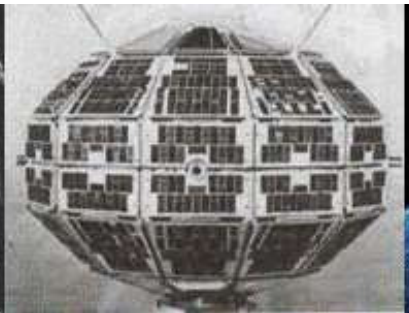
Submission to the Aerospace Review
Part 2 of 3

Using Tools from the Mining Industry to Spur Innovation and Grow the Canadian Space Industry.

This submission prepared pursuant to the submissions request of the
Canadian Federal Aerospace Review 2012,
Review Head: David Emerson

Canadian Space Commerce Association
Chuck Black, Treasurer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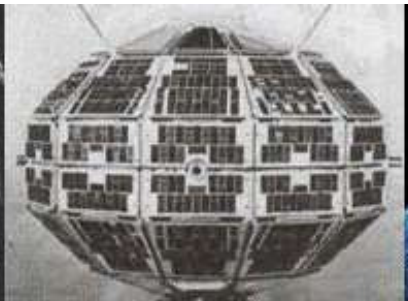
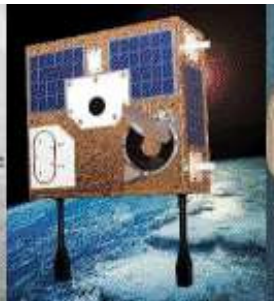



1. Summary of 2nd Set of CSCA Recommendations to the Aerospace Review

Canada has unparalleled expertise in all areas of terrestrial mining and this expertise has been developed through a national tax and legal infrastructure which helps to fund new start-ups and grow existing players.

This expertise is often promoted by the Federal Government during international events such as the recent Sixth Summit of the America's (http://www.summit-americas.org/sixthsummit.htm), which was covered in the April 14th, 2012 National Post article "*Stephen Harper touts Canada's mining industry as Americas summit gets off to rocky start*" at http://news.nationalpost.com/2012/04/14/stephen-harper-touts-canadas-mining-industry-as-americas-summit-gets-off-to-rocky-start/.

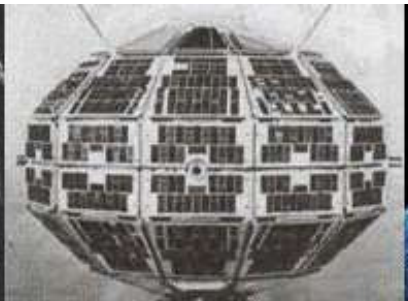
The Canadian Space Commerce Association (http://spacecommerce.ca/), a registered not-for-profit industry organization existing to advance the economic, legal and political environment for Canadian space focused companies, believes that a similar tax and legal framework would allow our indigenous space sector to self fund exploration, innovation and development in the very same way that those equivalent terrestrial functions are currently self funded in the Canadian mining industry.

To that end, the CSCA makes two specific recommendations to the Aerospace Review:

1. **Canadian companies engaging in extraterrestrial resource development should be granted all tax and other benefits now granted to them in their terrestrial exploration and development activities.**

   This recommendation is specifically designed to address the tax infrastructure needed for firms to self finance exploration, innovation and extraterrestrial development by allowing them to do so the very same way that those functions are currently funded by existing mining companies.

2. **The Federal government should create provisions in Canadian law for clear, transferable title to extraterrestrial mining claims and returned resources and work to negotiate international agreements to the same effect.**


This recommendation is specifically designed to address the legal requirements needed to develop extraterrestrial resources and encourage access to development capital for the space industry by allowing space companies to do this in the very same way as existing mining companies currently fund terrestrial exploration and development.

Section 1.1 of this document discusses the details of the first recommendation and Section 1.2 discusses the details of the second recommendation.

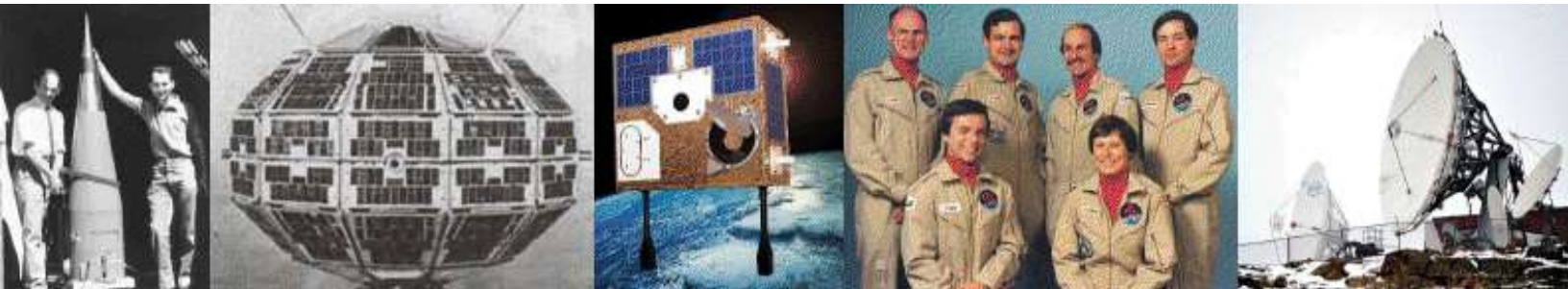
Section 2.0 and subsequent sections of this document provide supporting documentation for both recommendations and offer suggestions for further reading.

1.1. Recommendation 1: Canadian companies engaging in extraterrestrial resource development should be granted all tax and other benefits now granted to them in their terrestrial exploration and development activities

This recommendation is specifically designed to address the tax infrastructure needed for firms to self finance exploration, innovation and extraterrestrial development by allowing them to do so in the very same way that those functions are currently funded by existing mining companies.

The idea of using existing mining industry tax code regulations to jump-start innovation in other industries is not a new idea and is often brought up in discussions relating to specific industries like information technology, where it is currently advocated by organizations such as the Conference Board of Canada (http://www.conferenceboard.ca/).

The idea is also often brought up in more general discussions relating to regional economic development (such as the December 2009 report on "*Using Flow-Through Shares to Stimulate Innovation Companies in Canada: A Research Project Presented to the Greater Saskatoon Chamber of Commerce,*" which is available online at http://www.saskatoonchamber.com/file/Newsroom/Research_Papers/2009/Flow_Through_Share.pdf).



1.1.1. Similarities Between the Mining Industry and Space Activities

Space mining has long been the subject of speculation.

But until recently, commercial interest was confined largely to mining-equipment companies using it as a promotional tool (having noticed that the same equipment used for mining on Earth would work, with modifications, pretty much anywhere else in the solar system).

For example, this 2007 Universe Today post "*Heavy Construction on the Moon,*" was essentially a promotion for Caterpillar, the worlds leading manufacturer of construction and mining equipment (http://www.universetoday.com/12234/heavy-construction-on-the-moon/).

