Canadian SPACE GAZETTE

Winter Issue
2007/8

Successful CSS Summit

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China's Space Industry

✦

Canada's Own SCISAT-I

✦

Space Entrepreneurship

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President's Message

Welcome to 2008! Of course I am writing this in late 2007, but we are members of this Society because we are able to envisage a future that we wish to come to pass.

Furthermore we are prepared to put in the hard yards to see that it does. So let us reflect for a moment on what has been achieved by our fellow travelers on this road, and to re-focus our efforts to shape the future we desire.

This issue of the gazette highlights the diversity of activities that support our efforts to move into space, covering interesting developments in engineering, science, governance, history and entertainment. Canadian processionals and companies are contributing to these efforts, and grass-roots organizations such as the Canadian Space Society provide a forum for the ideas and talents that feed them.

Our efforts, such as education programs at the Toronto Aerospace Museum, encourage young people to pursue studies that take them into projects small (see "Lunette") and large (see "In the Shadow of the Moon"). Our off-shoot organizations such as the Canadian Space Commerce Association provide a forum to assist entrepreneurs to build businesses around yet other ideas and visions.

I hope by now to have seen you at the Canadian Space Summit in Calgary, and shared your ideas with the wider community that pursues our vision. This is our first Summit held in the West, and it looks like another high quality event. If you've missed it then keep your eyes out for the 2008 Summit, keep pursuing your vision, we'll see you there.

Our thanks to the Gazette team for another excellent issue. I am sure you will enjoy it.

Ad Astra,

Daniel Faber

Daniel Faber *President, CSS*

The Road Ahead
From the Editor

The Canadian Space Gazette has over the last six months built up a solid core team of editors and journalists. In addition, we are pleased to announce the appointment of two business officers. Firstly, we have appointed an advertising editor to bring the Gazette into the industry sector while allowing us to raise revenues for our future plans. Secondly, we have brought on a management editor with whom we have done the work of ensuring the Gazette is PST exempt, and to begin plans to raise subscribers and to get the Gazette onto as many store shelves as possible.

As we move towards creating a sustainable publication with a vision to grow in length and subscribers, we are still on the look out for three new associate editors to help build our editorial team. We are also looking to recruit at least two regular columnists for each of our five sections – Canada in Space, Earth Observation, Solar System Exploration, Robotics and Human Factors.

If we can achieve the vision laid out here while maintaining the quality of our publication until next summer, we will be eligible for applying to Heritage Canada and other grant giving agencies for significant funds. This will allow us to then remake the Gazette as the leading space enthusiast magazine in Canada.

Justin Trottier *Editor-in-Chief*

The Canadian Space Society is a grass-roots space advocacy group, a unique combination of amateur and professional interests pursuing the human exploration and development of the Solar System. With some of Canada's top aerospace experts and engineers on board, the CSS is made up of people of all backgrounds and interests, including teachers, environmentalists, writers, and marketers.

A Brief Tour of China's Space Industry

Kevin Shortt
Networking Officer for the CSS

There has been much media coverage surrounding China's launch into the international spot light, both good and bad. There is no doubt that while mistakes have been made, China is going to continue its strong pursuit towards becoming a major competitor on the world market. This is especially true for China's space industry.

Since the late 1960's, China has had a healthy space program with the launch and operation of a series of successful scientific satellites. That all changed in 2003 with the launch of China's first taikonaut, thrusting China's relatively modest space program into the world spotlight. Since then, the Chinese government has set an aggressive space station and lunar program. Given that China's space program has accomplished more in the last 10 years than any of the other space agencies, it is well poised to accomplish its lofty goals.

Much like any space program, the Chinese government has an agency that oversees the execution of its space missions, namely the Chinese National Space Agency (CNSA). Unlike other nations' space programs, there is really only one contractor that develops and builds the nation's space hardware, the China Aerospace Science and Technology Corporation (CASC). Subordinate to the parent organisation is a series of academies that carry out specific aspects of space technology development: China Academy of Launch Technology (CALT), China Academy of Space Technology (CAST), China Centre for Resources Satellite Data and Application (CRESDA), China Great Wall Industry Corporation (CGWIC), China Academy of Rocket Motor Technology (CARMT), China Aerospace Propellant Technology Academy (CAPA), Shanghai Academy of Space Flight Technology (SAST), Shanghai Bureau of Astronautics (SHBOA), China Academy of Space Electronics Technology (CASET), China Academy of Aerospace Navigation Technology (CAANT) and Sichuan Space Industry Corporation (SSIC).

