develop the cadets' interest in space by introducing elements of survival in space. Understanding the challenges astronauts face while living in space may be of use in future space activities in the Cadet Program.

INSTRUCTOR NOTES/REMARKS

N/A.

REFERENCES

C3-111 Lakeland Central School District. (2007). *Space Survival Challenge.* Retrieved 27 February 2007, from http://www.lakelandschools.org/EDTECH/leslie/space.htm.

SPACE SURVIVAL SCENARIO

Situation

You are a member of a shuttle crew scheduled to meet with the International Space Station (ISS). Due to a systems failure, you and three astronauts had to crash-land on the Moon. During the landing, much of the equipment aboard was damaged. Only eight items of equipment were left undamaged. Since survival depends on waiting for the arrival of a rescue shuttle from the ISS, the most critical items must be chosen to help you survive while waiting for the arrival of the shuttle.

Mission

You will be working in groups of four as a team of astronauts. Your survival depends on selecting a maximum of five items that you will need while waiting for the rescue shuttle to arrive. Your challenge is to rank, in order (most to least important), those items that have been left undamaged on your shuttle. Base your decisions on what you already know about conditions in space and on the Moon.

Items that Survived the Crash Landing

- a box of matches,
- 2 x 50 kg tanks of oxygen,
- 20 litre of water,
- 15 m of nylon rope,
- a magnetic compass,
- a stellar map of the Moon’s constellations,
- a solar-powered receiver-transmitter, and
- a reconstituted food package.

Instructions

1. Select five items from the list that your team will need to survive until the arrival of the rescue shuttle.
2. Rank your objects in order from most to least important.
3. Justify your choices within your group.
4. Prepare to present your findings to the class in a group discussion.

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ROYAL CANADIAN AIR CADETS

PROFICIENCY LEVEL TWO

INSTRUCTIONAL GUIDE

SECTION 4

EO C240.01 – PARTICIPATE IN A NON-VERBAL COMMUNICATION ACTIVITY

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.

Prepare a slide or handouts for each cadet of Figure A-1.

Prepare cue cards located at Annex B to be used during the in-class activity in TP3.

PRE-LESSON ASSIGNMENT

N/A.

APPROACH

An interactive lecture was chosen for TP1 and TP2 to orient the cadets to the topic, generate interest and to give an overview of non-verbal communication.

An in-class activity was chosen for TP3 as it is an interactive way to provoke thought and stimulate an interest among cadets.

INTRODUCTION

REVIEW

N/A.

OBJECTIVES

By the end of this lesson the cadet shall have participated in a non-verbal communication activity to gain a familiarization with an alternate method of communication.

IMPORTANCE

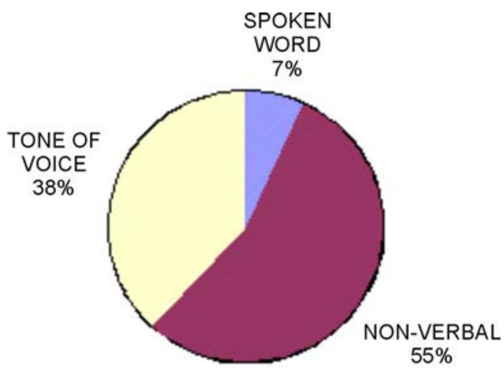
It is important for cadets to understand how to communicate using methods other than speech. If radio communication is lost in space, astronauts must still be able to communicate with one another. The cadets' participation in a non-verbal communication activity will help stimulate an interest in other methods of communication.

Teaching Point 1 **Explain the Use of Body Language as a Form of Non-verbal Communication**

Time: 5 min Method: Interactive Lecture

When people use spoken language to communicate, they do more than just listen to what is said in order to understand the message. They also look at the person who is speaking to see what their body is doing (body language), and listen to the way they are saying the words (tone) to understand their full message.

Studies have been done that show us the percentage of understanding that is gained from the spoken word. It is considerably less than the meaning that people gain from listening to a person's tone of voice and looking at their non-verbal communication.



"Department of Education Training and Youth Affairs", Non-verbal Communication. Retrieved 20 March 2007, from http://www.dest.gov.au/nwt/hospitality/comm_non.htm

Figure 1 Non-verbal Communication

Body Language. Includes the way people walk, talk, how they stand and their facial features (shown by a person's body attitude or movements).

CONFIRMATION OF TEACHING POINT 1

QUESTIONS

Q1. When people use spoken language to communicate, what other things do people do besides listening, to understand what is being said?

Q2. What is the percentage of understanding gained through non-verbal communication?

Q3. Does this percentage surprise you? Why or why not?

ANTICIPATED ANSWERS

A1. They also look at the person who is speaking to see what their body is doing.

A2. 55% of understanding is gained through non-verbal communication.

A3. Answers will vary.

Teaching Point 2	Explain the Use of Gestures as a Form of Non-verbal Communication
Time: 5 min	Method: Interactive Lecture

Gesture. A gesture is a form of non-verbal communication made with a part of the body, used instead of or in combination with verbal communication. Examples of non-verbal communication are facial expressions, hand signals, eye gazing and body postures (e.g. smile, handshake, wave, etc.).

Gestures that people use also convey meanings, such as:

- **Waving.** Saying hello or goodbye, or to get someone's attention.
- **Making a Fist.** You are angry.
- **Thumbs Up.** Okay.
- **Pointing.** Showing something.

Not all simple gestures are always understood and misunderstandings occur because of these gestures. It is important to understand that gestures mean different things in different cultures. Sometimes gestures can be rude in one culture, but okay in another. In North America spinning your finger around your ear is known as "You're crazy". In Argentina the same gesture means "You have a phone call".

CONFIRMATION OF TEACHING POINT 2

QUESTIONS

Q1. What is a gesture?

Q2. What is the gesture for anger?

Q3. Can you think of another gesture that has not been mentioned, that people use and what does it mean?

ANTICIPATED ANSWERS

A1. A gesture is a form of non-verbal communication made with a part of the body, used instead of or in combination with verbal communication.

A2. Making a fist.

A3. Answers will vary but may include:

- finger to lips—shhh, be quiet,
- shaking head—no,
- nodding—yes or agreement to something,
- wagging finger at someone—scolding, or
- yawn and put flat hand to lips—I'm tired.

Teaching Point 3 — **Conduct an Activity Where the Cadets Name an Emotion That They Have Shown in the Last Week**

Time: 15 min — Method: In-Class Activity

ACTIVITY

OBJECTIVE

The objective of this activity is to develop the cadets' knowledge of non-verbal communication and understand the challenges in communicating without speech.

RESOURCES

Cue cards located at Annex B.

ACTIVITY LAYOUT

N/A.

ACTIVITY INSTRUCTIONS

> Prior to the start of the activity, ask the cadets to name an emotion that they have shown during the past week. Some of their responses may be anger, fear, happiness, satisfaction, sorrow or surprise.

1. Request a volunteer to stand in front of the class and select a cue card with an emotion.
2. Once the cadet has selected the cue card ask them to act out the emotion to the class using body language to communicate the emotion. The cadet cannot tell the emotion to the class using speech.
3. The class must determine the emotion.
4. Once the class determines the correct answer, have another volunteer come to the front of the class and select a cue card and repeat the activity.

> This activity is not limited to the emotions on the cue cards. Allow the cadets to create additional cue cards and act out additional emotions.

SAFETY

N/A.

CONFIRMATION OF TEACHING POINT 3

The cadets' participation in the in-class activity will serve as the confirmation of this lesson.

END OF LESSON CONFIRMATION

The cadets' participation in the non-verbal communication activity will serve as the confirmation of this lesson.

CONCLUSION

HOMEWORK/READING/PRACTICE

N/A.

METHOD OF EVALUATION

N/A.

CLOSING STATEMENT

Participating in the non-verbal communication activity helps the cadets understand the importance body language has on communication.

INSTRUCTOR NOTES/REMARKS

N/A.

REFERENCES

C3-104 Australian Government, Department of Education, Science and Training. (2007). *Communication in the Workplace: Non-verbal Communication (Body Language).* Retrieved 22 February 2007, from http://www.dest.gov.au/nwt/hospitality/comm_non.htm.

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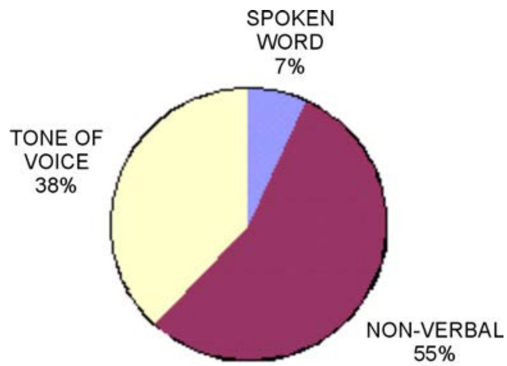
NON-VERBAL COMMUNICATION

7% Spoken words

38% Tone of voice

55% Non verbal



"Department of Education Training and Youth Affairs", Non-verbal Communication. Retrieved 20 March 2007, from http://www.dest.gov.au/nwt/hospitality/comm_non.htm

Figure A-1 Non-verbal Communication

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CUE CARDS

SORROW

FEAR

SATISFACTION

SURPRISE

HAPPINESS

ANGER

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ROYAL CANADIAN AIR CADETS

PROFICIENCY LEVEL TWO

INSTRUCTIONAL GUIDE

SECTION 5

EO C240.02 – INVENT A COMMUNICATION SYSTEM FOR SPACE

Total Time:	60 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.

