

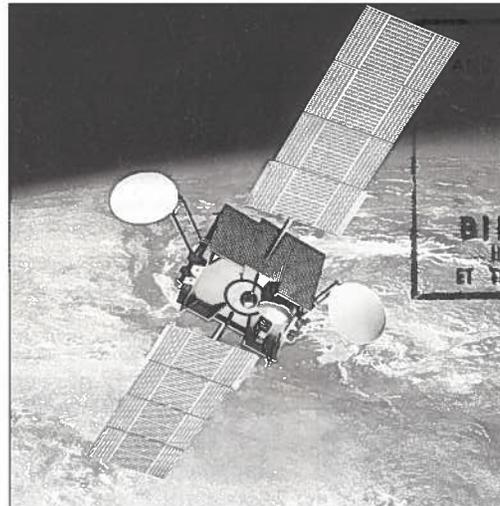
# APOGEE

THE CANADIAN SPACE AGENCY NEWSBULLETIN

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## Canadian Space Program Beneficial at Ground Level

The Canadian Space Program's greatest achievements are fulfilled on Earth. Ongoing projects to be completed in the 1990s, such as *RADARSAT*, the *Mobile Servicing System (MSS)* and the *Wind Imaging Interferometer (WINDII)*, carry on that space science tradition.

Since the commercialization of *Anik A2* in January 1973, Canada's space program has focused on the practical ends of space exploration. The *Anik* series of communication satellites has provided telephone and television services to the entire country, greatly reducing the isolation of remote areas. *Anik E*, slated for launch next March, is being tested at the David Florida Laboratory (DFL) in Ottawa.

The *Mobile Communications Satellite (MSAT)* will make simple voice transmissions accessible to the entire country. Through a low-cost transmitter, users in isolated regions will be

able to contact other Canadians as easily as people in urban areas do now through the long-distance telephone system. *MSAT* will also make possible a coast-to-coast cellular network.

With *RADARSAT*, Canada becomes a major-league player in remote-sensing satellites. Along with the valuable geological and meteorological information it provides, *RADARSAT* will help reinforce Canada's Arctic sovereignty.

"Technology developed for these new initiatives produces a valuable influx of new skills for Canadian

(see **Space Program**, p. 2)

*Above: Depiction of Anik E, the fifth generation of Anik satellites, which will provide Canadians with coast-to-coast communication services following its launch, scheduled for March 1991.*



Canadian  
Space Agency

Agence spatiale  
canadienne

Canada

# Message from the President



Dr. Larkin Kerwin, President, Canadian Space Agency.

## APOGEE

Apogee is the term applied to the highest point above the Earth in the orbit of the Moon or an artificial satellite.

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As we prepare for the promulgation of the Act (C-16) establishing the Canadian Space Agency, it is gratifying to look back at what has been accomplished since its creation, a little more than a year ago, on March 1, 1989.

Designed to provide a focus for Canada's space effort, the Agency was initiated by drawing together space activities of various government departments and of the National Research Council. Today we can take pride, not only in having maintained a complex program of inherited projects, but also in having moved them forward successfully.

The two largest projects now being managed by the Agency are Canada's participation in the international Space Station *Freedom*, and the Canadian-led development of *RADARSAT*, which, when launched in 1994, will be one of the world's most advanced remote-sensing satellites. Canada's contribution to the Space Station consists of the development of its robotic *Mobile Servicing System*, the largest international technology development project ever approved in Canada.

Another important and vital component of the Space Agency is the Astronaut Program. Last January 18, Dr. Roberta Bondar was chosen as the next Canadian to fly aboard the shuttle,

rescheduled for April 1991. Dr. Steve Maclean will be the third to undertake a Canadian mission scheduled for 1992. Canadian astronauts will also operate the *Mobile Servicing System* for the Space Station and perform scientific work on behalf of Canadian researchers.

On the international front, the Canadian Space Agency renewed an agreement to collaborate with the European Space Agency. Successful bilateral meetings were held with NASA and Japanese space officials. In addition, an agreement to co-operate further in space science research was signed last fall with the U.S.S.R.

As a separate, independent organization, the Agency has had to build up its own administrative infrastructure. Interim headquarters space has been leased at Place Air Canada in Montreal, until the permanent headquarters in Saint-Hubert are available in 1992.

The progress that has taken place during the first year of the Canadian Space Agency could only have been made possible through the dedication and best efforts of all its personnel. May we continue to meet the expectations of Canada's promising future in space.

Larkin Kerwin, C.C.  
President  
Canadian Space Agency

## Space Program (from page 1)

industry," said Mario Patenaude of SPAR Aerospace Ltd. Technology also allows Canadians to enhance skills they already have in ground receiving stations, image analysis systems and mapping and geographic information systems, he added.

Canada also has a well-established reputation in space robotics, ensured by the success of the *Canadarm*. This technology is being further developed for the Space Station's *Mobile Servicing System* (see page 4).

On the space science side, from the launch of the first *Black Brant* sounding rocket in 1959, the Canadian Space Science Program has contributed to the

knowledge of our near Earth space environment and the development of high technology industries. The *WINDII* instrument, included on NASA's *Upper Atmosphere Research Satellite (UARS)* to be launched in 1991, experiments to be conducted by Dr. Roberta Bondar on the *IML-1* shuttle flight and Canada's work on the fine guidance system for the Explorer Lyman *FUSE* telescope, scheduled to be launched in 1997 (see page 5), are but a few of the space science programs that continue to add to Canadian knowledge of space while promoting the development of our high technology industries.