The national headquarters for the Chinese National Space Agency is located in Beijing and it is in this city where most of the development of China's space program takes place. In this one city, China develops and builds spacecraft for a variety of applications (e.g. remote sensing, communications, global positioning), builds the rockets that carries them to orbit and hosts the organisations that disseminate the satellite data to the rest of the country (e.g. China National Weather Services). In August, technicians at the China Academy of Launch Technology were busy integrating the launcher for the next AsiaSat, due to be launched this month.

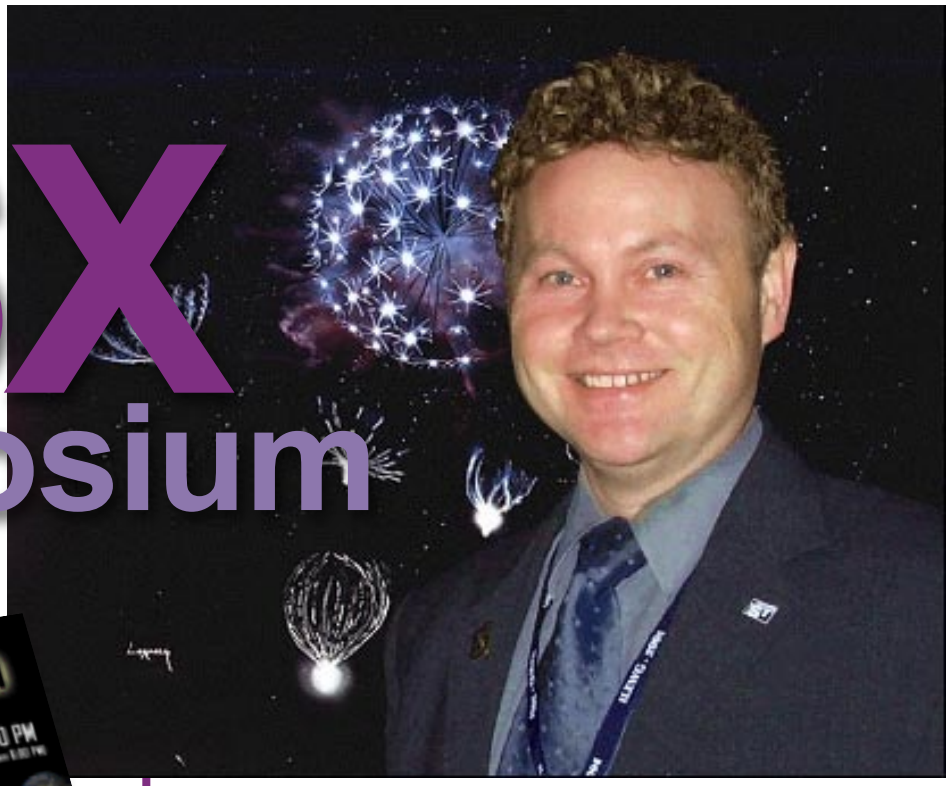
China has an aggressive schedule that includes plans for a space station and landing on the moon in 2018. Their plans also include a well-developed environmental monitoring system which will address growing national and international concerns over pollution, amongst other issues. Chinese officials are well-grounded in their plans and understand that they cannot accomplish all of this on their own. That is why they are turning to other space agencies from around the world for cooperation. Already, China is working with Nigeria, Russia and Europe. Despite the cold shoulder that the U.S. has turned, China continues its interest in working with NASA on future missions.

One of the most successful and prosperous relationships has been with Brazil. In cooperation with the National Institute for Space Research in Brazil, CASC has worked to bring the China Brazil Earth Resources Satellite (CBERS) series spacecraft to fruition. The latest rendition of the CBERS spacecraft is CBERS-4 carrying a payload made up of a Panchromatic and Multispectral camera (PAN), a Multispectral Camera (MUX), an Infrared Multispectral scanner and a Wide Field Imager. This variety of scanners and imagers affords CBERS-4 a total spectral range of 11 microns (between 0.51 microns to 12.5 microns). Orbiting at an altitude of 778 km with an inclination of 98.5 degrees provides complete coverage of the Earth every 26 days.