Photocopy the message cue cards located at Annex A to be used during the in-class activity in TP2.

PRE-LESSON ASSIGNMENT

N/A.

APPROACH

An interactive lecture was chosen for TP1 to orient the cadets to space communication, to give an overview of it and to generate interest in the subject.

An in-class activity was chosen for TP2 as it is an interactive way to present the content and stimulate an interest among cadets.

A group discussion was chosen for TP3 as it allows the cadets to interact with their peers and share their knowledge, experience, opinions and feelings about space communication.

INTRODUCTION

REVIEW

N/A.

OBJECTIVES

By the end of this lesson and in groups of no more than four the cadet shall be expected to invent a communication system for space.

IMPORTANCE

It is important for cadets to understand how to communicate in space using methods other than speech. Communication is one of the challenges to living in space. If radio communication is lost in space, astronauts must still be able to communicate with one another. The cadets' participation in a non-verbal communication activity will help stimulate an interest in other methods of communication.

Teaching Point 1 — **Explain That Astronauts Use Radio Communication While in Space to Communicate With Other Astronauts and Ground Control**

Time: 5 min — Method: Interactive Lecture

RADIO COMMUNICATION

While in space, shuttle astronauts use ultra high frequency (UHF) radio transceivers to communicate with their colleagues inside the shuttle cabin. The astronauts also sometimes use their UHF radios to talk with ground control during launch or landing.

COMMUNICATIONS CARRIER ASSEMBLY (CCA)

The CCA is a fabric cap worn by the astronaut. It contains microphones and speakers for use with the radio. It allows for hands-free radio communication while wearing a spacesuit.

RADIO COMMUNICATION FAILURE

It is virtually impossible to provide regulations and procedures applicable to all possible situations associated with two-way radio communication failure. During two-way radio communication failure, when confronted with a situation not covered in the regulations, astronauts are expected to exercise good judgement in whatever alternative communication method they choose to communicate with each other.

CONFIRMATION OF TEACHING POINT 1

QUESTIONS

Q1. While in space, what do shuttle astronauts use to communicate with their colleagues inside the shuttle cabin?

Q2. What allows hands-free radio communication while wearing a spacesuit?

Q3. What must astronauts do during two-way radio communication failure?

ANTICIPATED ANSWERS

A1. While in space, shuttle astronauts use UHF radio transceivers to communicate with their colleagues inside the shuttle cabin.

A2. The CCA is a fabric cap worn by the astronaut. It contains microphones and speakers for use with the radio.

A3. Astronauts are expected to exercise good judgement in whatever alternative communication method they choose to communicate with each other.

Teaching Point 2 — **Invent a Communication System for Space**

Time: 40 min — Method: In-Class Activity

ACTIVITY

OBJECTIVE

The objective of this activity is to have cadets invent a communication system for space that does not involve the use of speech.

RESOURCES

Message cue cards located at Annex A.

ACTIVITY LAYOUT

N/A.

ACTIVITY INSTRUCTIONS

1. Divide the cadets into groups of no more than four.
2. Provide the groups with a message cue card located at Annex A to focus on what they must be able to communicate using their communication invention.
3. Groups will have 30 minutes to invent a communication system for space.

If the groups complete the task quickly, have them make up additional messages using their inventions.

Use the remaining 10 minutes to complete the following steps.

4. One cadet from each group will present their group's invention to the class by communicating the message from their cue card using the invention.
5. Once the cadet has communicated the message using their invention, the class must determine the message. The cadet cannot communicate the message to the class using speech.
6. The cadet will read the message aloud to the class once they determine the message.

If the class cannot determine the message, have the group read out the message to the class. The group will not be penalized if they are unsuccessful in communicating the message.

7. Repeat steps 4–6 until all groups have presented their invention.

SAFETY

N/A.

CONFIRMATION OF TEACHING POINT 2

The cadets' invention of a communication system for space will serve as the confirmation of this TP.

Teaching Point 3	Discuss Communication System Inventions With the Entire Group
Time: 10 min	Method: Group Discussion

BACKGROUND KNOWLEDGE

The point of the group discussion is to discuss the non-verbal communication inventions using the tips for answering/facilitating discussion and the suggested questions provided.

GROUP DISCUSSION

TIPS FOR ANSWERING/FACILITATING DISCUSSION

- Establish ground rules for discussion, e.g. everyone should listen respectfully; don't interrupt; only one person speaks at a time; no one's ideas should be made fun of; you can disagree with ideas but not with the person; try to understand others as much as you hope they understand you; etc.
- Sit the group in a circle, making sure all cadets can be seen by everyone else.
- Ask questions that will provoke thought; in other words avoid questions with yes or no answers.
- Manage time by ensuring the cadets stay on topic.
- Listen and respond in a way that indicates you have heard and understood the cadet. This can be done by paraphrasing their ideas.
- Give the cadets time to respond to your questions.
- Ensure every cadet has an opportunity to participate. One option is to go around the group and have each cadet answer the question with a short answer. Cadets must also have the option to pass if they wish.
- Additional questions should be prepared ahead of time.

SUGGESTED QUESTIONS

Q1. Why did your group select this alternative method of communication to communicate your message?

Q2. What was the biggest challenge in developing your invention?

Q3. What was the most challenging part in communicating your message?

Q4. How would you modify the inventions to be more effective?

Q5. Are there other non-verbal communication systems that could have been more effective?

Other questions and answers will develop throughout the group discussion. The group discussion should not be limited to only those suggested.

Reinforce those answers given and comments made during the group discussion, ensuring the teaching point has been covered.

CONFIRMATION OF TEACHING POINT 3

The cadets' participation in the group discussion will serve as the confirmation of this TP.

END OF LESSON CONFIRMATION

The cadets' participation in the invention of a communication system for space will serve as the confirmation of this lesson.

CONCLUSION

HOMEWORK/READING/PRACTICE

N/A.

METHOD OF EVALUATION

N/A.

CLOSING STATEMENT

Participating in the invention of a communication system for space may emphasize how important communication is for astronauts in space.

INSTRUCTOR NOTES/REMARKS

N/A.

REFERENCES

C3-135 Virtual Skies. (2007). *Two-way Radio Communication Failure (Aeronautical Information Manual Section 6.4.1).* Retrieved 18 March 2007, from http://virtualskies.arc.nasa.gov/communication/youDecide/AIM6_4_1.html.

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MESSAGE CUE CARDS

I am out of air.

I am stuck.

Come here.

I am sick.

I need help.

I am lost.

ROYAL CANADIAN AIR CADETS

PROFICIENCY LEVEL TWO

INSTRUCTIONAL GUIDE

SECTION 6

EO C240.03 – IDENTIFY PARTS OF A ROCKET

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.

Photocopy the handout located at Annex A for each cadet.

Photocopy and cut out the rocket puzzle pieces located at Annex B to be used in TP2.

PRE-LESSON ASSIGNMENT

N/A.

APPROACH

An interactive lecture was chosen for TP1 to orient the cadets to the parts of a rocket, to generate interest and to present basic material.

An in-class activity was chosen for TP2 as it is an interactive way to confirm the cadet's comprehension of the material.

INTRODUCTION

REVIEW

N/A.

OBJECTIVES

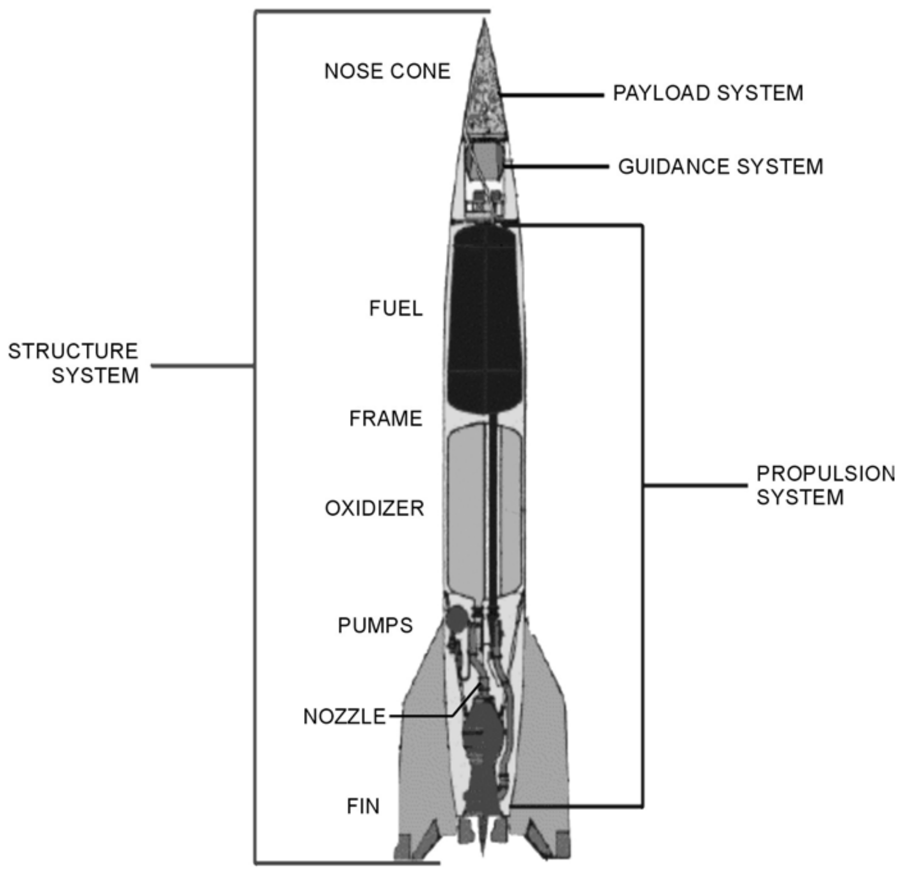
By the end of this lesson the cadet shall be expected to identify parts of a rocket to become familiar with its components.