Over time, mining and resource companies started coming into more direct contact with space based activities through their use of earth imaging satellites and technology to assist with resource location and development activities.

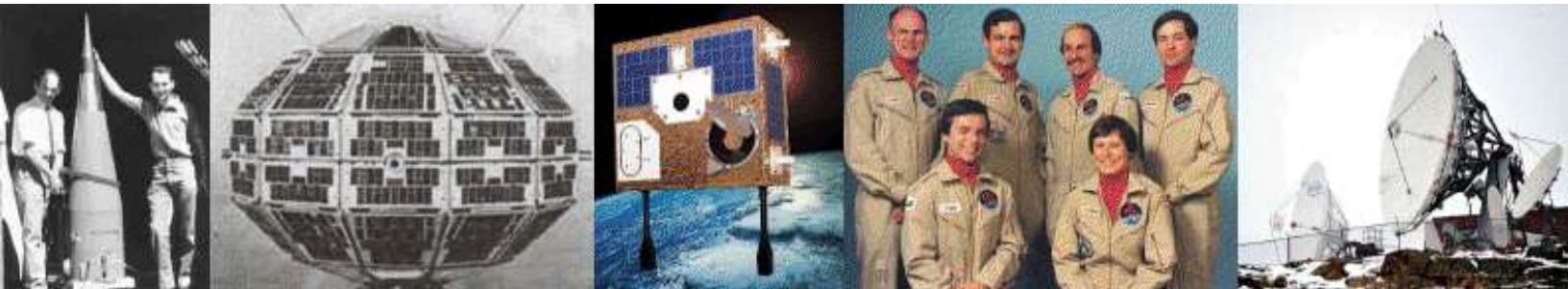
At some point, they even began supporting cooperative ventures like the Northern Centre for Advanced Technology or NORCAT (http://www.norcat.org/), a not-for-profit, non-share incorporated company located in Sudbury, Ontario which provides specialized mine training, occupational health and safety services and develops mining technology for both terrestrial and space missions.

Eventually all this cross-pollination got the space gurus and the mining geniuses talking about commonalities and several concluded that the industries are quite similar, with both being highly speculative and requiring large amounts of money up-front for a potential return on investment that could take decades to materialize.

As well, since mining companies often depend on tax credits to fund their activities, they normally have quite a few accountants on the payroll and some of the brighter accountants started thinking that there was essentially no good reason why space focused companies can't use the same tax credits that mining companies use to raise money, just so long as mining eventually ends up occurring somewhere.

1.1.2. A 2005 Paper on the “Historical Investment Financing of Explorations”

The first peer reviewed paper to make an explicit, demonstrated and causal connection between mining, exploration in general and space activities in particular



was the 2005 paper "*Historical Investment Financing of Exploration for New Worlds, Current Analogies to Other Industries, and Ideas for the Future*" (http://evainterviews.wordpress.com/about/evas-conference-papers-and-presentations/paper-investment-financing-of-exploration-to-new-worlds/) which was presented at the 7th International Lunar Conference (http://sci.esa.int/science-e/www/object/index.cfm?fobjectid=43268) in September 2005 and then revised for a second presentation at the 25th Annual International Space Development Conference (http://isdc.nss.org/2006/) in May 2006.

Authored by Canadian investment banker Eva-Jane Lark (http://evainterviews.wordpress.com/about/bio-eva-jane-lark-eva/), the paper looked at how exploration has historically been funded and concluded that extensive exploration activities naturally followed from businesses focused on mining and resource collection.

According to Lark:

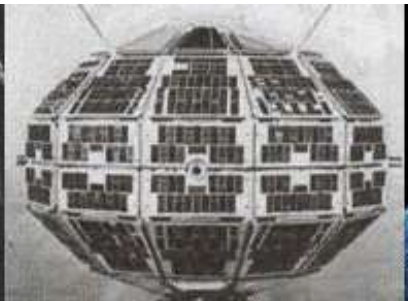
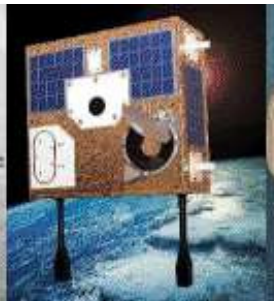
> *There are many similarities between mining (or oil/gas) exploration and space or lunar exploration. Other than scientific motivations and perhaps tourism, the search for natural resources may be one of the key commercial motivators in establishing a permanent human presence there.*

She goes on to state that:

> *In Canada, federal and provincial tax incentives are often available to encourage exploration. This is because there are major benefits to society, particularly to the infrastructure development of, and employment opportunities for the residents of, rural and remote communities. Mining has been responsible for the founding and continued existence of many Northern communities. It could easily form the basis for communities on other worlds as well. Incidentally, mining has also been a major user of technologies developed by the Space industry such as GPS, satellite phone communications and small plane technologies.*

She states that mining companies have one further point in common with historic explorers and current space advocates. In essence, all three groups are selling a dream, which will likely not come true for everyone.

However, with the proper tax infrastructure (such as is currently in place in Canada) the dream could come true for enough people to build a large and very profitable industry. According to Lark:

Junior exploration companies that explore for new mines are often selling a dream. Usually these are companies with few assets but some key people, land to explore and an idea (which is a structure very similar to all but the largest Canadian space companies).

Canadians, as a whole, perhaps because of our resource heritage, are more likely to gamble on a penny mining company than finance a high-tech company out of someone's garage. Usually these types of mining companies are very inexpensive (per share – resulting in the term "penny" mining stocks to describe many juniors) but the reward, if ore is discovered, is substantial.

(Under the present Canadian tax provisions) mining companies have raised almost twice as much equity capital on the TSX (Toronto Stock Exchange) and TSX Venture exchanges in Canada as on any other major exchange in the world.

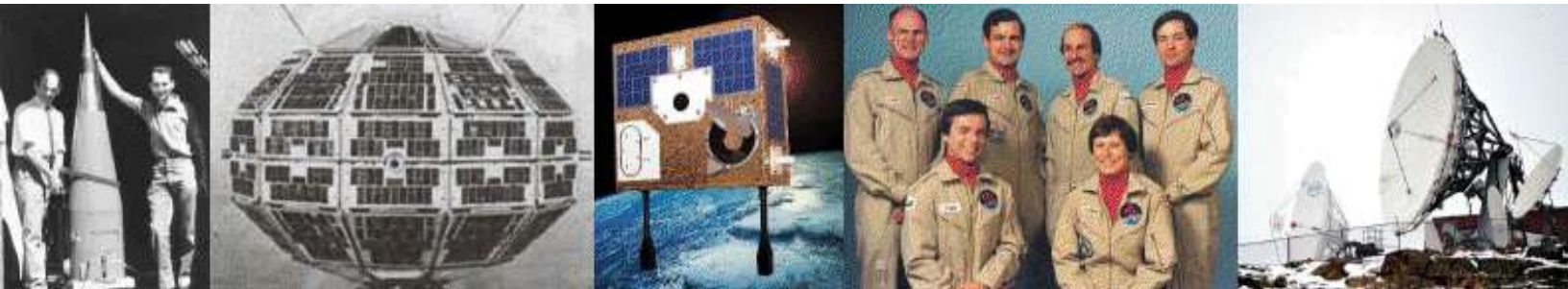
1.1.3. The 2008 Paper on "Creating a Robust Canadian Space Research and Development Industry"

The 2008 paper titled "*Creating A Robust Canadian Space Research Exploration & Development Industry - The Canadian Mineral Industry Flow-Though Share Analog,"* available online at http://mining.ubc.ca/faculty/meech/MINE290/space%20financing%20-%20flow-through%20shares.pdf makes explicit the causal connections between the successful Canadian mining industry and specific Canadian tax code provisions.