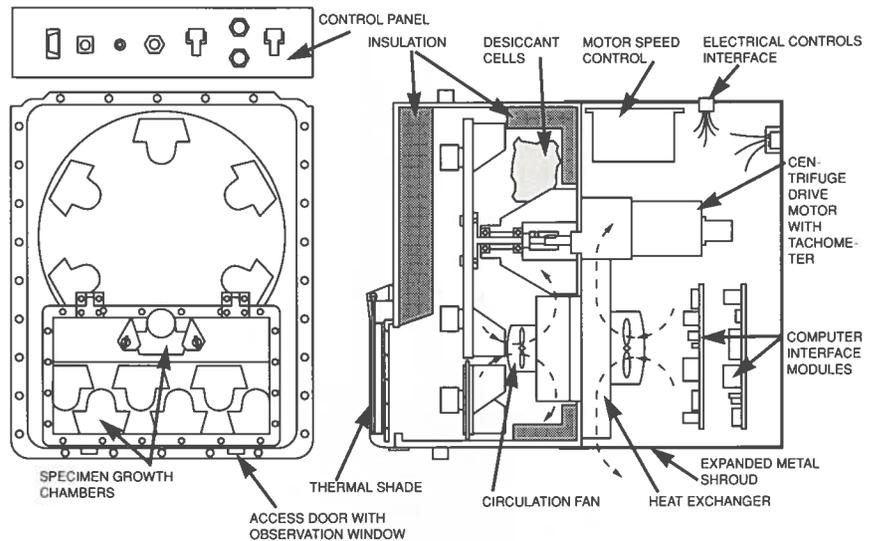
## Space Science

### Canadian-built Aquatic Research Facility to be launched

NASA has agreed to fly a Canadian-built Aquatic Research Facility (ARF) as a middledeck payload on the NASA shuttle. The facility is presently scheduled for the STS-56 flight in June 1992, and at least two more flights are being discussed.

The ARF will be designed to study the response of small aquatic life forms such as bacteria and plankton to microgravity. It will have two sets of specimen growth chambers: test chambers for experimentation in microgravity, and control chambers where the level of gravity will be the same as it is on Earth. The facility will include photographic apparatus and a system to arrest growth and changes in the specimens for later study. The ARF will be used by both Canadian and NASA investigators.

The first Scientific Requirements Meeting for ARF was held April 17, in



The ARF concept provides a cooled experiment enclosure for specimen growth chambers.

Ottawa. Canadian specialists Dr. Bruce Crawford, Dr. Ron O'Dor, Dr. Alan Lewis, Dr. Brad Thompson, and Dr. Richard Wassersug, who have all submitted proposals for the ARF, were invited to advise on the development of the facility based on a study done by Rockwell International.

The flight hardware for the STS-56 flight has to be ready for delivery in December 1991. Modifications to hardware design will be finalized by the end of June and the procurement process for the construction of the Facility will be started.

## Space International

### Soviet Researchers Find High Radiation Levels in Space

Radiation levels in space are much higher than previously thought, said Dr. Albert Mareny of the Soviet Union's Laboratory of Radiation Physics.

Astronauts have not been harmed by radiation in the past because they have been exposed for short periods of time, in orbits where radiation levels are at a minimum.

But a flight to Mars — a priority of the Soviet Space Program — would take more than a year. "Our desire to ensure that the cosmonauts are not exposed to any health hazards led to research (in radiation)," said Dr. Yuri Voronkov of the Soviet Union's Institute for Biomedical Problems.

Doctors Mareny and Voronkov were members of a team of Soviet scientists who visited Canadian Space Agency facilities during April and May as part of an ongoing research program

on health hazards in space. A major part of that work involves Canadian experiments on the Soviet *Biocosmos* satellite.

Dr. Harry Ing, President of Bubble Technologies Industries (BTI), a company which manufactured a radiation detection device flown on board *Biocosmos*, said the information Dr. Mareny presented is well known in the Soviet space program, but came as news to many Canadian researchers. "(It's) a summary of what the Soviets have done. They are the leaders in this area," said Dr. Ing.

The radiation detection devices produced by BTI and included on *Biocosmos* are capable of distinguishing between neutron and other types of radiation. "Neutrons are a major component of the radiation hazard inside spacecraft," Dr. Ing explained. "They are very dangerous and penetrating."