IMPORTANCE

It is important for cadets to know the parts of a rocket so that they can understand how they are constructed. Identifying the parts of a rocket may develop an interest in the components that make up a rocket, which may lead to future aerospace opportunities in the Air Cadet Program.

Teaching Point 1	Explain the Parts of a Rocket
Time: 15 min	Method: Interactive Lecture

In flight, a rocket is subjected to the forces of weight, thrust, and aerodynamics. There are many parts that make up a rocket. For design and analysis, engineers group parts that have the same function into systems.



NASA, 2007, Rocket Parts, Retrieved 26 February 2007, from http://exploration.grc.nasa.gov/education/rockerpart.html#

Figure 1 Parts of a Rocket

ROCKET PARTS

Structural System. Also known as the frame, it is similar to the fuselage of an airplane. The frame is made from very strong but light-weight materials, like titanium or aluminum. The frame employs long “stringers” that run from the top to the bottom, which are connected to “hoops” that run around the circumference. The “skin” is then attached to the stringers and hoops to form the basic shape of the rocket. The skin may be coated with a thermal protection system to keep out the heat of air friction during flight and to keep in the cold temperatures needed for certain fuels and oxidizers. Fins are attached to rockets at the bottom of the frame to provide stability during flight.

The structure system includes the following parts:

- the nose cone,
- fuel,
- the frame,

- the oxidizer,
- the pumps,
- the nozzle, and
- the fins.

Propulsion System. Most of a full-scale rocket is made up of the propulsion system. There are two main classes of propulsion systems, liquid rocket engines and solid rocket engines. The V2 used a liquid rocket engine consisting of fuel and oxidizer (propellant) tanks, pumps, a combustion chamber with nozzle, and the associated plumbing. The Space Shuttle, Delta II, and Titan III all use solid external rockets.

Payload System. Payload systems depend on the rocket's mission. The earliest examples of payloads on rockets were fireworks for celebrating holidays. The payload of the German V2, shown in Figure 1, was several thousand pounds of explosives. Following World War II, many countries developed guided ballistic missiles armed with nuclear warheads for payloads. The same rockets were modified to launch satellites with a wide range of missions; communications, weather monitoring, spying, planetary exploration, and observatories, like the Hubble Space Telescope. Special rockets were developed to launch people into Earth's orbit and onto the surface of the Moon.

Guidance System. Guidance systems include very sophisticated sensors, on-board computers, radars, and communication equipment to manoeuvre the rocket in flight. Many different methods have been developed to control rockets in flight. The V2 guidance system included small veins in the exhaust of the nozzle to deflect the thrust from the engine. Modern rockets typically rotate the nozzle to manoeuvre the rocket. The guidance system must also provide some level of stability so that the rocket does not tumble in flight.

Distribute a handout of the parts of a rocket located at Annex A to each cadet.

CONFIRMATION OF TEACHING POINT 1

QUESTIONS

Q1. How do engineers group parts of rockets and why?

Q2. What rocket parts make up the structure system?

Q3. What are the systems in a rocket?

ANTICIPATED ANSWERS

A1. Engineers group rocket parts that have the same function into systems for design and analysis purposes.

A2. The structure system includes the following parts:

- the nose cone,
- fuel,
- the frame,
- the oxidizer,
- the pumps,

- the nozzle, and
- the fin.

A3. The systems of a rocket include:

- the structure system,
- the propulsion system,
- the payload system, and
- the guidance system.

Teaching Point 2 **Name the Parts of a Rocket**

Time: 10 min Method: In-Class Activity

ACTIVITY

OBJECTIVE

The objective of this activity is to help cadets become familiar with the parts of a rocket.

RESOURCES

- The puzzle located at Annex B, and
- Tape.

ACTIVITY LAYOUT

N/A.

ACTIVITY INSTRUCTIONS

1. Provide the cadets with the puzzle parts and shapes of a rocket.
2. Request a cadet to volunteer and select a shape and place it on the board in front of the class.
3. Repeat the steps until all the shapes are up on the board and the rocket is built. Then repeat the steps using the words and pictures to label the rocket.

Allow cadets to make corrections if the parts of the puzzle are in the wrong place.

4. Use the handout located at Annex A as a guide to confirm if the puzzle is correct.

SAFETY

N/A.

CONFIRMATION OF TEACHING POINT 2

The cadets' participation in the parts of a rocket activity will serve as the confirmation of this TP.

END OF LESSON CONFIRMATION

The cadets' participation in identifying the parts of a rocket will serve as the confirmation of this lesson.

CONCLUSION

HOMEWORK/READING/PRACTICE

N/A.

METHOD OF EVALUATION

N/A.

CLOSING STATEMENT

Knowing the parts of a rocket will help cadets understand how rockets are constructed. Identifying the parts of a rocket will help cadets understand the components that make up the rocket, which may develop an interest in rocket technology that may lead to future aerospace opportunities in the Air Cadet Program.

INSTRUCTOR NOTES/REMARKS

N/A.

REFERENCES

C3-106 NASA. (2006). *Rocket Parts.* Retrieved 22 February 2007, from http://exploration.grc.nasa.gov/education/rocket/rockpart.html#.

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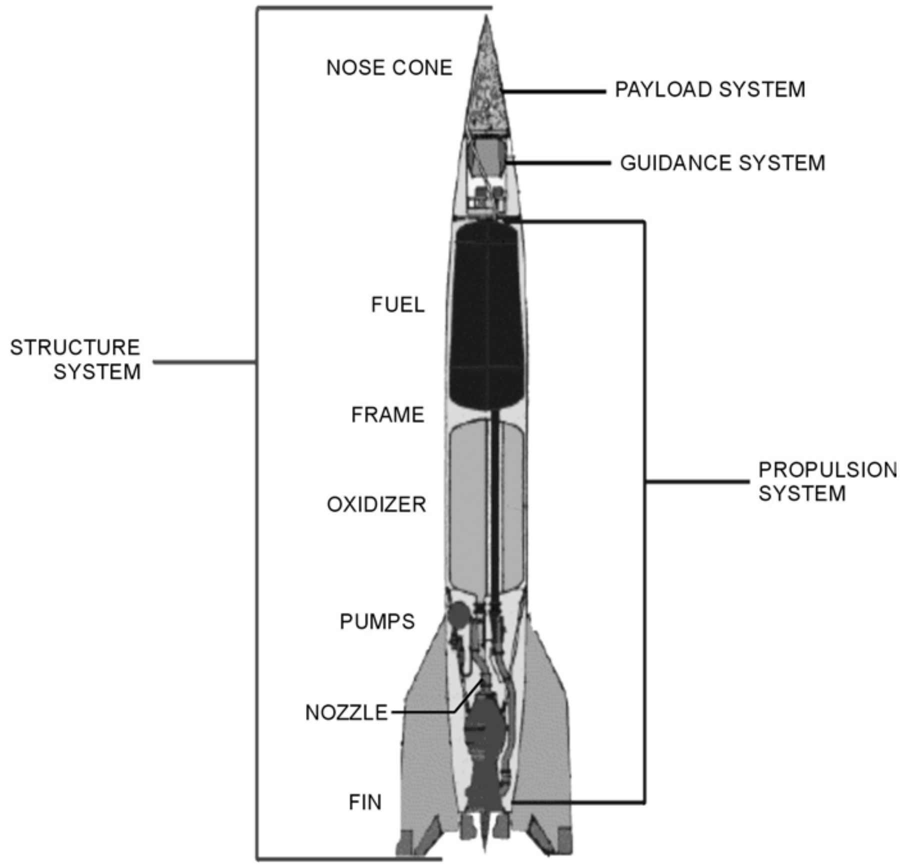
PARTS OF A ROCKET



"NASA", Parts of a Rocket. Retrieved 23 April 2007, from http://exploration.grc.nasa.gov/education/rocketpart.html#