The paper, written by retired Canadian mining executive John Chapman (profiled at http://acuriousguy.blogspot.ca/2009/11/preparing-for-next-great-gold-rush.html) plus three employees from iconic Canadian space company MacDonald Dettwiler and Associates (Nadeem Ghafoor, Christian Sallaberger and Frank Teti), was first presented by Frank Teti at the 2008 Canadian Space Summit (http://spacecommerce.ca/wp-content/uploads/2008/11/2008-canadian-space_summit_program.pdf).

According to the paper:

Financing of space research, exploration and development in the past has been mainly by governments. To create a vibrant and sustainable space program, the



private sector needs to be aggressively involved, building upon the foundation established mainly by the USA and Soviet Union governments.

There is an analog that could point the way to rapidly opening space to private enterprise – that is the Canadian flow-through tax incentive for mineral exploration. The flow-through tax credit program in Canada has facilitated the raising of billions of dollars annually by mineral exploration companies, mainly from wealthy individuals, and this has kept Canada in the forefront of world mineral exploration and mine development.

In addition, Canada has, through this tax incentive, developed a large base of experts in science, technology, legal, accounting, finance, etc. for mineral exploration and mine development world wide.

The paper goes on to state:

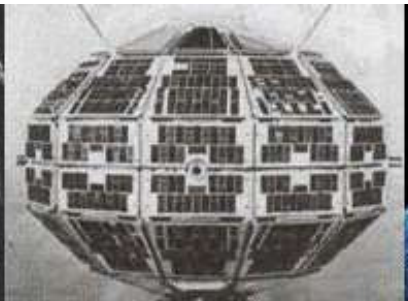
Canada continues to be the foremost destination for exploration capital globally. In 2004, some 20% of the mineral exploration programs planned by the world's mining companies were expected to be conducted in Canada. As for Canadian companies, they were expected to undertake 43% of all the exploration programs in the world in 2004, a share that is by far the largest of the global mineral exploration market.

In 2003, C$12.7 billion in equity financing was raised for mineral exploration and development projects around the world. More than 45% of the new funds were raised by companies listed on Canadian stock exchanges.

These are amazing statistics as Canada represents only 7% of the land area on Earth and only 0.5% of the world's population.

The remainder of the paper provides details on the applicable tax credits and how they can be used to build the Canadian space industry to "*create a whole new class of industries and capabilities in Canada*" without the need for any new Federal government funding or additional budget allocations in much the same way as happened with the Canadian mining industry.

Since this new class of industries does not yet exist in Canada and hence is not paying taxes yet, giving it favorable tax treatment will not reduce today's government revenues. This makes this change *'revenue neutral'* for the Federal government.


Establishing a Canadian lead in this area can be expected to eventually provide major new tax revenue for the Federal government, just as it did with the mining industry."

The new industries developed under the revised tax code will also allow Canadian companies to assist with fulfilling Industry Canada mandates on Canadian science and technology (S&T) such as the 2007 Mobilizing Science and Technology to Canada's Advantage report (http://www.ic.gc.ca/eic/site/ic1.nsf/eng/00861.html) and the 2009 Mobilizing Science and Technology to Canada's Advantage Progress Report (http://www.ic.gc.ca/eic/site/ic1.nsf/eng/00861.html).

1.1.4. Conclusions Regarding Recommendation 1

Canada continues to be the foremost destination for exploration capital globally, in large part because of an existing tax infrastructure which supports high-risk mining activities.

The idea of using existing mining industry tax code regulations to jump-start innovation in other industries is not a new idea and is often brought up in discussions relating to specific industries.

There are explicit, demonstrated and causal connections/ correlations between mining, exploration in general and space activities in particular. These include:

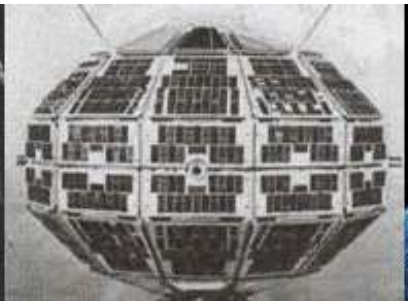
- Similarities in the business models used to fund terrestrial mining activities and extraterrestrial space activities (both which are perceived of as being high risk, with high up-front costs and with a return on investment requiring decades).

- The common focus on exploration first and then development.

- The common requirement to utilize high technology robotics, innovative sensor technology and the variety of life support tools required to keep people alive in extreme environments.

Mining companies recognize this and already collaborate with space companies in a variety of areas.

Canadian companies engaging in extraterrestrial resource development, if granted all tax and other benefits now granted to them in their terrestrial exploration and


development activities would likely "*create a whole new class of industries and capabilities in Canada*" without the need for any new funding or additional budget allocations in much the same way as happened with the Canadian mining industry.

CSCA advocates this approach.

1.2. Recommendation 2: The government should create provisions in Canadian law for clear and transferable title to extraterrestrial mining claims and returned resources, and work to negotiate international agreements to the same effect

This recommendation is specifically designed to address the legal requirements needed to develop extraterrestrial resources and encourage access to development capital for the space industry by allowing space companies to do so in the very same way as existing mining companies currently fund terrestrial exploration and development.

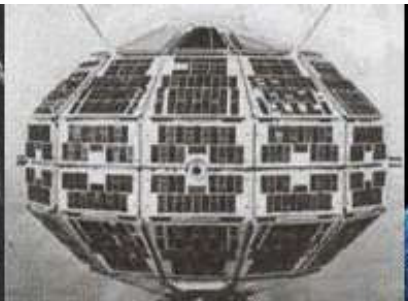
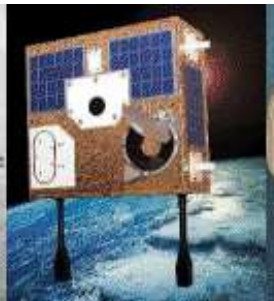
Its worth noting that Canadians are blessed with a unique and world renowned Institute of Space Law at McGill University (http://www.mcgill.ca/iasl/) that could assist greatly with any effort relating to the implementation and revision of national and international issues relating to "*space*" law.

1.2.1. The 1967 United Nations Outer Space Treaty

As outlined by space advocate Daniel Faber in the February 5th, 2010 Commercial Space post "*Feedback on "The Men Who've Sold the Moon*"" at http://acuriousguy.blogspot.ca/2010/02/feedback-on-men-whove-sold-moon.html, a great many people have attempted to buy, sell and/ or claim portions of the Moon and other extraterrestrial bodies.