China's inaugural mission to the moon is Chang'e, named after the Chinese goddess of the moon. While the Chinese government has remained elusive with a specific date for launch, Chang'e is due to start its journey to the moon within the coming weeks. Upon arrival at the moon the spacecraft will start a rigorous campaign of 3D imaging of the lunar surface, study distribution of multiple elements, measure the depth of the regolith and explore the cis-lunar environment. This mission will no doubt set the stage for China's future lunar missions including a lunar rover and sample return.

This has just been a sample of the activities China is embarking upon with its space industry. The missions selected so far are as varied as they are ambitious. Such ambitions will require help from the international community and Canada is capable of lending a helping hand. The question is, are we ready and willing to answer the call?

ASX Symposium



Farnaz Ghadaki

Many believe that the Moon is the next step in human space exploration. At 380,000 km, it is the closest world to our own, and the only one which humans have both traveled to and walked on. The Moon holds secrets to the Earth's past, as well as promise for humanity's future.

A new space race has begun. There is a rebirth of lunar interest in the United States, while European, Chinese and Indian space agencies have begun their own campaigns of lunar exploration. Canada has also taken on a bigger role by shifting focus from inspiration to exploration. Lunar exploration is even attracting the attention of the private sector, notably spurred by the new Google Lunar X PRIZE. Many believe that the task is not only one of exploration, but that this time we return to the moon to stay.

In response to news and developments in the space industry, and recognizing the need to educate and inspire the public about lunar exploration, the Astronomy and Space Exploration Society (ASX) in Toronto, Canada, dedicated its 5th annual "Expanding Canada's Frontiers" Symposium to this topic. This Symposium took place on Friday, January 25, 2008, at the Bloor Cinema (506 Bloor Street West, Toronto), where the plan for exploring the moon—and the reasons we must— was unveiled. Topics of discussion included various aspects of Lunar Exploration – the past, present, and future of lunar missions. The line-up of distinguished speakers consisted of Dr. Robert D. Richards, Founder & CEO, Odyssey Moon; John F. Connolly, Lunar Lander Vehicle Engineering and Integration Manager, NASA; and Ariel D. Anbar, Associate Professor, Arizona State University.

Dr. Robert D. Richards – The New Race to the Moon

In recent news, Canada's Bob Richards unveiled Odyssey Moon, a private commercial lunar enterprise that is the first team to complete registration for the $30M Google Lunar X PRIZE. Another important announcement for Canada was that Odyssey Moon chose as its prime contractor MDA of Canada, an experienced company with substantial space heritage in providing robotics on the Space Shuttle and International Space Station. At the ASX Symposium, Bob Richards outlined how a carefully planned private Moon mission could set in motion the technological, political, legal and regulatory precedents that will allow humanity to rationally and peacefully embrace and develop the Moon as the world's eighth continent.

John F. Connolly – Building the Next Lunar Spaceships

NASA's Johnson Space Center (JSC) has a team dedicated to defining the future systems that will return crews to the Moon and transport them to Mars and beyond. Altair, previously referred to as the Lunar Surface Access Module (LSAM) is NASA's next generation lunar lander, and is developed and managed by the Constellation Lunar Lander Project Office at JSC. JSC is working directly with Apollo astronauts, various industry suppliers and universities to develop the architecture for Altair. John Connolly, who currently leads the engineering design of Altair, presented details of NASA's next generation lunar mission design at the ASX Symposium. His discussion was more of an academic treatment of returning humans to the Moon, describing various processes such as selecting the spacecraft, flight mechanics, and launch vehicles.

Ariel D. Anbar – Earth's Ancient Past: Revealing Secrets of the Moon

Many biologists, chemists, and geologists research and study the development of Earth as a habitable planet, and use this knowledge to search for inhabited worlds beyond Earth. Ariel Anbar and researchers in his group are such biogeochemists, who study various processes that shape the Earth's surface environment and how they evolve throughout time. Study of these processes provide valuable information about the habitability of the Earth, the history of life and the environment, the effects of human activities on the environment, and the prospects for life beyond Earth. On January 25, 2008, Ariel Anbar presented what we know about the early Earth and how this relates to space exploration, with connections to the lunar exploration program and other aspects of space science.