Figure A-1 Parts of a Rocket

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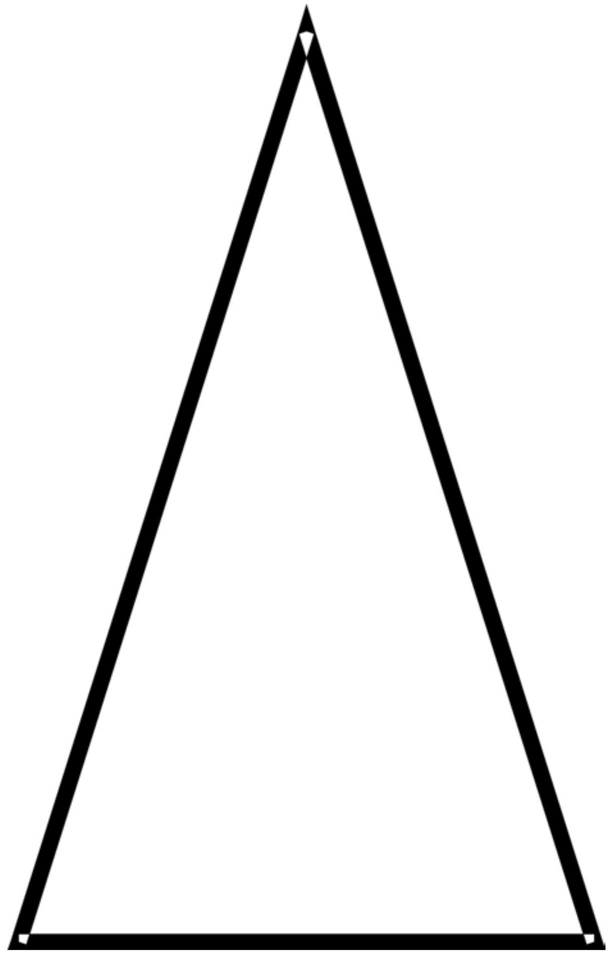
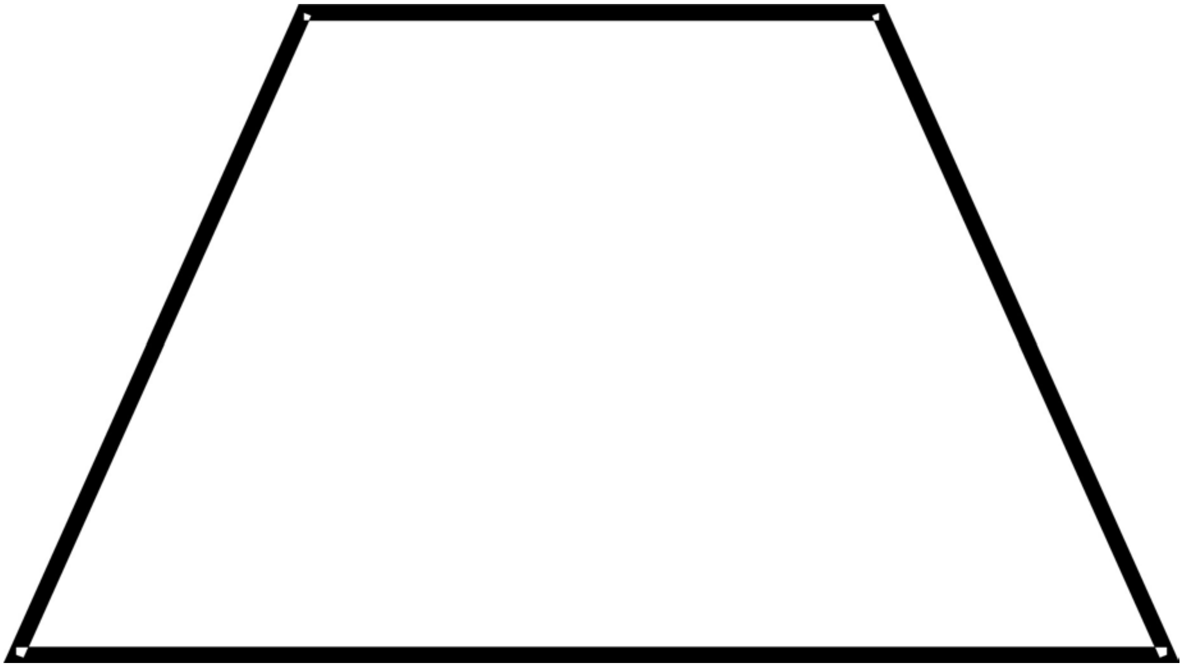
ROCKET PUZZLE PIECES



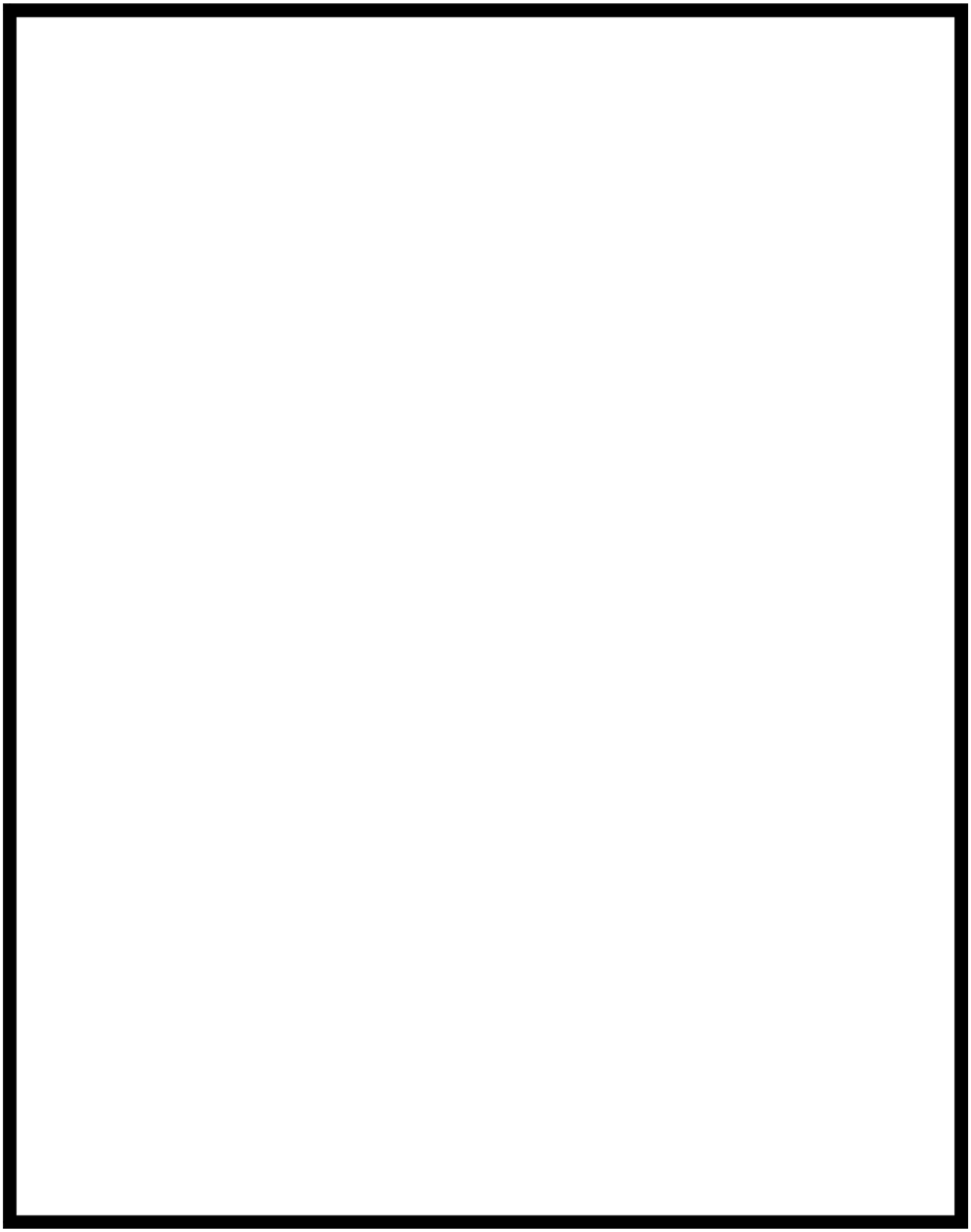
D Cdts 3, 2006, Ottawa, ON: Department of National Defence

Figure B-1 Nose Cone (Part A)



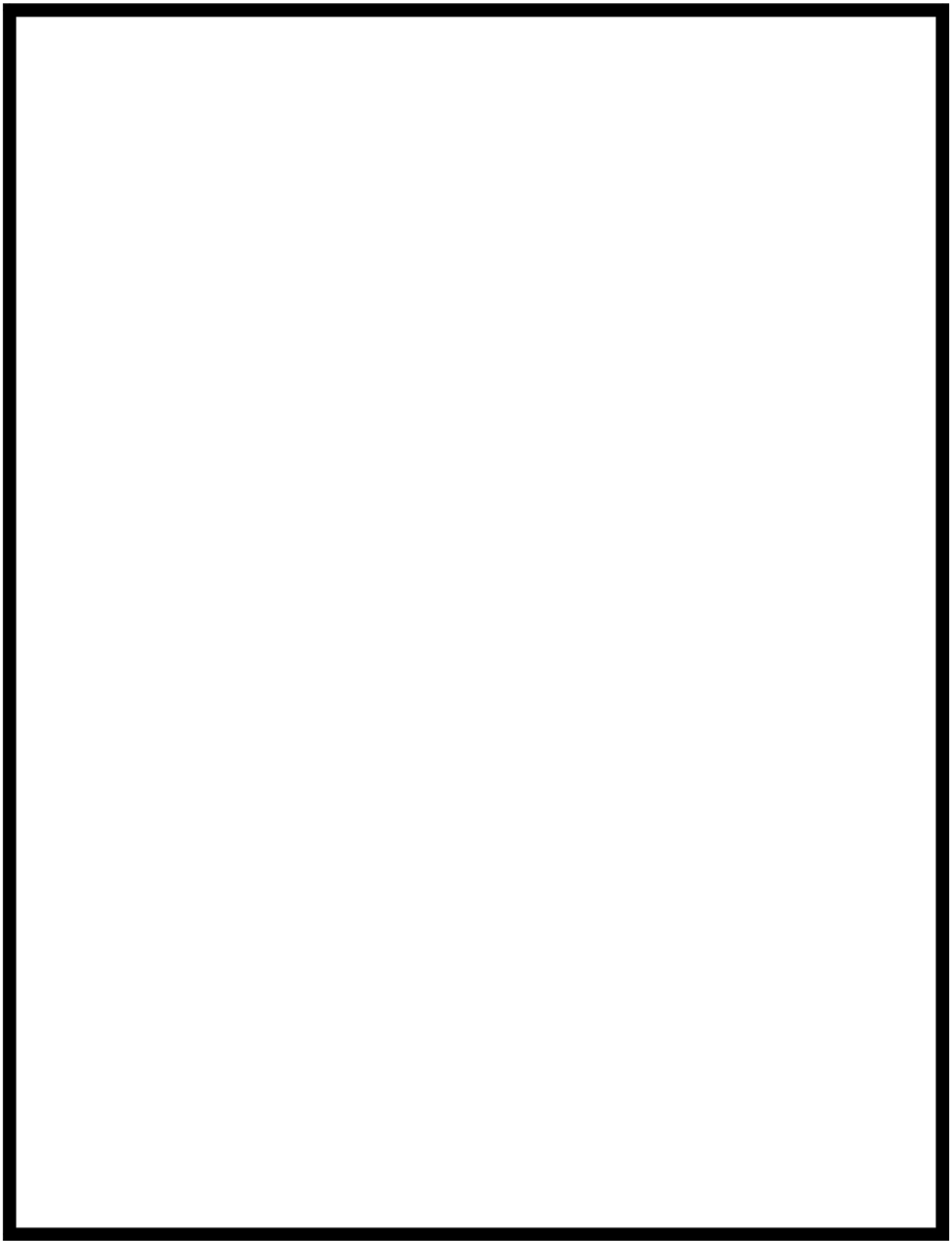
D Cdts 3, 2006, Ottawa, ON: Department of National Defence