However, no one has so far succeeded in making any specific claim stick.

This is mostly due to the terms of the 1967 United Nations Outer Space Treaty (http://www.oosa.unvienna.org/oosa/SpaceLaw/outerspt.html), which defines extraterrestrial bodies as belonging to "*everyone and no-one*" and provides the UN with the legitimacy to require any nation to defend its "*rights*" as defined in the treaty through UN sanctioned international courts.

According to Faber, who is essentially paraphrasing author Virgiliu Pop from his book "*Who Owns the Moon?: Extraterrestrial Aspects of Land and Mineral Resources Ownership*" available online at (http://www.amazon.com/Who-Owns-Moon-Extraterrestrial-Regulations/dp/1402091346), anything extracted from the moon (or any other extraterrestrial body) under the Outer Space Treaty, such as rocks or minerals is treated like "*fish from the sea*" under current terrestrial law of the sea regulations and becomes the property of whoever extracts them under the terms of the Outer Space Treaty.

> *So you can mine indeed the moon. You can operate a business. You can own your equipment and the things you extract - just not the real estate itself.*

However, you can't currently make an advanced claim to anything you hope to extract and have that claim protected in national or international courts. Therefore, under the Outer Space Treaty, private investors cannot secure title for exploration and extraction to the property being explored.

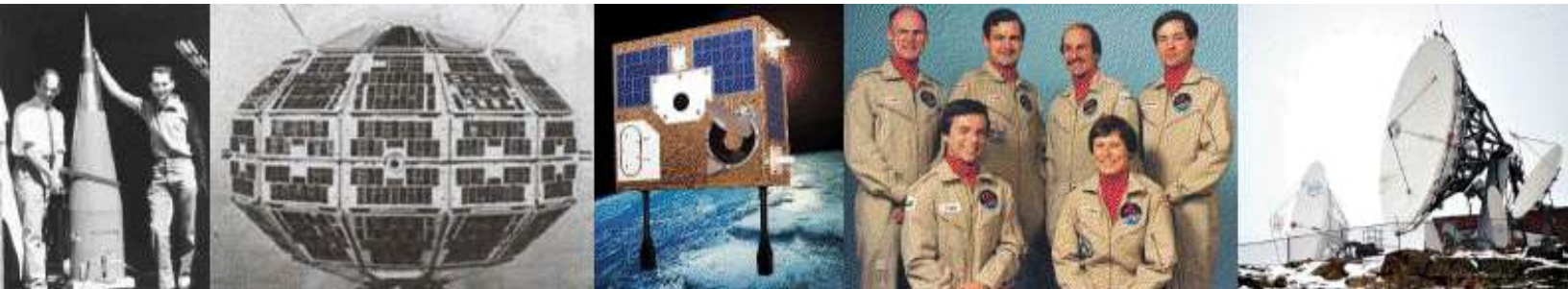
This is essentially a reasonable and common (although not universal) interpretation of the Outer Space Treaty in that it only prohibits territorial claims and not private property in outer space.

This is also the model used by the satellite industry, which places privately owned telecommunications, Earth imaging and other types of satellites in specific orbits for specific uses.

Of course, this interpretation is also contrary to the current law of the sea treaties and regulations (which allow for secure title under specified conditions relating to access and utilization) as outlined by Eric A. Posner and Alan O. Sykes in their December 2009 paper "*Economic Foundations of the Law of the Sea*" available online from the University of Chicago Law School website at (http://www.law.uchicago.edu/files/file/504-eap-sea.pdf).

This oversight (whether intentional or not) of the Outer Space Treaty means that any sort of venture fund raising for space focused mining activities, which uses a secure title as collateral for fund raising, is completely out of the question.

According to Faber:



> *…if you wish to raise a couple of hundred million dollars to characterize an ore body on the moon and prepare a mine plan (not an unusual price for such activities on the earth, before starting to construct a mine), you have no guarantee that someone will not jump in and build a mine on that spot while you are still trying to raise the necessary billion dollars or so to build your own mine.*
>
> *You can't hide something on that scale - everyone will know where the riches are.*
>
> *The usurper's business plan will look much better than yours, having saved those hundreds of millions of exploration costs. If I were an investor I know where I would put my money, and no court in the world could help you.*
>
> *The result is that you will never get the hundreds of millions for the initial exploration.*

While there are signatories to the treaty who would argue that private property is also outlawed under the treaty, the current ambiguity, even under the more optimistic interpretation (which simply makes it unprofitable for most private organizations to explore and develop space rather than illegal) seems more than sufficient to restrict most space exploration and development initiatives to government funded organizations.

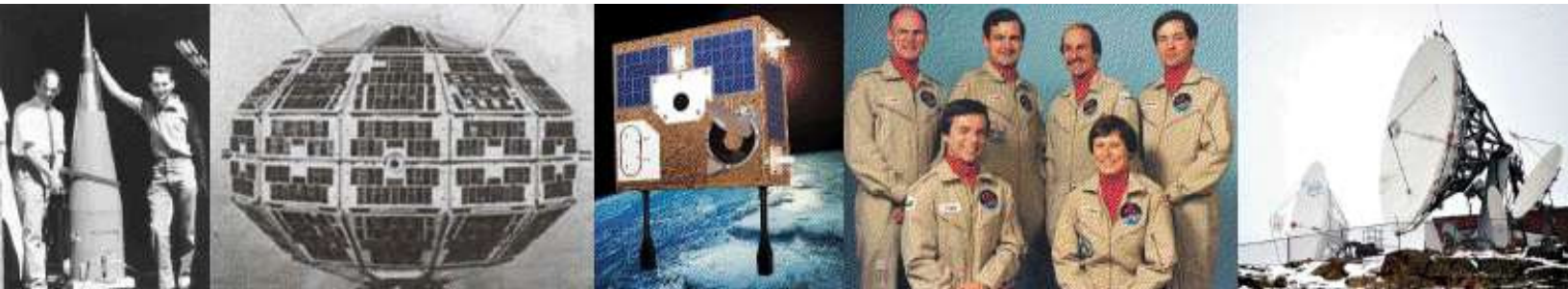
Therefore, any tax code revisions based on the current Canadian provisions covering the mining industry will be of limited benefit to the Canadian space systems industry without the development of an explicit legal re-interpretation of international treaties like the 1967 Outer Space Treaty.

1.2.2. Rand Simberg

As stated in the previous section, any tax code revisions based on the current Canadian provisions covering the mining industry will be of limited benefit to the Canadian space systems industry without the development of an explicit legal re-interpretation of international treaties like the 1967 Outer Space Treaty.

Fortunately there is a person who has worked through the details.

As described in the April 2nd posting titled "*Homesteading the Final Frontier*" on the Competitive Enterprise Institute website (http://cei.org/issue-analysis/homesteading-final-frontier), author Rand Simberg (an aerospace engineer



and an adjunct scholar at the institute) believes that the real solution to space access is a question of legislation and not of technology.