The annual "Expanding Canada's Frontiers" Symposium provides a remarkable and exclusive opportunity for students, professionals, and the general public to learn about and be excited and inspired by the latest developments in the exciting fields of astronomy and space exploration all across the world. For more information about these symposia and other ASX events, such as our Faces of Space lecture series, frequent observing nights, special outreach and other activities, please visit our website at:

http://asx.sa.utoronto.ca/

To receive automatic updates and news about ASX events, please send an e-mail to: space.society@utoronto.ca, with subject line "Newsletter Sign-up". ASX contact for Media and Public Relations:

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Space Entrepreneurship 101

Rocky Persaud
Chair, Canadian Space Commerce Association

The mandate of the Canadian Space Commerce Association (CSCA) is to serve as a network of people and organizations operating directly or indirectly in the space industry, providing opportunities to meet future business partners, clients or customers also operating in the industry, and opportunities to discuss issues, such as raising investor capital, building a management team, navigating the legal and political framework of the industry, and bringing to market products or services, which are challenges that all space entrepreneurs must face.

Some of our members include AstroKeys Inc., a Canadian company led by former CSS president Jocelyn Boily, which is developing satellite on-orbit servicing using small robotic spacecraft employing innovative new technologies; The DreamSpace Group, led by former X-Prize contender Brian Feeney, who is designing a series of suborbital vehicles for both high-velocity "extreme" personal spaceflight and high "hang-time" space tourism; Heliocentric Technologies, Inc., led by CSS president Daniel Faber, who is developing a transportable elemental analysis system for both the mining industry and planetary science applications; Columbiad Launch Services, led by Richard Graf, which is building a launch system employing a large diameter gun as a first stage; Continuum Aerospace, led by Arny Sokoloff, which is developing propulsion technology; and my own company, IPX, which is doing a variety of things ranging from developing exploration operational protocols for planetary scientists to developing the world's first zero gravity sports for parabolic aircraft and orbital stations.

The majority of companies represented by the CSCA are (in terms familiar to investors and start-ups) seed or pre-seed stage, and led by entrepreneurs that come from backgrounds in engineering, science, or technical design. In this current age of the so-called "New Space" industry – a moniker usually associated with the personal spaceflight industry or space tourism but encompassing other sectors ranging from satellite technology to space-themed entertainment – we are all on a steep learning curve, as entrepreneurs typically are, to develop skills in financing, marketing and the general administration of our businesses. There are three ways to go forward: attract talented people with the skills we lack; help each other to learn to do it ourselves; or seek help from outside experts.

The normal process for technology start-ups used to be: write a business plan, pitch to venture capitalists, get funded, build a management team, develop your technology, bring it to market. Venture capitalists used to mentor new entrepreneurs and be a part of the management team or board of directors of the newly funded company. In the 1980's this started to change, with VCs withdrawing from their mentoring roles. Now VCs expect to see a solid management team in place before they will consider funding you. Angel Investors, those typically investing smaller sums in order to build up a company for later funding by VCs, are usually unable to do that sort of mentoring themselves or take on management roles. So this shift in the funding process leaves a gap in which a new style of organization has emerged that provides a model for what the space industry needs today.

The concept is called a "business accelerator". Originated by The Foundry in California for the medical technologies industry, a business accelerator is a for-profit company that becomes a temporary management team for new start-ups that the accelerator accepts as clients, provides some seed-funding, injects a dose of reality to the entrepreneur's business plan, and mentors the entrepreneur to additional rounds of funding, while teaching the entrepreneur the necessary skills to lead the start-up to success. These accelerators apparently have a 85-90% success rate. We at the CSCA believe this is exactly what the entrepreneurial space industry needs to foster new commercial space efforts. Over the next year, starting with our Accelerating Space Conference in January, we are looking to provide a forum to discuss its creation.

"...we are all on a steep learning curve, as entrepreneurs typically are, to develop skills in financing, marketing and the general administration of our businesses."

An International Space Business Accelerator would be funded by angels and VCs, and have a roster of experts from the business and academic worlds. In exchange for equity in the new start-up, the accelerator's roster of experts would decide which start-ups to join as a temporary management team for the 1 to 2 year mentorship phase. One person could be the CFO for several clients, for instance, since most start-ups wouldn't need full-time CFOs to begin with.

At the Accelerating Space Conference we gathered investors, entrepreneurial-minded academics, and business people with a successful career in management and/or finance in order to discuss the creation of an International Space Business Accelerator.