According to Dr. Ing, the indicators performed well during their first use in space. "The neutron dose measured is

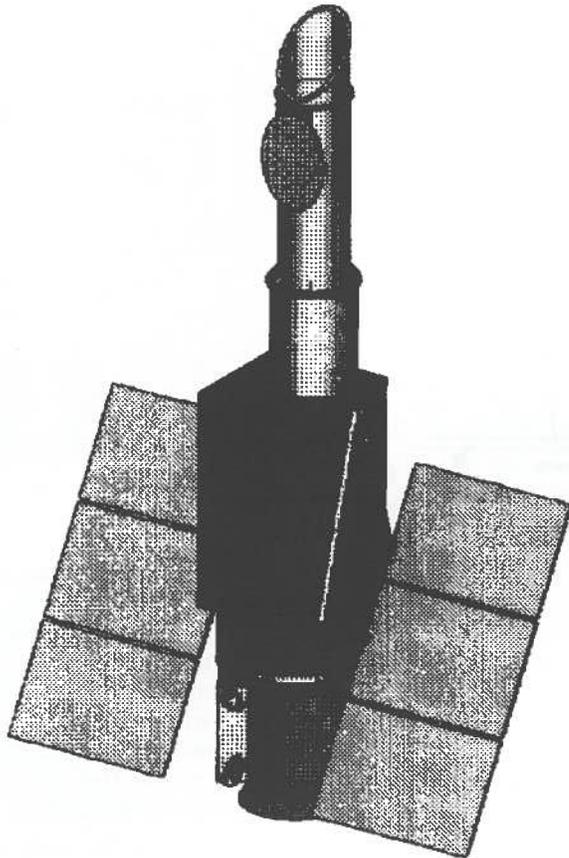
in reasonable agreement with what was expected, but the neutrons were more energetic than was originally thought," he said.

The research program on health hazards in space is part of the agreement signed on space co-operation last November by Prime Minister Brian Mulroney and the Chairman of the Council of Ministers Nikolai I. Ryzhkov.

The agreement provides a flexible framework for space co-operation. It also facilitates the development of projects in various scientific fields, such as space physics, space biology and life sciences, space astronomy, and remote sensing.

At present, Canada is building an ultraviolet camera for the Soviet-led *Interball* project which will provide pictures of the aurora borealis (Northern Lights) from space. Soviet officials have invited the Canadian Space Agency to consider flying an astronaut on their *MIR* Space Station.

# Space Scan



The Lyman FUSE telescope, to be launched in 1997, will allow scientists to view phenomena visible in ultraviolet light, which is blocked by the Earth's atmosphere.

## Canada Helps Design and Construct FUSE Telescope

At NASA's invitation, the Canadian Space Agency is participating in the development of a new orbiting telescope that will allow scientists to examine phenomena visible in ultraviolet light, normally blocked by the Earth's atmosphere.

Canadian high technology industry will develop the optical components of the fine guidance system for the Lyman Far Ultraviolet Spectroscopic Explorer (FUSE) telescope. The fine guidance system, to be developed with the British National Space Centre, is expected to keep the telescope pointed within one ten-thousandth of a degree.

The baffle system that will prevent stray light from entering into the telescope will also be developed in Canada.

"There are problems working with ultraviolet light," said Gerry Atkinson, Chief Scientist, Space Sciences Program of the Canadian Space Agency. "We

can't find material that is transparent to use for lenses. It's also difficult to find suitable reflective mirror coatings." As a consequence, the telescope will use a series of mirrors to collect ultraviolet light.

When launched in 1997, FUSE will provide opportunities to expand current knowledge of the outer planets of the solar system, study the formation of stars and investigate the evolution of the Earth's and other galaxies.

Another important feature of the telescope will be its ability to identify complex gases. FUSE's ability to distinguish between different kinds of hydrogen, for example, will enable scientists to answer questions about the history of the universe, said Atkinson.

The \$15 million that Canada has pledged to the project will be used to provide hardware for the telescope. In return, Canadian scientists will have access to the orbiting telescope and all data collected by the mission. A Canadian Science Team will be formed to co-ordinate the use of Canada's share

of the mission. Astronomers from across Canada are expected to participate.

The lead Canadian scientist for the project is Dr. John Hutchings of the National Research Council's Dominion Astrophysical Observatory, who has, together with his team of co-investigators from across the country, actively participated in all phases of the project. All Canadian astronomers can submit proposals to use the new telescope.



## Communications

### New Aircraft Instrument System Tested at DFL

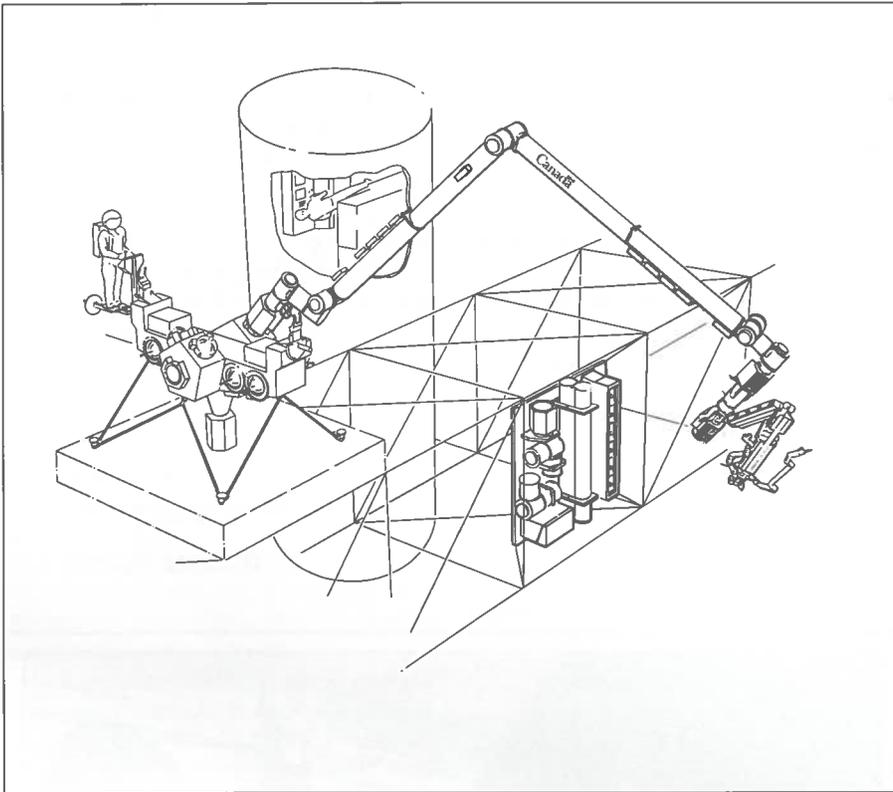
The David Florida Laboratory (DFL) in Ottawa is testing components of a new aircraft guidance system that could significantly reduce the risk of flying and landing aircraft in low-visibility conditions.