According to Simberg, three actions need to be taken:

- First of all, the 1967 Outer Space Treaty needs to be formally re-interpreted at the national level by the Federal government as only prohibiting declarations of national sovereignty and not as prohibiting ownership of land and mineral rights in outer space. This is already a plausible, although not yet widespread interpretation of the treaty as outlined in Section 1.2.1 of this document, under the title "*The 1967 United Nations Outer Space Treaty*."

- Secondly, a new federal law needs to be passed to provide national recognition of land and property claims off-planet under specified conditions relating to access and utilization (in much the same way as the current law of the sea treaties and regulations). This would allow the use of the property claimed for loan collateral or as an asset to be sold to raise the funds needed for development in much the same way that funds are currently raised for mining exploration. The legal specifics of the claims process could even be taken from the existing mining legislation as it covers land claims.

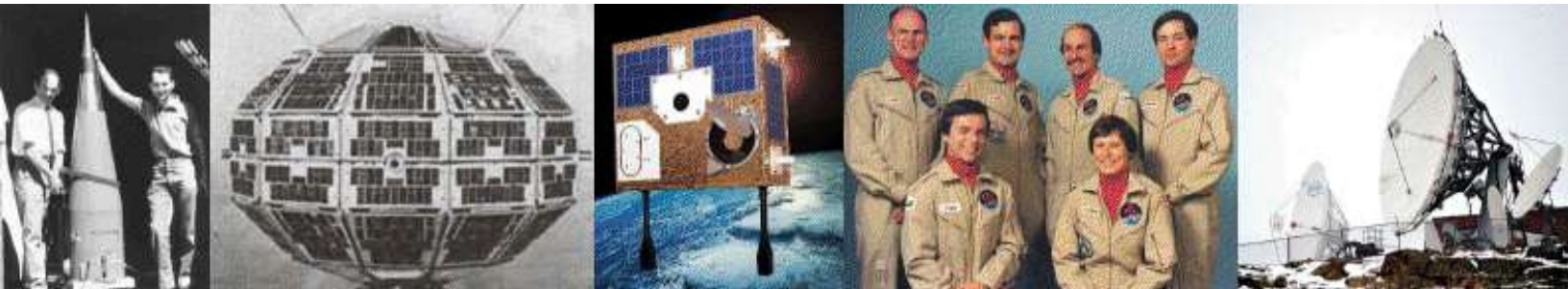
- And finally, the Federal government should initiate international negotiations with the long-term goal of revising the treaty's wording to clearly favor this revised interpretation.

Of course, Simberg's recommendations have ignited a storm of controversy among international legal experts and outer space advocates, some of whom contest his claims in much the same way as they would contest the claims of any other legal debate.

But the key here is to note that Simberg advocates federal actions which can be taken by virtually any national government, which make his solutions quite appropriate with the current Canadian context and the mandate of the Aerospace Review.

1.2.3. Conclusions Regarding Recommendation 2

Under the terms of the 1967 Outer Space Treaty, private investors cannot secure title for exploration and extraction to the property being explored and are therefore



restricted in their ability to raise private funds in the manner normally utilized by terrestrial resource companies.

While there are signatories to the 1967 Outer Space Treaty who would argue that private property is also outlawed under the treaty, the current ambiguity, even under the more optimistic interpretation of the treaty (which simply makes it unprofitable for most private organizations to explore and develop space) seems more than sufficient to limit space exploration and development initiatives to government funded organizations.

Therefore, simple tax code revisions based on the current Canadian provisions covering the mining industry will not immediately assist the Canadian space systems industry without the development of an explicit legal re-interpretation of international treaties like the 1967 Outer Space Treaty.

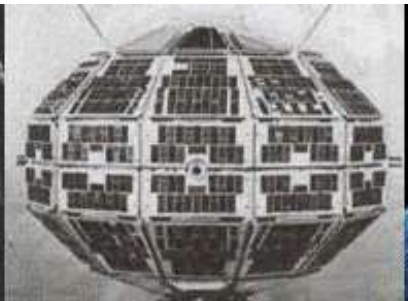
Author Rand Simberg advocates three specific federal actions which can be taken by virtually any national government which would address this requirement for a legal re-interpretation:

- First of all, the 1967 Outer Space Treaty needs to be formally re-interpreted at the national level by the Federal government as only prohibiting declarations of national sovereignty and not as prohibiting ownership of land and mineral rights in outer space. This is already a plausible, although not yet widespread interpretation of the treaty as outlined in Section 1.2.1 of this document, under the title "*The 1967 United Nations Outer Space Treaty*."

- Secondly, a new federal law needs to be passed to provide national recognition of land and property claims off-planet under specified conditions relating to access and utilization (in much the same way as the current law of the sea treaties and regulations). This would allow the use of the property claimed for loan collateral or as an asset to be sold to raise the funds needed for development in much the same way that funds are currently raised for mining exploration. The legal specifics of the claims process could even be taken from the existing mining legislation as it covers land claims.

- And finally, the Federal government should initiate international negotiations with the long-term goal of revising the treaty's wording to clearly favor this revised interpretation.

CSCA advocates this approach


2. Supporting Documentation

2.1. Size and Employment Statistics for the International and Canadian Space Sectors

Approximately 14,000 government and private organizations are considered as part of the international space industry, according to the 2011 Space Report (http://www.thespacereport.org/files/The_Space_Report_2011_exec_summary.pdf).

Theses organizations generated $276.52 Billion USD last year and employ over 300,000 people throughout the world.

Of course, the Canadian industry is presently much smaller.

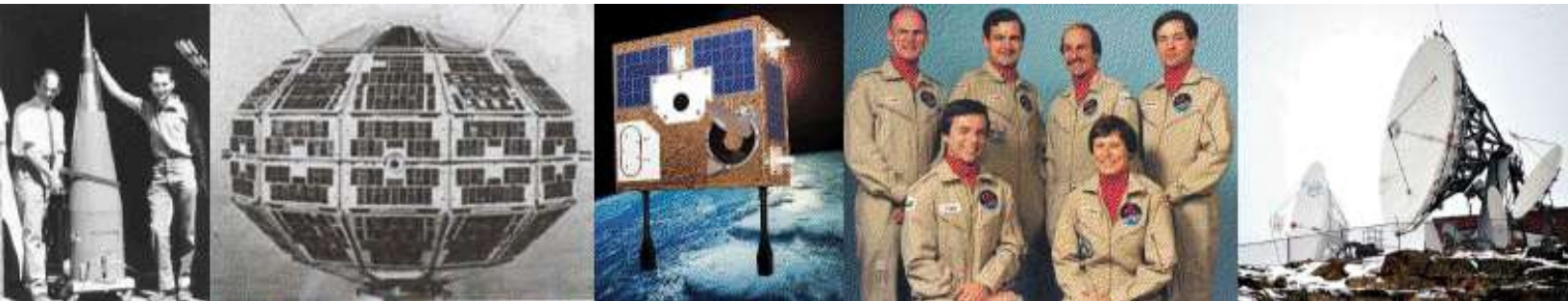
The 140 companies and organizations listed in the Canadian Space Directory (http://www5.asc-csa.gc.ca/eng/industry/csd.asp) generated $3.44 billion CDN in revenue and employed over 8000 Canadians in 2010, according to the 2010 State of the Canadian Space Sector Report (http://www.asc-csa.gc.ca/eng/industry/state.asp).