Speaking at the conference were:

o Burton Lee, co-founder of the Space Angels Network, discussing investing in space.

o Peter Evans, of the MaRS (Medical and Related Sciences) Discovery District, discussing business incubators and creating a management team.

o Directors of the CSCA leading discussion on the International Space Business Accelerator concept.

We have also invited additional speakers and hope to announce their participation soon.

If you are an investor, entrepreneur or entrepreneurial-minded academic or are just interested in what we are doing, please check our conference webpage at http://spacecommerce.ca/conference2008/

The Accelerating Space Conference is fortunate to have as a sponsor AstroKeys Inc., and we hope to add additional sponsors soon.

Rocky Persaud is Chair of the Canadian Space Commerce Association, and president of Interplanetary Expeditions Inc. (http://interplanetary.ca/)

International Sputnik Day: CSS made it a day to remember

Guy de Carufel

Toronto did not miss celebrating the 50th anniversary of the launch of Sputnik. At the Toronto Aerospace Museum, CSS made this day a day to remember. Pizza, hot coffee and talks on space, what more could you ask for?! The first speaker, Slavica Ceperkovic, presented wonderful imagery on space art. She showed that space is by no means limited to scientists and engineers, but rather that artists of all forms can use space as an inspiration for their creations.

The next speaker, Dr. Zelina Iskanderova, has lived through the hardships but also the glory of the USSR when it shocked the world with its amazing achievements. The First satellite, the first man in space, the first orbit around the moon… the list goes on and on. But with great victories also came great tragedies. Zelina described with passion how cosmonauts were admired as national heroes and how tragic it was when some were lost.

To complement Zelina's great account of the Russian's successes in space, filmmaker Michael Lennick showed an episode of "Rocket Science", where America's struggle to keep up with the Russians at the beginning of the Space Age brings you to the edge of your seat. Michael's account of the Space Age and his explanation on why he thinks Space was forgotten after the Apollo program was not only enlightening but also deeply tragic. For over 30 years man has not been able to pasts the Earth's orbit. After such accomplishments as walking on the moon, one can only wonder why the human race has lost curiosity for the vast worlds beyond our planet.

Sputnik is an event to remember. And Sputnik Night on the 4th of October showed how significant it was and inspired us to dream big and reach for the stars, as the Russians did in 1957.

Canadian Space Summit 2007 A Resounding Success!

John Thaler

The Canadian Space Summit is an annual event, hosted by the Canadian Space Society and organized by a different local space advocacy organization each year. The Summit is a long standing tradition of the CSS. Starting in Toronto in 2005 and continuing in Ottawa in 2006 the CSS introduced a new, much more ambitious gameplan for this unique event, including keynote presentations by leaders in space sciences and engineering, technical and general break-out sessions, group discussion periods, project presentations by student leaders and the union of as many national space advocacy organizations at one place and time as possible.

This year's Canadian Space Summit 2007, held at the University of Calgary on November 17-18, 2007, built on all those components. The Summit was a resounding success with over 65 participants attending the weekend long event. Six keynote speakers and over 14 individuals and groups were able to present their current activities, projects and research for the benefit of the rest of the Canadian space community. The topics covered by these presentations varied widely from astrophysics to analogue missions to satellite engineering to geophysics. This year's Summit highlighted western Canadian efforts in space research and exploration.

The Summit experience involved more than just listening to the fascinating speakers since participants were able to view interactive displays set up by the Calgary Space Worker's Society (CSW) and the University of Saskatchewan Space Design Team (USST). The CSW provided tours of their mobile lunar habitat module that has been designed and built entirely by volunteers and will soon find a permanent home in the Alberta badlands. The USST proudly displayed their space elevator climber that recently won first place at the 2007 Space Elevator Games held in Salt Lake City, Utah.

The Summit 2007 Optech Banquet was also a success with 50 people in attendance, providing a great opportunity for both networking and socializing. Optech Inc.'s Space Division Director Bob Richard's talk on the New Race to the Moon provided wonderful evening entertainment.

The annual general meetings of both the Mars Society Canada and SEDS-Canada (Students for the Exploration and Development of Space) were also held during the Summit and both groups dutifully elected their national executive boards and held planning sessions for the upcoming year. The Summit culminated with a meeting of the leaders of space advocacy groups including the Canadian Space Society, Calgary Space Worker's Society, Mars Society Canada, Calgary Space Frontier Society, SEDS-Canada and MDA (MacDonald, Dettwiler and Associates Ltd). This meeting allowed each group to present their current and future projects and provided a venue to work out future collaboration and cooperation. The meeting resulted in a cohesive action plan, a sharing of resources and ideas, and renewed communication between the groups.