The *Microwave Landing System (MLS)* will use microwave radar instead of conventional radio signals. Microwave radar can pinpoint an airplane's location better than current systems can. "Ultimately, the system will enable pilots to land within one foot of their intended destination," said David Lee, a Radio Frequency Technologist at the DFL.

The tests are being carried out for a firm called Micro-Nav which will supply the system to most Canadian airports. The system should reduce the number of days airports have to shut down because of fog. This should be particularly beneficial to airports in bad weather areas, such as Toronto's Island Airport.

"Currently, most airports use a system called the *Instrument Landing System (ILS)*," said Lee. "It allows aircraft to fly from one place to another following a signal, but it still requires a lot of concentration and decision making on the pilot's part." Lee said the *MLS* would make hands-free flights technically possible.

# Space Scan



The development of the Mobile Servicing System (MSS) is keeping Canada in the forefront of space automation and robotics. The MSS, a robotic device similar to Canadarm, will be used to assemble and maintain the Space Station Freedom.



## Space Station

### The MSS: Canada's Contribution to the Space Station

Canada's contribution to the Space Station is being undertaken by the Canadian Space Agency. The *Mobile Servicing System (MSS)* is comprised of a large Canadarm-like robot attached to a Mobile Transporter provided by NASA, and a small dexterous robot that, between them, will be able to perform most external servicing and maintenance tasks on the Space Station.

Currently in the design phase, the MSS will play the predominant role in Space Station assembly and maintenance, moving equipment and supplies around the station, releasing and capturing satellites, supporting astronauts working in space and servicing instruments and other payloads attached to the station. It will also be used for docking the shuttle orbiter to the Space Station and then loading and unloading materials from its cargo bay.

"The research and development of these space robots are keeping us in the forefront of an activity that is essential for the future well-being of our nation," said Dr. Karl Doetsch, Director of the Canadian Space Station Program.

The Canadian system will consist of equipment located both in space and on the ground. The MSS will be a "roving space robot", attached to a travelling base provided by the United States. Installations for ground operations and logistics will be located in Canada.

It will take approximately 30 shuttle runs to bring up all elements necessary to assemble Space Station in outer space. The MSS is scheduled to be on the fourth assembly flight of the Space Station, to be launched in 1997.

According to Dr. Doetsch, the robots that the Canadian Space Agency will be producing for Space Station will be of significant practical value. "More extensive maintenance and repairs of Space Station will place great demand on our system," he said.

Canada is technologically strong in the application of automation and

robotics to space. The MSS builds on the niche filled by the first generation Canadarm and "is of strategic importance for the future of the country," said Dr. Doetsch.

The development and research now being done for the MSS doesn't end with Space Station. Dr. Doetsch explained that present research is applicable to hostile environments on earth, where humans might otherwise be endangered. "For example, in mining; robotic devices developed from the technology of the MSS would be able to perform functions underground that would otherwise endanger the miner," he said.

Other terrestrial applications include assembly and manufacturing operations in underwater and underground mining (driverless vehicles, automated positioning and inspection systems), agriculture (automated planting and harvesting systems) and fire-fighting.

Canada's Space Station Program, through the Canadian Space Agency, is also supporting the development of strategic technologies for the future, such as artificial intelligence and vision systems.

The economic and technological spin-offs of the Canadian Space Program are expected to be significant. Canadian involvement in Space Station *Freedom* alone could result in benefits of \$4 billion (Cdn) and 63,000 person-years of employment.

The Space Station will also enable our scientific community to have access to one of the most important laboratories of the 21st century and will place Canada at the leading edge of scientific discovery along with its partners from the U.S.A., Europe and Japan.

# Space Scan



## Astronaut Program

### Roberta Bondar Prepares for Flight

Canada's next astronaut in space, Dr. Roberta Bondar, is following a very demanding training program in preparation for her space flight, rescheduled for April 1991.



Canadian astronaut Roberta Bondar.

Dr. Bondar and Dr. Ulf Merbold of the European Space Agency will be payload specialists for the *International Microgravity Laboratory (IML-1)* to be launched on board the space shuttle. During their preparations, they are being assisted by Canada's Dr. Ken Money and NASA's Dr. Roger Crouch, back-up payload specialists.