Over the last five years, total revenues generated by the Canadian space sector have increased by 38% which is comparable to the 41% increase reported by the Space Report for the larger, international market.

As outlined in Section 1 of this document under the title "*Summary of CSCA Recommendations to the Aerospace Review,"* the CSCA recommendations are designed specifically to insure that private investment money going to support the international space industry ends up in Canada to build Canadian industry and create Canadian jobs.

2.2. Four Short Investment Stories from the Canadian Space Industry

Here are four short, perhaps even anecdotal stories indicating the scope of investment money available for development in the international space industry as described in the Space Report.

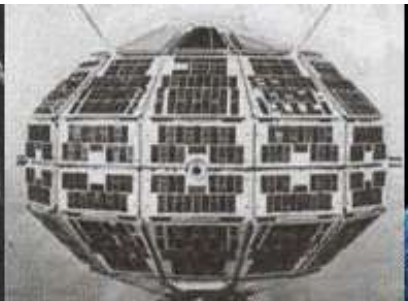


These stories suggest that most of the international investment money going into the industry isn't going to end up in Canada without changes being made.

1. The June 26th, 2012 announcement by BC based MacDonald Dettwiler and Associates (http://www.mdacorporation.com/corporate/news/) of the intent to acquire 100% of Space Systems/Loral, Inc. for US$875 million in order to open up the US commercial market and provide new markets for its Canadarm based on-orbit satellite servicing technology plus move the company away from the current reliance on government contracts (as described at http://acuriousguy.blogspot.ca/2012/06/macdonald-dettwiler-buys-space-systems.html). This suggests that the expanded company, currently the prime contractor for RADARSAT Constellation (http://en.wikipedia.org/wiki/RADARSAT_Constellation) and the iconic Canadarm (http://www.thecanadianencyclopedia.com/articles/canadarm), will slowly move the existing Canadian based space systems infrastructure and manufacturing capabilities into the Palo Alto based Space Systems/Loral facilities over the next few years in much the same way as the unmanned aerial vehicle services (http://www.uavs.ca/) migrated to Australia when Canadian government contracts dried up in 2010.

2. Given the recent successes of US based Space Exploration Technologies (http://www.spacex.com/) with the independent private development of a whole series of orbital launch vehicles (as described at http://en.wikipedia.org/wiki/Falcon_%28rocket_family%29) for far less cost than typical for wholly government funded projects, it's important to note that SpaceX CEO Elon Musk (http://en.wikipedia.org/wiki/Elon_Musk) is South African born; his mother is Canadian and he is a naturalized US citizen who could certainly have located his businesses in Canada (or anywhere else), given the appropriate local support and business environment.

3. The April 24th, 2012 announcement by Planetary Resources Incorporated (http://en.wikipedia.org/wiki/Planetary_Resources), a US based mining company backed by major financiers such as Canadian film director James Cameron (http://en.wikipedia.org/wiki/James_Cameron), of a multi-year plan to inventory and eventually mine asteroid resources suggests strongly that others already recognize the natural synergy and business cycle similarities between the space and mining industries. Other investors in the company include Google co-founder Larry Paige, executive chairman Eric Schmidt and investor and board member Kavitark Ram Shriram, internet entrepreneur/ astronaut Charles Simonyi and Henry Ross Perot, Jr., the chairman of the


board of Perot Systems. Of course, individual Canadian investors like Cameron and his international colleagues who understand the concepts behind these new types of businesses are currently investing where the business environment supports their business activities.

4. Even Canadian born serial space entrepreneur Dr. Robert Richards (http://robertdrichards.com/id4.html), the former Optech International Director, the co-founder of the International Space University (along with Planetary Resources Co-Founder Peter H. Diamandis) and current Google Lunar X PRIZE competitor Moon Express, Inc. has decided that it's more useful to become an American citizen and build American companies. According to the December 29th, 2010 Spaceref.ca article "*This Week in Space for Canada (*online at http://spaceref.ca/this-week-in-space-for-canada/this-week-in-space-for-canada-34.htm)," the good Canadian doctor immigrated to the US because "*Canada was not a good place to build a commercial space company*."

As outlined in Section 1 of this document under the title "*Summary of CSCA Recommendations to the Aerospace Review,"* the CSCA recommendations are designed specifically to insure that private investment money going to support the international space industry ends up in Canada to build Canadian industry and create Canadian jobs.

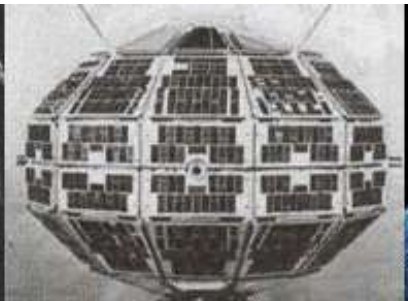
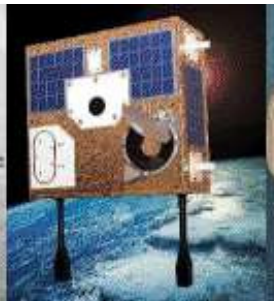
2.3. Why Not Build Planetary Resources a NEOSSAT?

Here's an article, originally posted on May 7th, 2012 (http://acuriousguy.blogspot.ca/2012/05/why-not-build-planetary-resources.html) which gives some idea of the current Canadian technology available and what we could be doing with it, given the correct business environment.

Why Not Build Planetary Resources a NEOSSAT?

The mass media, in their rush to judgment over the current financial state of the Canadian Space Agency (CSA) and the ongoing confusion over recent proposals from the billionaire backed Planetary Resources (PR) to mine the asteroids, seems to have completely forgotten how very well positioned Canada is to take advantage of this new entrepreneurial environment.

First of all, we already have what is arguably the best tax code in the world for

terrestrial mining operations. As outlined in my June 20th, 2010 post "*Mining as a Model for the Commercial Space Industry*" it would take only a very few legislative changes plus the reassessment of only one international treaty (the 1967 Outer Space Treaty, as per my April 7th, 2012 post "*Do Current Laws Support Private Space Activities?")* to make Canada the best place in the world to set up a "*space*" mining company.

But Canada also has at least two examples of the technology required for the proposed Arkyd 101, or Leo Space telescope, which PR promotes as being the core of its "*phase-1*" plan to first inventory and then mine near Earth asteroids for water and various metals.