This year's Summit could not have happened without the generous support of our sponsors: Optech Inc., the University of Calgary Physics and Astronomy Department, the University of Calgary Institute for Space Research, and the Calgary Space Worker's Society.

Stay tuned for future announcements regarding next year's Summit, currently planned to be held next November at McGill University in Montreal, QC.

Gazette Job Postings

Space Exhibit Staff (Toronto Aerospace Museum)

The Canadian Space Society is looking for additional CSS members to volunteer as staff to perform research and other regular duties as required for its growing space exhibit at the Toronto Aerospace Museum. We are looking for 10 enthusiastic individuals to install and maintain the artifacts in the exhibit as well as to perform background research for use as reading material to accompany the displays. This is an excellent opportunity to engage with senior professionals in the space industry while learning about the major players, both past and present. The minimum commitment for these positions is 2 hours per week for 6 months. At the end of the term you will receive a Certificate of Completion outlining skills that have been acquired. If you are interested in these positions, please contact the CSS's Networking Officer at network@css.ca.

Web Development Team (Canadian Space Society)

The Canadian Space Society is looking for volunteers to assist in the ongoing development and maintenance of its website. As Canada's national organization devoted to space exploration and technology development, the CSS's website plays a key role in the communication and cooperation between other space related groups. Those that work on the website will have the chance to have their work recognized at all levels of the space and technology fields across Canada and around the world. The ideal candidates will be self-motivated, work with little supervision and have some background in web development including MySQL (or similar) programming experience and experience with setting up web-based user accounts. The minimum commitment for these positions is 2 hours per week for 6 months. At the end of the term you will receive a Certificate of Completion outlining skills that have been acquired. If you are interested in these positions, please contact the CSS's External Director at external@css.ca.

Staff Writers, Canadian Space Gazette (Canadian Space Society)

The Canadian Space Society is looking for enthusiastic volunteers (CSS or other space organisation members) to report on the latest news in Canada's space industry, both at home and abroad. As a Gazette reporter you will have the unique opportunity to speak with leaders in the Canadian space community and find out the latest technological and scientific discoveries. The Canadian Space Gazette gets distributed across Canada and around the world, in industry and government. The minimum commitment for these positions is 2 hours per week for 6 months. At the end of the term you will receive a Certificate of Completion outlining skills that have been acquired. If you are interested in becoming a part of a dynamic and trend setting team, please contact the Gazette editor at editor@css.ca.

Engineering Strategies and Practice (University of Toronto)

All First Year Engineering students other than those in Engineering Science now take a course called Engineering Strategies and Practice (ESP). In the spring term a major element of the course is the development by teams of approximately five students of a solution to a problem posed by a real client. ESP attributes a great deal of its success to its involvement with our clients in the community who support and contribute to the learning experience. At the end of the term a client receives a faculty-supervised engineering design, including human/environmental impact assessment, cost assessment, etc. Clients also help our engineering students to engage in the social, cultural, ethical, political, and economic dimensions of an engineering project. We invite all alumni to consider participation in the course as clients for design projects during the 2008 spring term (January-April). Only 3 1/2 hours of your time is needed over the term.

If you decide to become a client, you start the process by submitting a problem. This might involve a facility, a process, or a device. Some problems that our students have worked on previously can be found in the Project Clients section of our website at www.ecf.utoronto.ca/~apsesp/. All projects should be submitted by November 30, 2007.

If you want to become a client for the coming spring term, please go to our website and complete the brief application form found in the Project Clients section. If you think that you might be interested in becoming a client but you have questions, please contact John Carter (416-946-5209 or john.carter@utoronto.ca). Finally, if you know of others that might be interested in participating, please pass the contact information on to them.

Looking for help with your space project? Post your company or group's positions here and get recognised!! The Canadian Space Gazette spans across Canada and through all levels of industry and government. Get your project on the fast track TODAY!

Contact editor@css.ca for more information.

SCISAT & the Ozone Layer

Marcia Hon

SCISAT-1 is a Canadian-led satellite with Dr. Peter F. Bernath of the Department of Chemistry, University of Waterloo, as lead. Launched on August 12, 2003, the goal of the satellite is to provide valuable data to investigate ozone layer depletion, climate change and their effects on Canada, especially our Arctic.