Figure B-2 Nose Cone (Part B)



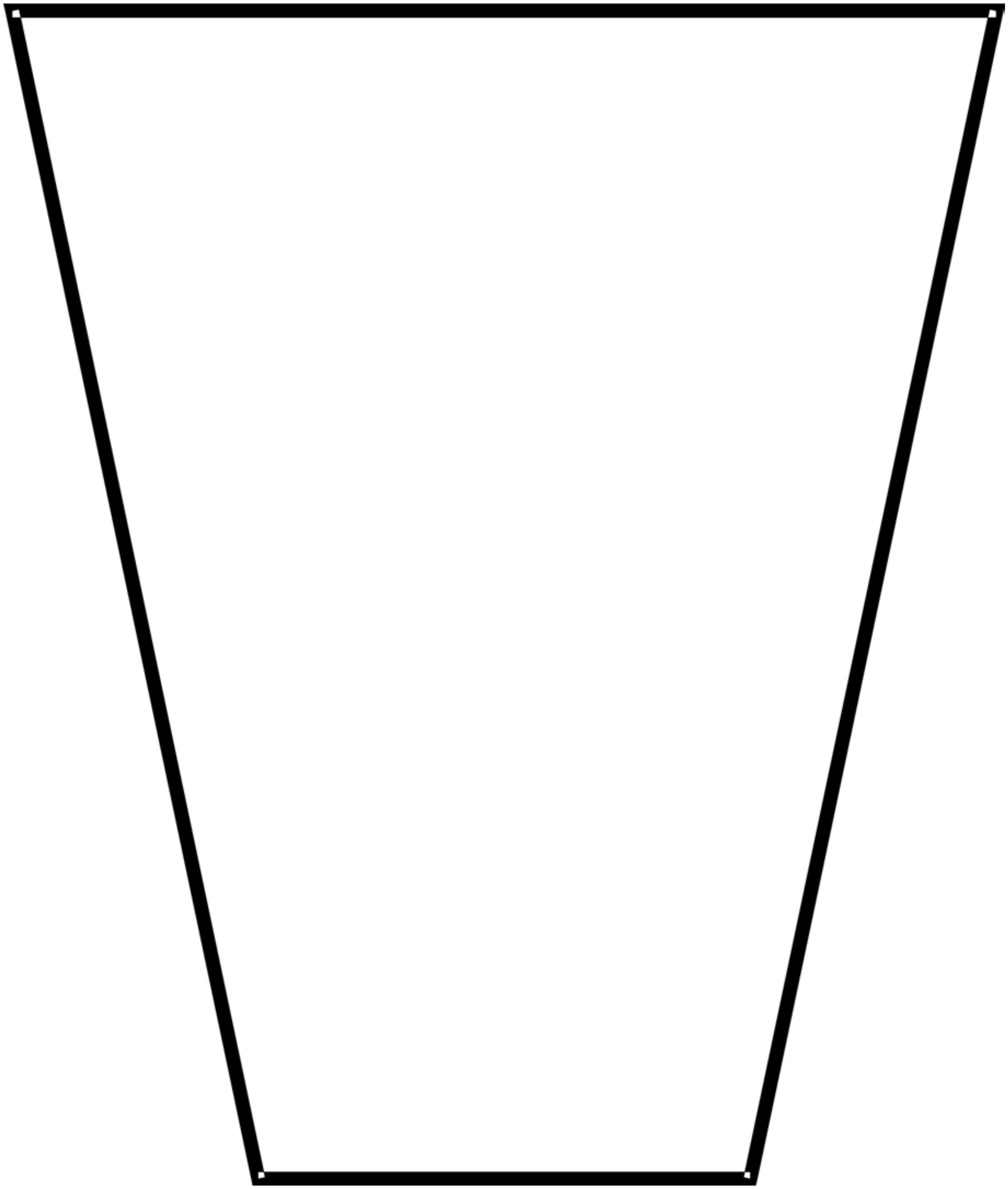
D Cdts 3, 2006, Ottawa, ON: Department of National Defence

Figure B-3 Frame (Fuel Section)



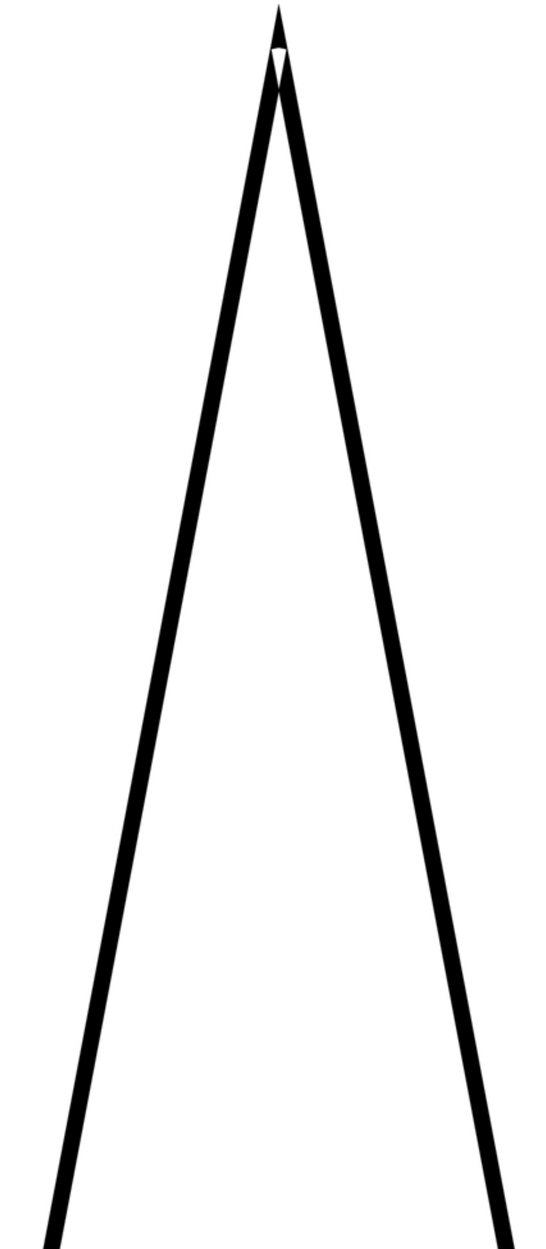
D Cdts 3, 2006, Ottawa, ON: Department of National Defence

Figure B-4 Frame (Oxidizer Section)



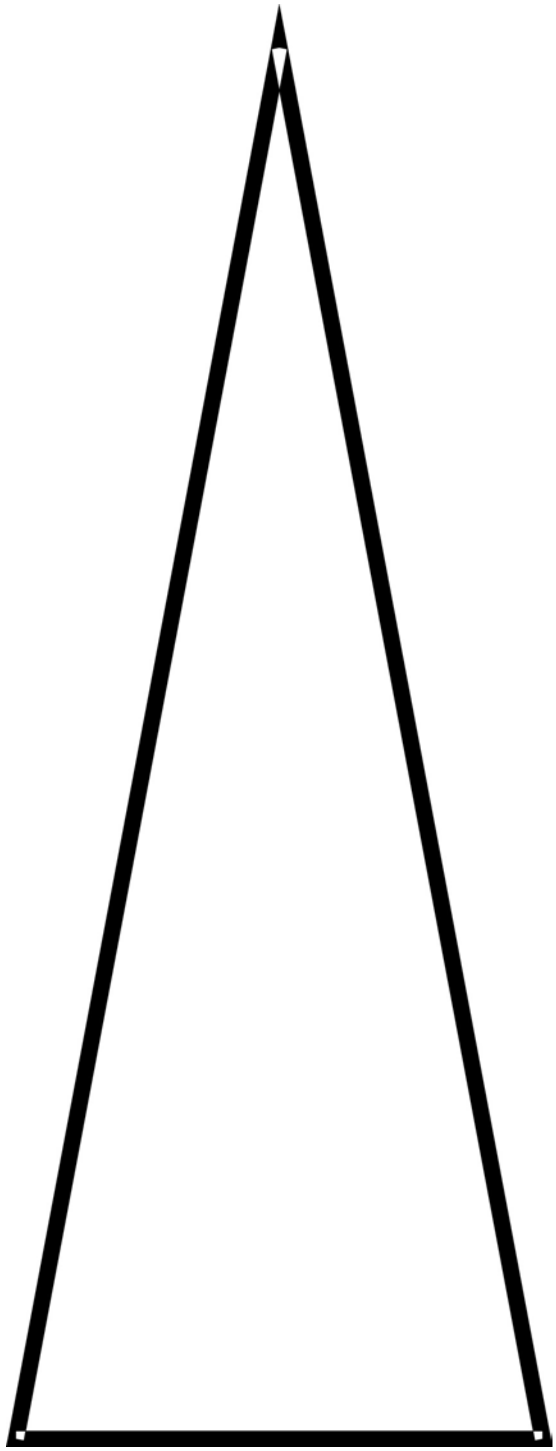
D Cdts 3, 2006, Ottawa, ON: Department of National Defence