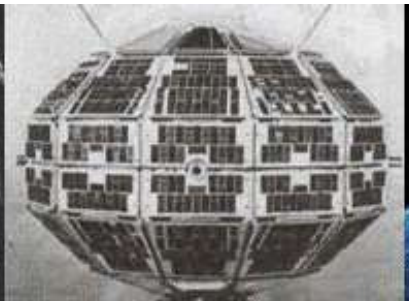
Those two examples are the Micro-variability and Oscillations of STars (MOST) space telescope and the Near Earth Object Surveillance Satellite (NEOSSat).

According to the May 6th, 2012 post on the HobbySpace website titled "*Planetary Resources Arkyd 101 - not the first smallsat asteroid finder*" at http://hobbyspace.com/nucleus/index.php?itemid=37658, the Canadian MOST micro-satellite (which has been in orbit since 2003) also uses a small telescope for stellar photometry. Although it uses only a 15-cm aperture for its telescope, the MOST is able (through the use of four reaction wheels, devices which aim a spacecraft in different directions without firing rockets or jets) to achieve a pointing error of less than one arc-second, which is the level of accuracy listed as being required for the LEO space telescope to effectively search for near Earth asteroids.

Of course, MOST is designed to monitor variations in star light and doesn't officially look for asteroids.

However, NEOSSat, based around the same 15-cm aperture telescope technology first used in MOST, is specifically designed and built to be the world's first space telescope dedicated to detecting and tracking asteroid and space debris. According to the CSA NEOSSat website (http://www.asc-csa.gc.ca/eng/satellites/neossat/):

> *... it will circle the globe every 100 minutes (when launched in the fall of 2012), scanning space near the Sun to pinpoint asteroids that may someday pass near our planet. NEOSSat will also sweep the skies in search of satellites and space debris as part of Canada's commitment to keeping orbital space safe for everyone. NEOSSat applies key technology already demonstrated in Canada's very successful MOST satellite.*

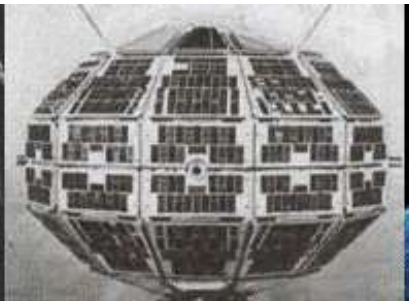
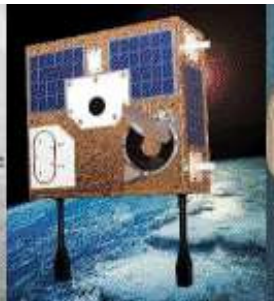

This sounds a lot like what PR is planning to do.

According to Kieran Carroll, the mission and system architect for MOST, the key to achieving an accuracy of less than one arc-second depends on two main innovations. The first is:

> *…the development of a star-tracker that has accuracy at the arc-second level.*
>
> *This level of accuracy is hard to achieve, requiring a narrow field of view for the star tracker, which is rather narrower than that used in most commercially available star trackers. What we decided on for MOST was to use the same set of optics for the star tracker and for the satellite's science instrument (in essence, putting two CCDs at the focal plane of the optics).*
>
> *This trick (which the Hubble Space Telescope also uses) allowed us to not have to carry a second set of optics (which are large, heavy and expensive), and also avoided the need to keep two sets of optics co-aligned to arc-second level (which is a very difficult thing to accomplish).*
>
> *Each CCD on MOST has a 0.86 degree field of view (3070 arc/sec), each having 1024x1024 pixels, so that each pixel sees a 3 arc/sec x 3 arc/sec patch of sky. We use made the image slightly out of focus, smearing the star images over several pixels, which enables us to do "sub-pixel interpolation" in order to measure star centroids down to better than 3 arc/sec --- I think that with software upgrades over the years, the guys eventually got the measurement accuracy down to 0.5-1 arc/sec.*

The second innovation was the development of very small reaction wheel actuators. According to Carroll:

> *Larger reaction wheels had existed for many years before MOST, but we couldn't afford the mass or volume they'd need, and also they were pretty darn expensive, given our budget.*
>
> *Instead, we developed a new reaction wheel design, meant not only for MOST but as a commercial product. It was designed to be small, low-mass and low-cost. Also, it was designed to have a very low power consumption (to avoid driving up the cost of the power subsystem since photovoltaic cells are also pretty expensive), and to have a really very good speed/torque controller built into it, to*

minimize the errors between the torque we were commanding the actual torque delivered (too much torque jitter would have resulted in too-large errors in MOST's line of sight).

While there are a number of current suppliers of similar reaction wheels on the market today, the star tracker system is still a unique Canadian innovation and only really available here.

Someone should call up PR co-founder Eric Anderson and tell him about this. We could end up building him a NEOSSat.

2.4. From Astronaut Hero to Space Trucker: The Human Spin on Space Commercialization

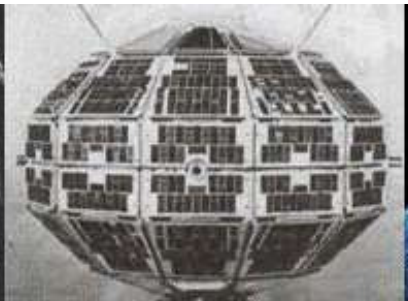
Here's an article, originally posted on May 17th, 2012 on the Forbes Magazine website (http://www.forbes.com/sites/brucedorminey/2012/05/17/from-astronaut-hero-to-space-trucker-the-human-spin-on-space-commercialization/) which gives some idea of the current international perceptions regarding extraterrestrial resource gathering.

From Astronaut Hero to Space Trucker: The Human Spin on Space Commercialization

By Bruce Dorminey

The characters in "*Alien*," Ridley Scott's 1979 sci-fi blockbuster, may actually be more akin to future space-farers than our citizen heroes from NASA's Apollo era. After all, the film presents a view of space travel that is based as much on economics as wanderlust and this is arguably as it should be.

How can anyone forget the hangdog eyes of Harry Dean Stanton, who so clearly is out that far in space solely for the cash? The crew of the Nostromo, the film's ore-carrying cargo vessel under threat from a ravenous extraterrestrial, inherently understands that sometimes great profit only comes with great risk.


We all hope that there are more glory moments in our future, with a manned trip to Mars and scientific colonies on the moon. But the recent announcement by Bellevue, Wa.-based Planetary Resources, Inc. that it plans to mine Near-Earth Asteroids (NEAs) could also be a step in the right direction. As the startup company, backed in part by Google billionaires Larry Page and Eric Schmidt, notes, a solitary 500-meter asteroid could potentially reap the equivalent of all the Platinum Group Metals ever mined here on earth.

"*After this [Planetary Resources] announcement, space travel is no longer rocket science,"* said Chuck Black, the Toronto-based treasurer of the Canadian Space Commerce Association (CSCA). "*It's simply an adjunct of the mining industry with high upfront costs, long lead times before return on investment, and the strong possibility that any single venture will fail."* But Black notes, such ventures are also rife with great potential for profit.