SCISAT-1 conducts the Atmospheric Chemistry Experiment (ACE) for remote sensing of the stratosphere and the upper troposphere. There are four main purposes to this mission:

1. To better understand the chemical and dynamical processes that control the distribution of ozone, especially in the Arctic

2. To study the relationship between atmospheric chemistry and climate change.

3. To study the effects of biomass burning in the free troposphere.

4. To measure aerosols and clouds to reduce the uncertainties in their effects on the global energy balance.

The team is most interested in ozone chemistry due to anthropogenic (human-caused) changes in the ozone. Such changes have led to increased amounts of ultraviolet radiation reaching the ground, which in turn generate climate change.

The satellite is composed of two major instruments. The first one is the infrared Fourier transform spectrometer (FTS) which measures the vertical distribution of trace gases, particles and temperature. The second is called MAESTRO (Measurement of Aerosol Extinction in the Stratosphere and Troposphere Retrieved by Occultation). Its purpose is to measure primarily ozone, nitrogen dioxide and aerosol/cloud extinction.

Raw data from SCISAT-1 is transmitted to ground using two Canadian ground stations augmented by a NASA station in Fairbanks, Alaska and a European station in Kiruna, Sweden. At optimum the downlink capacity is about 2 Gbyte/day.

The findings are thus far:

1. Anthropogenic release of chlorofluorocarbons (CFCs) affects the stratospheric ozone layer through gas phase chemical reactions such as the chlorine/chlorine monoxide (Cl/ClO) catalytic ozone-destruction cycle:

a. $Cl + O3 \ddagger ClO + O2$

b. $ClO + O \ddagger Cl + O2$

The ozone layer is also affected by heterogeneous chemistry on polar stratospheric clouds (PSCs). The CFCs are transported to the stratosphere, where they are broken apart by ultraviolet radiation to release "active" chlorine species, such as the chlorine atom. They destroy "odd oxygen" (O + O2).

The Antarctic ozone hole was discovered in 1985 by Joe Farman. This led to the realization that heterogeneous reactions are important in determining the ozone budget in polar regions.

It appears that heterogeneous reactions account for the severe ozone loss in the Antarctic spring. Springtime ozone depletion differs between Arctic and Antarctic because of differences in seasonal temperature extremes due to the atmospheric dynamics specific to the different topographies. The north is larger, less defined, warmer, and more stable than that of the south. The north is also more exposed to sunlight during the Arctic winter which increases the complexity of both its chemistry and physics. The ACE observations are in general agreement with these accepted chemical models for polar ozone loss, but some very recent data in the Arctic is not in accord with the model predictions.

2. Water is a crucial molecule in atmospheric chemistry and climate change. The long term trend for water in the stratosphere has been an increase of about 1% per year as noted by other researchers. ACE has found that this increase has stopped in recent years. Additionally, the measurements have provided evidence of the impact of the emission restrictions imposed by the Montreal Protocol banning the production of CFCs.

3. A major source of carbon dioxide, methane, nitrogen oxides, and other pollution emissions is biomass burning. Significantly, SCISAT-1 shows for the first time that atmospheric methanol can be detected from orbit in biomass burning plumes and at background levels. Methanol is the most important hydrocarbon in our atmosphere after methane and it is involved in the formation of tropospheric ozone.

SCISAT-1 is funded by the Natural Sciences and Engineering Research Council of Canada, the Canadian Space Agency, the Meteorological Service of Canada, and the Canadian Foundation for Climate and Atmospheric Sciences.

Book Reviews

The Lunar Exploration Scrapbook

Alexandra Mihai

In 1938 a committee of the British Interplanetary Society drew up the first serious plans for a manned lunar spacecraft. The BIS moon ship would be the first in a long line of designs that would ultimately lead to Tranquility Base and beyond. Working alongside engineers and scientists from Britain, Canada and Germany, the elite of American industrial engineers turned their attention to not only reaching the moon but to establishing a long-term presence there. Between 1958 and 1971 millions of man-hours and untold amounts of money were spent to try and create the hardware necessary to accomplish this unprecedented goal.