The astronauts have visited laboratories throughout Europe, Canada and the United States over the past year learning about *IML-1's* 40 material and life sciences experiments, six of which are from Canada.

Over the next few months, Dr. Bondar will continue her work at the Marshall Space Flight Center in Huntsville, Alabama, where the Space-lab simulator is located. The full seven-member crew will also train at the Johnson Space Flight Center in Houston, Texas, where they will acquaint themselves with crew operations, housekeeping and emergency procedures.

Dr. Bondar, Dr. Merbold and two NASA mission specialists, Dr. Norm Thagard and Dr. Manley 'Sonny' Carter, will conduct the experiments in two 10-hour shifts. The remainder of the day will consist of sleep, two hours of pre- and post-sleep activities, meals and exercising. "We will be working minute by minute, so we can't just decide on the spur of the moment, 'Okay, now I'll spend half an hour working on this experiment over here.' Our time is completely allocated throughout the whole day," said Dr. Bondar.

Because the astronauts will be moving from one experiment to another, sometimes taking over where someone else has left off, it is important they be completely familiar with all experiment procedures.

"As part of our training, we're going through procedures to make sure we know exactly what to do, and it's very important that we be precise. The scientists and engineers are giving us all the steps and guidelines. We can't have any steps missing, so we have to pay great attention to detail," said Dr. Bondar.

During the mission, Dr. Bondar and Dr. Merbold will be in voice contact with Dr. Money and Dr. Crouch at the Payload Operations Control Center in Huntsville.

Once the mission is over, Dr. Bondar will be travelling again — this time around Canada — speaking about the implications of the *IML-1*

(see Roberta Bondar, p.7)



Dr. Brad Thompson (right) of the Alberta Research Council keeps a grip on Canadian astronaut Dr. Bjarni Tryggvason, of the Canadian Astronaut Program, during one of the KC-135 flights. The scientists in the background are working on the University of Toronto's Gyroscope Altitude Drift experiment. The NASA plane made four flights of 40 low-gravity parabolas in February and another four took place in June. Thirty-two Canadian experiments, selected by competition, are being carried out during the flights.

# Space Scan

**Roberta Bondar** (from page 6)

experiment results for Canadians and the Canadian Space Program. "I'll be talking to people about what happened, and discussing the experiments and expertise we've gained from this flight," she said.

Asked what aspect of the mission she's looking forward to most, Dr. Bondar said, "Probably the pre-sleep activities, when I'll have a chance to look out the window."

## Canadian Medical Research Heads for Space

Physiology experiments to be conducted on *IML-1* may have valuable medical spin-offs on Earth.

A process which could be applied to a cure for cancer is being developed by Dr. Donald Brooks of the University of British Columbia. His experiment investigates the possibilities of separating certain molecules out of mixtures.

"This experiment may lead to ways of separating malignant cancer cells in the blood of people with leukemia, so they can then be filtered out," explained *IML-1* payload specialist Dr. Roberta Bondar.

A series of eight experiments designed by McGill University's Dr. Douglas Watt to study how the nervous system functions in space will help scientists understand the sensations astronauts experience (dizziness, nausea and blurred vision) as their bodies adapt to reduced gravity.

"Some of these sensations are similar to symptoms people with multiple sclerosis and diabetes experience," said Dr. Bondar. "The experiment results may help us find a new way of looking at these symptoms and why they occur."

Several of the experiments deal with the balance mechanism of the inner ear. Signals are sent from the inner ear to the eyes to help them focus as the head moves. If the inner ear is damaged, the signals are not clear and dizziness and blurred vision may result. One experiment, developed by Dr. Joseph McClure of the London Ear

Clinic, will investigate two different types of eye movement.

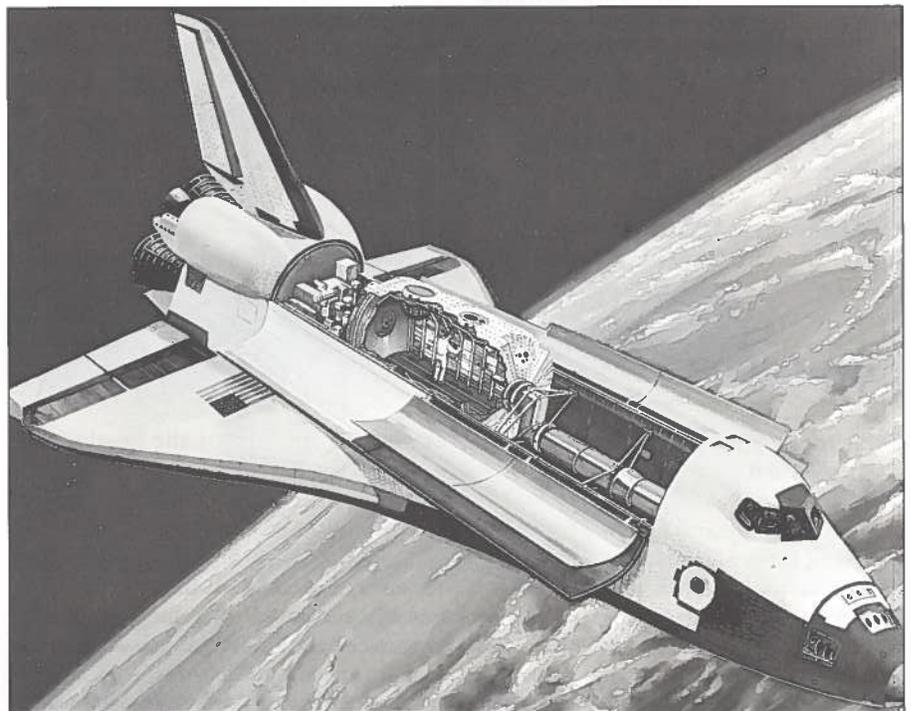
Dr. Ken Money, who is training as an alternate payload specialist for *IML-1*, is a co-investigator specializing in space motion sickness studies. He and his colleagues at Canada's Defence and Civil Institute of Environmental Medicine (DCIEM) hope to obtain new understanding of the disorder which may lead to more effective treatment or prevention of motion sickness problems.