Figure B-5 Frame (Pumps and Nozzle Section 0)



D Cdts 3, 2006, Ottawa, ON: Department of National Defence

Figure B-6 Fin (Section 1)

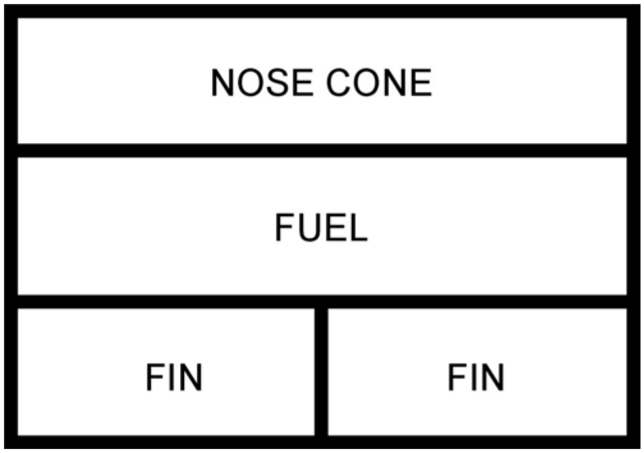


D Cdts 3, 2006, Ottawa, ON: Department of National Defence

Figure B-7 Fin (Section 2)

PARTS OF A ROCKET: LABELS

Cut out the following boxes and figures to be used to label the rocket puzzle.



D Cdts 3, 2006, Ottawa, ON: Department of National Defence

Figure B-8 Rocket Labels

GUIDANCE SYSTEM

"Clip Art", Microsoft Corporation, 2003 , Santa Rosa: CA: Impreza Systems, Copyright 2000, Impresa Systems

Figure B-9 Guidance System

PAYLOAD SYSTEM

"Clip Art", Microsoft Corporation, 2003 , Santa Rosa: CA: Impreza Systems, Copyright 2000, Impresa Systems

Figure B-10 Payload

FUEL PUMP

"Google Images", New Philadelphia, Ohio, Fuel Pump. Retrieved 18 April 2007, from http://www.neohiotravel.com/images/gaspump.gif

Figure B-11 Fuel Pump

OXIDIZER

"Google Images", California State University, Oxidizer Label. Retrieved 18 April 2007, from http://www.csudh.edu/oliver/chemdata/warnlabs/oxidizer.jpg

Figure B-12 Oxidizer

NOZZLE

"Google Images", Airwork Aviation Images, Engines. Retrieved 18 April 2007, from http://www.airwork-images.com/details.php?gid=278&sgid=&pid=456

Figure B-13 Nozzle

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ROYAL CANADIAN AIR CADETS

PROFICIENCY LEVEL TWO

INSTRUCTIONAL GUIDE

SECTION 7

EO C240.04 – NAVIGATE WITH A GLOBAL POSITIONING SYSTEM (GPS)

Total Time:	90 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.

Prepare a 200 m route for the cadets to navigate.

PRE-LESSON ASSIGNMENT

N/A.

APPROACH

An interactive lecture was chosen for TP1 to introduce a new subject and give an overview of GPS navigation.

Demonstration and performance was chosen for TP2 as it allows the instructor to explain and demonstrate navigating with a GPS while providing an opportunity for the cadet to practice the skill under supervision.

A practical activity was chosen for TPs 3 and 4 as it is an interactive way to introduce cadets to navigating with a GPS. This activity contributes to the development of these skills and knowledge in a fun and challenging setting.

INTRODUCTION

REVIEW

N/A.

OBJECTIVES

By the end of this lesson and in a group of no more than five, the cadet shall be expected to navigate with a GPS on a field exercise.

IMPORTANCE

It is important for cadets to navigate with a GPS and to learn its uses and limitations for future navigation on a field exercise. GPS navigation is a valuable tool and will serve as an excellent resource for navigating to a specific location.

Teaching Point 1 | **Describe the GPS**

Time: 5 min | Method: Interactive Lecture

WHAT IS GPS

Global Positioning System (GPS) is a satellite system used to navigate. It enables anyone on the planet who owns a GPS receiver to know where they are 24 hours a day in any kind of weather.

A GPS receiver must be locked on to the signal of at least three satellites to calculate a 2D position (latitude and longitude) and track movement. With four or more satellites in view, the receiver can determine the user's 3D position (latitude, longitude and altitude).

HOW ACCURATE IS GPS

Today's GPS receivers are extremely accurate, thanks to their parallel multi-channel design. Certain atmospheric factors and other sources of error can affect the accuracy of GPS receivers. GPS receivers are accurate to within 15 m on average.

> In 1998, the Wide Area Augmentation System (WAAS) was added to provide increased accuracy for use by commercial airplane navigation systems. WAAS increases accuracy to better than 3 m.

GPS SATELLITE SYSTEM

GPS satellites are powered by solar energy. They have backup batteries onboard to keep them running in the event of a solar eclipse, when there is no solar power. Small rocket boosters on each satellite keep them flying in the correct path.

> Here are some other interesting facts about the GPS satellites (also called NAVSTAR, the official U.S. Department of Defense name for GPS):
>
> - The first GPS satellite was launched in 1978.
> - GPS was originally intended for military applications, but in the 1980s, the government made the system available for civilian use.
> - A full constellation of 24 satellites was achieved in 1994.
> - The 24 satellites that make up the GPS space segment are orbiting the Earth about 20 000 km above us. They are constantly moving, making two complete orbits in less than 24 hours. These satellites are travelling at speeds of roughly 12 000 km/h.
> - Each satellite is built to last about 10 years. Replacements are constantly being built and launched into orbit.
> - A GPS satellite weighs approximately 900 Kg and is about 5 m across with the solar panels extended.
> - Transmitter power is only 50 watts or less.
> - There are no subscription fees or set-up charges to use GPS.

SOURCES OF GPS SIGNAL ERRORS

Factors that can degrade the GPS signal and thus affect accuracy include the following:

- **Signal Multi-path.** This occurs when the GPS signal is reflected off objects such as tall buildings or large rock surfaces before it reaches the receiver. This increases the travel time of the signal, thereby causing errors.
- **Number of Satellites Visible.** The more satellites a GPS receiver can "see," the better the accuracy. Buildings, terrain, electronic interference, or sometimes even dense foliage can block signal reception, causing position errors or possibly no position reading at all. GPS units typically will not work indoors, underwater or underground.
- **Receiver Clock Errors.** A receiver's built-in clock is not as accurate as the atomic clocks onboard the GPS satellites. Therefore, it may have very slight timing errors.

Other factors that can degrade the GPS signal.

- **Ionosphere and Troposphere Delays.** The satellite signal slows as it passes through the atmosphere. The GPS system uses a built-in model that calculates an average amount of delay to partially correct for this type of error.
- **Orbital Errors.** Also known as ephemeris errors, these are inaccuracies of the satellite's reported location.
- **Satellite Geometry/Shading.** This refers to the relative position of the satellites at any given time. Ideal satellite geometry exits when the satellites are located at wide angles relative to each other. Poor geometry results when the satellites are located in a line or in a tight grouping.
- **Intentional Degradation of the Satellite Signal.** Selective Availability (SA) is an intentional degradation of the signal once imposed by the U.S. Department of Defense. SA was intended to prevent military adversaries from using the highly accurate GPS signals. The government turned off SA in May 2000, which significantly improved the accuracy of civilian GPS receivers.

CONFIRMATION OF TEACHING POINT 1

QUESTIONS

Q1. What is a GPS?

Q2. How accurate is a GPS?

Q3. How are GPS satellites powered?

ANTICIPATED ANSWERS

A1. A Global Positioning System (GPS) is a satellite-based navigation system made up of a network of 24 satellites placed into orbit by the U.S. Department of Defense.

A2. GPS receivers are accurate to within 15 m on average.

A3. GPS satellites are powered by solar energy and have backup batteries on board to keep them running in the event of a solar eclipse.

Teaching Point 2 | **Explain What a GPS Tells the User**

Time: 10 min | Method: Demonstration and Performance

WHAT A GPS TELLS THE USER

A GPS tells the user the following standard features:

- their position – coordinates and elevation;
- distance to a waypoint;
- speed of travel;
- direction of travel (may not work in low speeds);
- estimated time of arrival; and
- cross track error (lateral distance off a straight line course).