In this book, for the first time in one place, is a pictorial register of many of these incredible designs. A remarkable story of what might have happened if the mighty Saturn V rocket had not been relegated to the status of an historical footnote. In his latest book, The Lunar Exploration Scrapbook, editor and writer Robert Godwin has distilled years of research into an unprecedented look at the many machines considered by the United States for lunar exploration. Combining the blueprints of the 1950s and 1960s with modern computer graphics, Godwin has brought to life many of the past designs and experiments, and packed them all into one tightly woven package of colour and facts. The Lunar Exploration Scrapbook features colour texture-wrapped renderings of dozens of designs that never left the drawing board, creating a unique look at what might have happened if money had been no object, and humanity had gone to the moon to stay.

The Lunar Exploration Scrapbook is a full colour history of the golden era of lunar exploration. The book comprises over 200 3D wire-frame texture-mapped models of Lunar Vehicles. This includes over 80 different Lunar landers, over 80 lunar rovers and mobile laboratories (MOLAB), more than 50 lunar flying vehicles as well as sections on the Saturn and Nova rockets, lunar space suits, Command & Service module variants, LM laboratories and orbiters, training vehicles, lunar walkers and lunar shelters.

Altogether over 750 colour pictures of designs for lunar exploration vehicles, from NASA, Boeing, Lockheed, Grumman, USAF, US Army, GE, Chrysler, North American Rockwell, Bell Aerospace, Martin, Bendix and more.

From single-seat landers to rocket backpacks and lunar bulldozers, this study takes readers into the imagination of the world's top aerospace engineers by presenting NASA's lunar spacecraft research. A unique blend of history and imagination, this resource covers not only the actual exploration of the moon conducted during the Apollo program of the 1960s and 1970s, but also includes a presentation of dozens of spacecraft that were never built. Vivid, colourful renderings of the conceptual crafts—many of which are not available anywhere else—are also included, providing a visual progression of NASA's technological advancements.

Author Robert Godwin is the founder of Collector's Guide Publishing. In 1984 Godwin wrote The Illustrated Led Zeppelin Collection. Books he authored or edited between 1987 and 2007 include Apollo 11: First Men on the Moon, Project Apollo: The Test Program, Project Apollo: Exploring the Moon, Mars: The NASA Mission Reports, Russian Spacecraft, and Space Shuttle Pocket Space Guide. In 2005 Godwin co-authored Saturn with Alan Lawrie. The book won the Sir Arthur Clarke award for Best Presentation Written in 2006. In 1998, at the invitation of astronaut Buzz Aldrin, Godwin began his imprint Apogee Books. Between 1998 and 2007 Apogee Books published almost 100 book titles about space flight with contributions from Buzz Aldrin, Sir Arthur C. Clarke, Tom Hanks, Ron Howard, David R. Scott, Harrison Schmitt and Wernher von Braun. He also produced and directed the 2002 direct-to-DVD Apollo 11 - Moonwalk which featured the first ever time-synchronized multiple-camera-angle movie of the first moonwalk and moon landing. Godwin has consulted on the Discovery Channel TV series Rocket Science and in 2007 Mars Rising.

In the Shadow of the Moon

Sandy Chan

From a production viewpoint, it was successful in many ways. For space advocates, it satisfied their curiosity with never before seen footage; for the non-space fanatics, the personalities coming from the interviews were just the right doze for that necessary human touch; for those who remember that time, it was yet another chance to relive the buzz; and for those who grew up not questioning space travels, it could act as an eye-opener to the wonders of science and technology, and a chance for them to see how far the human race had come.

However, at the same time, watching the documentary and seeing that all we can do is find men already in their retirement to reminisce about glories of the past, one cannot help but be left with somewhat of an emptiness inside wondering what has happened to space sciences and exploration.

It would be unfair to say that aerospace has not advanced significantly since moon missions. But I cannot recall any other events that have marked history in such a triumphant way. Was it the science that made it so significant? Or the political victory that granted them their glory? Perhaps it was the union of science and technology with humanity that gave it that special sentimentality? Whatever it was, nothing in astronomical history seemed to be able to surpass it.

While watching the documentary, I could not help but notice the irony that perhaps aerospace science and technology has also stayed "in the shadow of the moon". As activists and innovators in aerospace, or even as individual human beings, it is great that we can remember and recognise how science has developed and progressed, but at the same time, we must be spurred on by the past to look ahead, to consider the essence which made these discoveries and developments so worthy of our respect and awe, and how we can be encouraged to not lose sight of that as we move forward.