Dr. Howard Parsons and his associates at the University of Calgary are studying the nutritional requirements for maintaining good health in space. Their experiment on *IML-1* will investigate how the body expends energy during space flight and how its composition (fat content and muscle mass) changes. The contents of urine samples from an astronaut taken before, during and after the *IML-1* mission will be analyzed to determine the relative concentrations of isotopes of hydrogen and oxygen following ingestion of a

precise quantity of doubly-labelled water. The differences in turnover rates is proportional to carbon dioxide production from which energy expenditure can be calculated.

Back pain experienced by most astronauts and cosmonauts is believed to be associated with changes in curvature and length of the spine during weightlessness. Dr. Peter Wing and his colleagues from the University of British Columbia have prepared experimental procedures for in-flight measurements which may provide new insight into back pain phenomena.

Dr. Robert Thirsk, another Canadian astronaut, has an *IML-1* experiment which will measure changes in the compliance of lower leg veins associated with the typical shift of blood into the upper body during space flight. A second part of the experiment will evaluate the effectiveness, following landing, of an experimental antigravity suit which he and his co-investigators at DCIEM have developed.



Experiment facilities inside the Spacelab module which will be used on board the space shuttle for the *IML-1* mission.

## Extended Exposure Proves Beneficial for LDEF Experiments

An extended tour of duty for the *Long Duration Exposure Facility (LDEF)* satellite has provided unexpected research results for Canadian scientists.

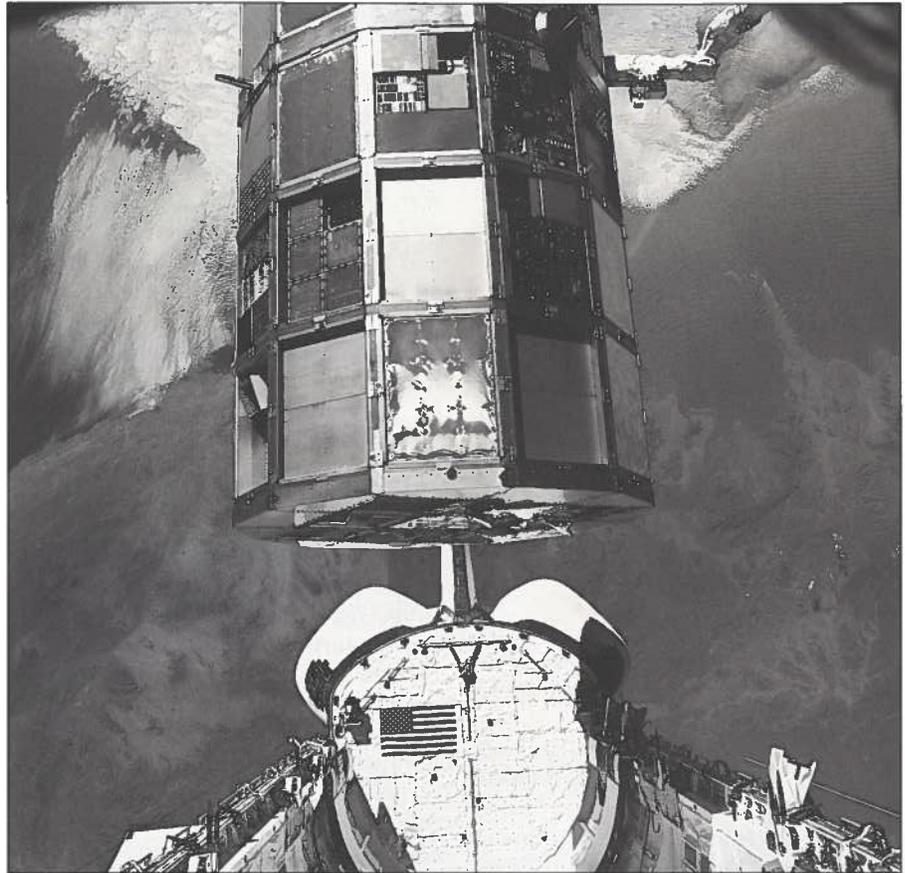
Launched in April 1984, the satellite was supposed to be retrieved in 1985, but a moratorium on shuttle flights after the *Challenger* disaster left the LDEF in orbit for almost six years until it was finally brought back to Earth last January. As a result, researchers have a better idea of how different materials respond to long-term space exposure, said Dr. Rod Tennyson of the University of Toronto's Institute for Aerospace Studies.