Some GPS models may have extra features, such as:

- built-in maps,
- sunrise/sunset,
- signal strength indicators,
- battery strength indicators,
- audible alarm, and
- course deviation errors.

CONFIRMATION OF TEACHING POINT 2

QUESTIONS

Q1. What does a GPS tell the user?

Q2. Does a GPS tell the user the direction of travel at slow speeds?

Q3. What extra features can be found on some GPS models?

ANTICIPATED ANSWERS

A1. Any of the following answers are correct.

- their position – coordinates and elevation;
- distance to a waypoint;
- speed of travel;
- direction of travel (may not work in low speeds);
- estimated time of arrival; and
- cross track error (lateral distance off a straight line course).

A2. Yes and no.

- Sometimes the direction of travel feature may not work in low speeds on a GPS.

A3. Any of the following answers are correct.

- built-in maps,
- sunrise/sunset,
- signal strength indicators,
- battery strength indicators,
- audible alarm, and
- course deviation errors.

Teaching Point 3	**Operate the GPS**
Time: 20 min	Method: Practical Activity

ACTIVITY

OBJECTIVE

The objective of this activity is for the cadets to become familiar with operating a GPS.

RESOURCES

GPS (one per five cadets) (Type TBD).

ACTIVITY LAYOUT

N/A.

ACTIVITY INSTRUCTIONS

Complete the following steps:

1. Divide the cadets into groups of no more than five.
2. Distribute one hand-held GPS to each group.
3. Turn on and initialize the GPS.
4. Review the various screens.
5. Identify battery strength.
6. Locate your current grid reference.
7. Identify your direction of travel.
8. Set your current waypoint.
9. Set a waypoint (not your current position).
10. Set the go-to to a preset waypoint.
11. Turn off the GPS.

SAFETY

N/A.

CONFIRMATION OF TEACHING POINT 3

The cadets' participation in the practical activity will serve as the confirmation of this TP.

Teaching Point 4	**Navigate a Route**
Time: 50 min	Method: Practical Activity

ACTIVITY

OBJECTIVE

The objective of this activity is for the cadets to become familiar with navigating with a GPS.

RESOURCES

GPS (one per five cadets) (Type TBD).

ACTIVITY LAYOUT

N/A.

ACTIVITY INSTRUCTIONS

1. In the same groups as TP3, have cadets turn on the GPS.
2. Using the bearing to the preset waypoint from TP3, have the cadets navigate the 200 m route (caution, waypoints too close together will not work; you will need approximately 200 m between waypoints).
3. Have the cadets identify when they have arrived at the preset waypoint.
4. Have the cadets turn off the GPS.
5. Have the cadets return the GPS to the instructor.

SAFETY

State the area boundaries for conducting this activity.

CONFIRMATION OF TEACHING POINT 4

The cadets' participation in the practical activity will serve as the confirmation of this TP.

END OF LESSON CONFIRMATION

The cadets' participation in the GPS navigation activity will serve as the confirmation of this lesson.

CONCLUSION

HOMEWORK/READING/PRACTICE

N/A.

METHOD OF EVALUATION

N/A.

CLOSING STATEMENT

A GPS is a valuable tool and serves as an excellent resource to find a specific place and navigate a route to that position.

INSTRUCTOR NOTES/REMARKS

This lesson will be presented during the field exercise associated with PO 290 (Participate in a Field Exercise).

REFERENCES

C3-117 (ISBN 0-96-522025-7) Ferguson, M. H. (1996). *GPS Land Navigation: A Complete Guide Book for Backcountry Users of the NAVSTAR Satellite System.* Calgary, AB: Glassford Publishing.

C3-132 (ISBN 1-894765-48-6) Letham, L. (2003). *GPS Made Easy.* Surrey, BC: Rocky Mountain Books.

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ROYAL CANADIAN AIR CADETS

PROFICIENCY LEVEL TWO

INSTRUCTIONAL GUIDE

SECTION 8

EO C240.05 – SIMULATE SURVIVAL IN SPACE

Total Time:	60 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.

Complete a recce of the area selected to conduct this lesson.

Obtain one map of the actual training area (where the activity will be conducted) for each group.

Photocopy the survival scenario located at Annex A for each group.

PRE-LESSON ASSIGNMENT

N/A.

APPROACH

An in-class activity was chosen for TP1 as it is an interactive way to revisit survival in space, provoke thought and stimulate an interest among cadets.

A group discussion was chosen for TP2 as it allows the cadets to interact with their peers and share their knowledge, experiences, opinions, and feelings about survival in space.

INTRODUCTION

REVIEW

N/A.

OBJECTIVES

By the end of this lesson, and in groups of no more than four, the cadet shall be expected to simulate survival in space.

IMPORTANCE

It is important for cadets to simulate survival in space as it gives them the opportunity to understand the challenges astronauts face while living in space by using their knowledge about survival and applying it to a new situation.

Teaching Point 1 **Conduct an In-class Activity Where Cadets Choose Five Items From a List to Survive in Space**

Time: 35 min Method: In-Class Activity

Water on the Moon

The lunar soil contains ice crystals in craters near the lunar poles (which cannot be seen from Earth). The ice is spread across thousands of square kilometres of lunar terrain, but only one percent of the soil is ice.

The Earth's Moon

The Moon is Earth's one natural satellite. It is more than one quarter the size of Earth itself (3474 km diameter). The Moon has no magnetic field and its gravity is one-sixth of the Earth's gravity because of its smaller size.

The footprints left by Apollo astronauts will last for centuries because there is no wind on the Moon. The Moon does not possess any atmosphere, so there is no weather as we are used to on Earth. The temperatures on the Moon are extreme, ranging from 100°C at noon to -173°C at night because there is no atmosphere to trap the heat.

ACTIVITY

OBJECTIVE

The objective of this activity is to further develop the cadets' interest and understanding of what surviving in a space environment might be like.

RESOURCES

- Handout the scenario located at Annex A,
- The following survival resources for each group:
  - a box of matches,
  - a magnetic compass,
  - a stellar map of the Moon,
  - 2 military water cans (to simulate oxygen tanks),
  - 4 two-litre bottles to simulate water,
  - 10 metres of nylon rope,
  - simulated food boxes,
  - a radio,

- a fire blanket, and
- a map of the training area.

ACTIVITY LAYOUT

- Layout survival items for each group.

ACTIVITY INSTRUCTIONS

1. Divide the cadets into groups of no more than four.
2. Provide each group with a copy of the scenario located at Annex A.
3. Each group will select the survival items for the survival scenario from the resources provided.
4. Inform the cadets that they have 35 minutes to complete the activity.

SAFETY

N/A.

CONFIRMATION OF TEACHING POINT 1

The cadets' participation in the activity will serve as the confirmation of this TP.

Teaching Point 2	Conduct a Group Discussion and Have the Groups Explain Why They Chose Their Items for Survival
Time: 20 min	Method: Group Discussion

BACKGROUND KNOWLEDGE

The point of the group discussion is to discuss the groups' reasons for choosing their items to complete the survival simulation using the tips for answering/facilitating discussion and the suggested questions provided.

GROUP DISCUSSION

TIPS FOR ANSWERING/FACILITATING DISCUSSION

- Establish ground rules for discussion, e.g. everyone should listen respectfully; don't interrupt; only one person speaks at a time; no one's ideas should be made fun of; you can disagree with ideas but not with the person; try to understand others as much as you hope they understand you; etc.
- Sit the group in a circle, making sure all cadets can be seen by everyone else.
- Ask questions that will provoke thought; in other words avoid questions with yes or no answers.
- Manage time by ensuring the cadets stay on topic.
- Listen and respond in a way that indicates you have heard and understood the cadet. This can be done by paraphrasing their ideas.
- Give the cadets time to respond to your questions.
- Ensure every cadet has an opportunity to participate. One option is to go around the group and have each cadet answer the question with a short answer. Cadets must also have the option to pass if they wish.
- Additional questions should be prepared ahead of time.

QUESTIONS

Q1. What were the items that your group selected to survive in space?

Q2. Why did your group select these survival items?

Q3. What was the most important item on your list and why?

Q4. What was the most challenging decision you had to make?

Q5. What item was not on this list that could be very useful to survival in space?

Q6. If you had a chance to do this exact simulation again, what would be one thing you would do differently and why?

Other questions and answers will develop throughout the group discussion. The group discussion should not be limited to only those suggested.

Reinforce those answers given and comments made during the group discussion, ensuring the teaching point has been covered.

SAFETY

N/A.

CONFIRMATION OF TEACHING POINT 2

The cadets' participation in the group discussion will serve as the confirmation of this TP.

END OF LESSON CONFIRMATION

The cadets' participation in the survival in space simulation will serve as the confirmation of this lesson.

CONCLUSION

HOMEWORK/READING/PRACTICE

N/A.

METHOD OF EVALUATION

N/A.

CLOSING STATEMENT

Stimulating the cadets' interest in space by introducing elements of survival in space through active participation in this EO may lead to future aerospace opportunities in the Air Cadet Program.

INSTRUCTOR NOTES/REMARKS

N/A.

REFERENCES

C3-111 Lakeland Central School District. (2007). *Space Survival Challenge.* Retrieved 27 February 2007, from http://www.lakelandschools.org/EDTECH/leslie/space.htm.

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SPACE SURVIVAL SCENARIO

Situation

You are a member of a space shuttle crew scheduled to meet with the Earth colony on the lighted surface of the Moon. Due to mechanical failure, you and your three crewmates had to crash land about 10 km from the colony. During the landing on the Moon, much of the equipment aboard was damaged. Only ten items were left undamaged. Since survival depends on reaching the colony as soon as possible, the most critical items must be chosen to help you return.