Materials in space are subject to four principal causes of degradation: oxidization, radiation damage, collisions with meteoroids and out-gassing. In addition, structures are subject to strains caused by the contraction and expansion of materials in the extreme temperatures of space.

Oxidization occurs when highly reactive oxygen in the atmosphere combines with elements of a material. This "space rust" eventually causes materials to fall apart in much the same way that car bodies do when attacked by iron rust.

The LDEF showed that damage caused by oxidization was more extensive than expected, and that it reached areas originally thought to be protected. "Places that were around corners and shadowed by other parts were still damaged," explained Dr. Tennyson.

The LDEF was also hit by many tiny meteoroids, most less than a millimetre in diameter, but some capable of killing an astronaut. Dr. Tennyson said that the meteoroids make the process of designing a



The bus-size LDEF satellite was recaptured by Canadarm on board Columbia in January 1990 over the coast of Namibia.

protective coat for materials more difficult. "These collisions could easily damage a coating and leave surfaces below exposed to oxygen," he said.

In the first 80 to 100 days of a space flight, gases such as water vapour escape from materials used to construct spacecraft. The resulting shrinkage could cause changes in the fit of interlocking parts. "We may now be able to predict the changes that out-gassing and temperature variation will

have for construction of structures in space," said Dr. Tennyson.

A data recording system designed and built at the University of Toronto for use on the satellite performed better than expected. "It worked in space and still works now," said Dr. Tennyson of the machine which cost \$70,000 to construct. "That's far less than the \$300,000 it costs to buy a competitive machine currently available on the market."

## Space Net

### Even Tomato Seeds can be Controversial

Junior, elementary and high school students from across Canada encountered heavy media scrutiny when they volunteered to grow tomatoes for NASA this spring.

The students volunteered to supervise the growth of seeds that flew aboard the *Long Duration Exposure Facility (LDEF)*. The experiment com-

pared the growth of the seeds from space with a control group of earth-bound seeds.

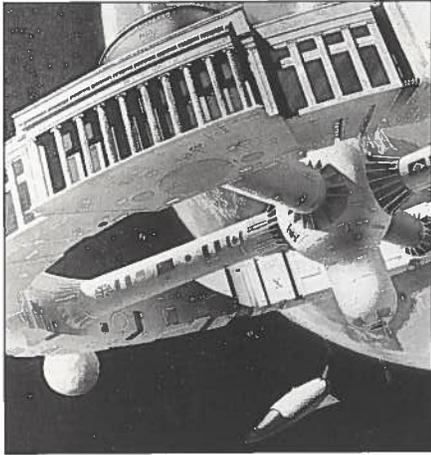
The students found themselves in the middle of a controversy when an internal NASA memo, leaked to the press, speculated that the seeds might produce radioactive fruit unsafe for human consumption.

NASA scientists and representatives of Park Seed, the company that supplied the seeds, quickly denied the

charges. They argue that the seeds will produce tomatoes as safe as those grown in any home garden. Past experience indicates that a change of colour is the most likely effect of radiation exposure.

Dr. James Alston at Park Seed said the container holding the 12.5 million tomato seeds aboard the LDEF was carefully checked and no evidence of harmful radiation was found.

## Space Net



Artist Pat Rawlings' representation of the International Space University, which may one day have a permanent campus in orbit.

### York University Hosts International Space University

More than 125 students, including 14 Canadians, were selected to attend the International Space University's (ISU) third session, held at York University in Toronto this summer.

ISU was founded in 1987 to identify, unite and educate young professionals and outstanding graduate students involved in space-related studies. Students come from a variety of educational backgrounds, including architecture, medicine, law and engineering.

The first session of ISU was held at the Massachusetts Institute of Technology in the summer of 1988 and the second at the Université Louis Pasteur in Strasbourg, France. The 1991 session will be held in Moscow, U.S.S.R. The university hopes to have a permanent facility following ISU '92, which will take place in Japan during International Space Year.

Students took courses in eight academic disciplines and attended lectures which stressed the interdisciplinary nature of space exploration. "ISU offers students a chance to become part of a growing world-wide network of talented people who are interested in pursuing a career in space-related industries," said Dr. Rod Tennyson, President of the Canadian Foundation for the International Space University (CFISU).

Canadian support for ISU has come from the Canadian Space Agency, granting councils, SPAR Aerospace Ltd., Oerlikon Aerospace, Canada Wire

and Cable, provincial governments, as well as other private sources.

The Canadian Space Agency was pleased to share its expertise with ISU in areas such as physical sciences and life sciences. Agency guest lecturers included Dr. David Kendall, Dr. Karl Doetsch, Bryan Erb and astronauts Dr. Ken Money, Dr. Bob Thirsk and Dr. Roberta Bondar.