Mission

You will be working in groups of four as a team of astronauts. Your survival depends on selecting no more than five items to bring with you as you try to get to the Earth colony on the Moon. Your challenge is to rank, in order (most important to least), those objects that have been left undamaged on your ship. Base your decisions on what you already know about conditions in space and on the Moon.

Items that Survived the Crash Landing

- a box of matches,
- a magnetic compass,
- a stellar map of the Moon,
- 2 military water cans (to simulate oxygen tanks),
- 4 two-litre bottles to simulate water,
- 10 metres of nylon rope,
- simulated food boxes,
- a radio,
- a fire blanket, and
- a map of the actual training area (to simulate a map of the moon).

Instructions

1. Select five items from the list that your team needs to survive and get back to the colony.
2. Rank your objects in order from most to least important.
3. Justify your choices within your group by explaining how the items will be used to return to the colony.
4. Prepare to present your findings to the class in a group discussion.

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INSTRUCTOR ANSWER KEY TO THE SPACE SURVIVAL SCENARIO

Cadets are encouraged to be creative with the application of their items. If they can justify the items used, then their decision to select the item is permissible with the exception of the following items.

The following items on the list will be of no use to the groups:

- The box of matches will be of no use because matches will not light because there is no oxygen on the moon.
- The magnetic compass will not work because there is no magnetic field on the moon.
- The handheld radios will not work because there is no air to carry sound waves and they are redundant because your spacesuit is equipped with built-in hands-free radio communication technology.

All other items from the list are useful for this simulation.

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ROYAL CANADIAN AIR CADETS

PROFICIENCY LEVEL TWO

INSTRUCTIONAL GUIDE

SECTION 9

EO C240.06 – DETERMINE DIRECTION USING CONSTELLATIONS ON A FIELD EXERCISE

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.

PRE-LESSON ASSIGNMENT

N/A.

APPROACH

Demonstration and performance was chosen for this lesson as it allows the instructor to explain and demonstrate determining direction while providing an opportunity for the cadet to practice this skill under supervision.

INTRODUCTION

REVIEW

N/A.

OBJECTIVES

By the end of this lesson the cadet shall be expected to determine direction using constellations on a field exercise.

IMPORTANCE

It is important for cadets to know how to identify Polaris, as a primary celestial reference, as it may be an important skill set to have when determining direction on a field exercise. This skill is also valuable when typical directional aids such as a map or a compass are not available.

Teaching Point 1 **Determine Direction at Night Using Polaris**

Time: 25 min Method: Demonstration and Performance

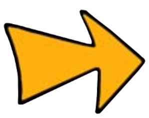
This teaching point is about stars; however, the knowledge portion can be instructed during daylight hours.

The Earth is in a constant state of motion spinning on its axis. It completes one full revolution every 24 hours. The points, where this axis intersects the Earth's surface, are known as the North and South Poles. If a person stood at the top of the North Pole, over the course of one day, that person would spin one complete rotation. On the surface of the Earth, this spin is undetectable. The spin actually makes it appear that the sky is revolving around the Earth.

THE RELATIONSHIP BETWEEN NORTH AND POLARIS

Polaris, more commonly known as the North Star, is most often used to determine north. It is a fixed point located over the North Pole, making it a consistent and reliable (stationary) reference point when determining which way is north.

Polaris is not a bright star, and is therefore difficult to identify in the night sky. It acts as a centre point while constellations move around it. Polaris is located at the tip of the Little Dipper (Ursa Minor). It can be found with the help of two constellations—the Big Dipper and Cassiopeia.



Constellations such as the Big Dipper and Cassiopeia revolve counterclockwise around Polaris.

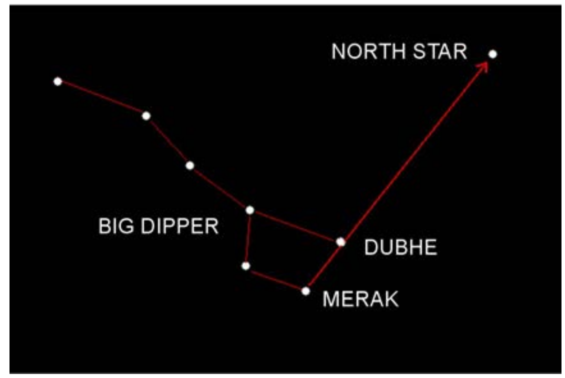
THE BIG DIPPER

The Big Dipper is the central feature of a very large constellation (Ursa Major) that wheels around Polaris. It is a combination of seven stars that resembles a small bowl with a long handle (dipper).

To find Polaris using the Big Dipper, follow its stars from the handle to the side of the bowl. The star Dubhe (DUB-ee), at the bowl's outer lip, is lined up with the star Merak (mer-AHK), inside the bowl. The stars Dubhe and Merak are commonly known as the pointer stars. They make a straight line that runs north and directly to Polaris. The distance from Dubhe to Polaris is five times the distance between the pointer stars.

"Map Reading and Navigation", Second Brigade: The South Carolina State Guard (SCSG) Basic Training Manual. Retrieved 30 October 2006, from http://www.nettally.com/hgowan/north_star.gif

Figure 1 North Pole



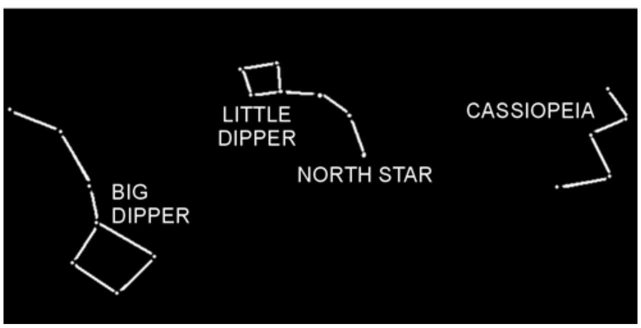
D Cdts 3, 2006, Ottawa, ON: Department of National Defence

Figure 2 Dubhe and Merak

CASSIOPEIA

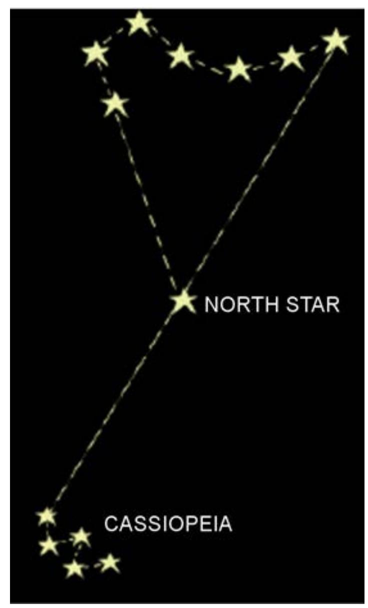
Cassiopeia is shaped like a W or an M, depending on the time of night, and wheels around the North Star.

Cassiopeia is perpendicular to Polaris (at a right angle) when the legs of the M are connected. The distance from Cassiopeia to Polaris is twice the width of the M.



D Cdts 3, 2006, Ottawa, ON: Department of National Defence

Figure 3 Little Dipper



"Navigation for Survival", The World Outdoor Web Navigation Guide. Retrieved 25 October 2006, from http://www.w-o-w.com/ARTICLES/navigation.figure12.gif

Figure 4 Cassiopeia

Determining direction using Polaris must be conducted during the night. This night activity will consist of numerous stop points that are lesson specific; however, time has been allotted for the confirmation of the following points:

- locating and identifying Polaris using the Big Dipper;
- locating and identifying the pointer stars; and
- locating and identifying Polaris using Cassiopeia.

If this lesson is taught on an overcast night and the stars are not visible, the process must still be explained. The demonstration by the instructor and the cadet activity must be conducted at a later time, preferably while on the field exercise.

Note: Cadets should also be able to locate the Little Dipper after finding Polaris.

CONFIRMATION OF TEACHING POINT 1

QUESTIONS

Q1. What is the common name for the star Polaris?

Q2. How far is the distance from Dubhe to Polaris?

Q3. What letter should Cassiopeia be viewed as when determining direction?

ANTICIPATED ANSWERS

A1. The North Star.

A2. The distance from Dubhe to Polaris is five times the distance between Dubhe and Merak.

A3. Cassiopeia must always be viewed as an M.

END OF LESSON CONFIRMATION

The cadets' participation in determining direction at night will serve as the confirmation of this lesson.

CONCLUSION

HOMEWORK/READING/PRACTICE

N/A.

METHOD OF EVALUATION

N/A.

CLOSING STATEMENT

Alternate means of determining direction are important skills to have when determining direction using constellations on a field exercise, specifically when typical direction aids such as a compass or map are unavailable. Using Polaris, as a primary celestial reference, to navigate is a skill set that may be used frequently and will be helpful in future training on a field exercise.

INSTRUCTOR NOTES/REMARKS

This lesson is to be conducted at night however the knowledge portion of this lesson can be conducted during daylight hours.

REFERENCES

C2-008 (ISBN 0-00-265314-7) Wiseman, J. (1999). *The SAS Survival Handbook.* Hammersmith, London: HarperCollins Publishers.

C2-041 (ISBN 0-07-136110-3) Seidman, D with Cleveland, P. (2001). *The Essential Wilderness Navigator.* Camden, ME: Ragged Mountain Press.