The Canadians selected to attend this session were: Philippe Charest of the Institute for Aerospace Studies at the University of Toronto; Bob Cheung, a life sciences student at York University; Alain Côté of the Optical Research Centre at Université Laval; Gary Crocker, an engineering student at the University of Toronto; Richard Desjardins, an engineering student at Université Laval; Pierre Fortin, a law and public policy student at McGill University; Otis Maréchaux, a space architect residing in Toronto; James Orlando, a student of satellite applications at McMaster University; Michel Pelletier, an engineering student at McGill University; Kamiel Rezkallah of the University of Saskatchewan; Brian Rishikoff, an engineering student at the University of Houston; Marianna Shepherd, a physical sciences student at York University; David Stewart, a computer engineer studying at Carnegie-Mellon University; and Brigitte Vachon, an aeronautical engineer who teaches

computer sciences at the Royal Military College in St-Jean, Quebec. Each of these students received a \$12,000 scholarship from the CFISU.

### Masters Program set up for Aerospace Engineering

The Canadian Space Agency and 11 Quebec aerospace companies have joined forces with three universities to provide a Masters program in aerospace engineering.

The participating companies have agreed to provide temporary positions for 40 students in the program each year. The Agency will hire students for eight-month work terms that will count as credits towards their degrees.

Concordia University, École Polytechnique and McGill University agreed to develop the program in response to a request from industry representatives in October 1989. The program's viability was confirmed by an information session held at Concordia that drew over 200 students.

The Canadian aerospace industry, of which half is located in Quebec, will require 600 new engineers in the next three years, said Serge Tremblay of the Centre d'adaptation de la main-d'œuvre au Québec (CAMAQ), a training group that promotes the maintenance and increase of employment in the aerospace industry.



Canadian Space Agency President, Dr. Larkin Kerwin, signs autographs for students at Pierre-Brosseau High School in Brossard, Quebec prior to their trip to the space camp in Huntsville, Alabama. Dr. Kerwin encouraged students to pursue studies that could lead to space-related careers. Last February, 73 students attended the space camp, the first of its kind available to Canadian students, for five days.

## Space Resources

### ◆ Canadian Space Agency Resources:

- **Canadian Space Program Profiles:** Canada's Place in Space/MSS Facts (Space Station)
- **Pamphlet:** Canada in Space: 25 Years and Counting
- **Video Tapes:** Canada in Space: 25 Years and Counting/Canada's Place in Space (Space Station)/RADARSAT
- **Posters:** Canada's Place in Space/Space Station (MSS)/RADARSAT
- **Photo Cards:** Canada's Place in Space/Space Station(MSS)/Space Science (Aurora)/RADARSAT/Canadian Astronauts
- **Stickers:** Canadian Space Program Patch
- **The David Florida Laboratory** fact sheets folder

Please write to:

Canadian Space Agency  
Communications Branch  
Place Air Canada, 4th floor  
500 René-Lévesque Boulevard West  
Montreal, Quebec  
H2Z 1Z7  
tel. (514) 496-4000  
fax: (514) 496-4039

- ◆ **The Space Resource Centre Catalogue, 1988, The Marc Garneau Collegiate Institute (MGCI).** The catalogue describes materials available for duplication in areas such as aeronautics, satellite applications, space life sciences, manned space-flight, space sciences, etc.

- ◆ **The Capsule** – MGCI's newsletter.  
Marc Garneau Collegiate Institute  
135 Overlea Boulevard  
Don Mills, Ontario  
M3C 1B3  
tel. (416) 429-6166

The Space Resource Centre at MGCI, a nation-wide NASA materials distribution centre, includes video tapes from numerous Canadian agencies and businesses. Other resources available to Canadian educators include packaged audio tapes and slide presentations, teacher guides and course materials. References to sources of information related to space science and a list of speakers and contact persons in related fields can also be ordered.

- ◆ **Directory of Publications and Audio-Visual Materials, Communications Canada.** The directory lists brochures and handbooks, fact sheets, newsletters, posters, studies, reports

and audio-visual material available from Communications Canada. Some publications are free of charge, others can be purchased from authorized bookstores or from the Canadian Government Publishing Centre. Audio-visual materials can be borrowed free of charge.

Communications Canada  
300 Slater Street,  
Ottawa, Ontario  
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## Calendar

**August 15-17, 1990:** Symposium on Antenna Technology and Applied Electromagnetics, Winnipeg, Manitoba, Canada

**August 21-23, 1990:** International Symposium on Electromagnetic Compatibility, Washington, D.C., U.S.A.

**September 4-6, 1990:** Canadian Conference on Electrical and Computer Engineering, "Ten Years to 2000", Ottawa, Ontario, Canada

**October 6-12, 1990:** International Astronautical Federation Congress, Dresden, West Germany

**October 8-11, 1990:** Antenna Measurement Techniques Association, 12th Annual Meeting and Symposium, Philadelphia, Pennsylvania, U.S.A.

**October 16-18, 1990:** 61st Shock and Vibration Symposium, Pasadena, California, U.S.A.

**November 5-8, 1990:** 16th Space Simulation Conference, Albuquerque, New Mexico, U.S.A.

November 12-20, 1990: International Symposium on Artificial Intelligence, Robotics and Automation in Space, Kobe, Japan

**November 13-15, 1990:** JINA '90, International Symposium on Antennas, Nice, France

**November 20-21, 1990:** Canadian Aeronautics and Space Institute 6th Astronautics Conference, "The Challenge for Space in the Changing World" — focus on industrial contribution, preceded November 19 by workshops on Space Education and Spacecraft Design, Ottawa, Ontario, Canada