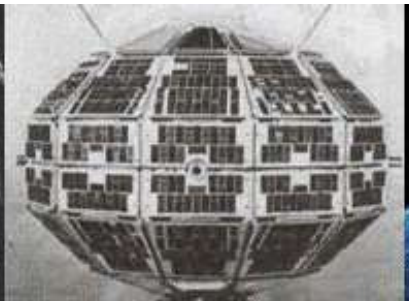
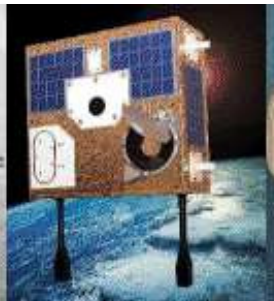
The global space community could stand a healthy injection of profit, since life doesn't run on "*Mr. Wizard*" alone. If the best practices of commercial exploration can be married with pure science, then we might soon be on our way towards creating the space-faring diversity necessary to sustain a permanent move back beyond low earth orbit. Otherwise, costs for manned space exploration may never see tenable levels.

Even so, some argue that today's drumbeat for space commercialization is beginning to sound an all too familiar refrain.

"*Space advocates have been talking about mining asteroids and the moon for a long time,"* said Roger Launius, a space historian and senior curator at the National Air & Space Museum in Washington, D.C. "*But costs are so high that the critical component in any mining operation will be finding economical, reliable transportation."*

Such transport may not always resemble the bright and shiny space vehicles from the days of the U.S. space shuttle as "*Alien*" reminds us. Although the film was shot in its entirety on soundstages at London's Shepperton Studios, parts of the film's set had more of the feel of a filthy industrial warehouse than an interstellar transport.

"*Ridley [Scott] was worried about getting that dirty, gritty real space-truck look,"* said Toronto-based film director Roger Christian, who won an Academy award for best set decoration on the original "*Star Wars*" film and received an Academy nomination for best art direction on "Alien." "*I broke down jet engines, pieces*

[discarded] from bombers, and bought truckloads of scrap to build into the set. I sprayed it army green, dressed and aged it, and that was the look."

Christian says the idea was to create the claustrophobic, cluttered work environment of a long haul cargo transport. Given likely commercial concerns over efficiency and profit, such spacecraft designs of the future may be more on target than the grand schematics of Star Trek's vaunted starship Enterprise which was on a "five-year" mission of exploration and discovery.

And aside from the threat of being devoured, unlike today's astronauts who are highly motivated and dedicated to their missions, the characters in "*Alien*" really didn't seem to want to be there. The job was a job, even though it happened to take place on a corporate-owned starship.

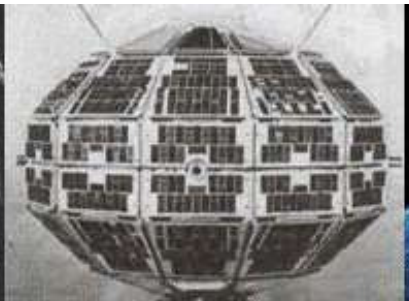
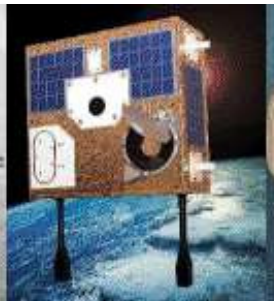
"*Ridley constantly said that these are "space truckers*," said Christian. "*They weren't heroes; just ordinary people pushed into extraordinary circumstances*."

An attitude of such nonchalance in space is still likely to be decades away. Until space commerce becomes as commonplace in real life as in science fiction, however, it will also probably involve some sort of public-private cooperation. At least that's the view of Leroy Chiao, a former NASA astronaut and International Space Station (ISS) commander, who is now an advisor to the Colorado-based Space Foundation.

"*Once spaceflight becomes "common" for commercial purposes, there will be a differentiation between "workers" flying on commercial spacecraft as passengers commuting to work, and professional "pilots" transporting them,"* said Chiao. "*The first "commercial" flights to mine asteroids, or other ventures, will break new ground and won't be "routine."*

But when business goes to space, to ensure that the venture can make a profit the owners are going to want to send only the best people, says spacecraft engineer Peter Swan of the Arizona-based Southwest Analytic Network, Inc., who led two recent "*space and society*" studies for the International Academy of Astronautics (IAA).

Swan says that commercial astronauts will probably not be subjected to the rigors of the Apollo era whose crews trained for years on any given mission. He says commercial astronaut training is likely to be done within a few months at most.

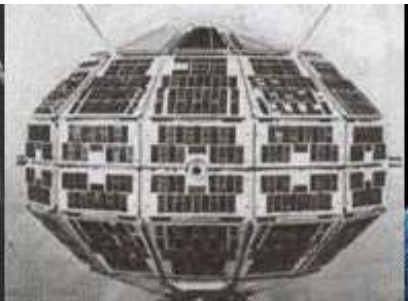




Does this mean that the public will be any less enamored of space voyagers of the future than those of the past? Probably not, says Swan, who notes that leaving earth's "*gravity well*" is still going to be seen as a remarkable privilege.

Even entry level jobs in space will have a certain cachet. "The perceived hierarchy of jobs that exist on earth will be replicated in space," said Launius. "Working at McDonalds is working at McDonalds, but doing it on the moon would give it a certain patina of coolness."

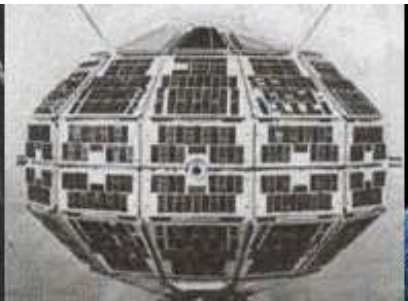
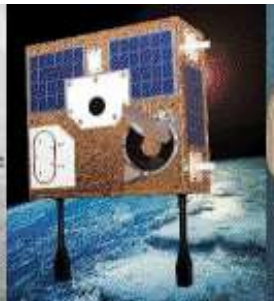
2.5. Suggestions for Further Reading

- **Canadian Space Flight History** (http://spaceistheplace.ca/hist.html) – A short history of Canadian efforts by Chris Gainor, the author of "*Arrows to the Moon*" and "*Canada in Space*."
- **Canada's 50 Years in Space: The COSPAR Anniversary** (http://www.apogeespacebooks.com/Books/50years.html) – Provides a thorough description of the parallel growth of the Canadian space science program and the international activities of the Paris based Committee on Space Research (COSPAR) from 1958 up until the 50th Anniversary of COSPAR in 2008. Written by Gordon Shepherd and Agnes Kruchio.
- **The Chapman Report** (https://docs.google.com/file/d/1eWuBcgldg64EfzPuAcKBIJVsltqv_qJgvU4HkPC3ZW9xje1zwm_thevCLgCF/edit?hl=en_US&pli=1) – Canada is today an international leader in the fields of communications and remote sensing because of John Chapman (1921-1979) who was senior author of a report entitled "*Upper Atmosphere and Space Programs in Canada."* The document, written in 1967 and now known simply as the "*Chapman Report*," recommended using Canadian satellite and space technology for commercial activities such as communications and resource management instead of focusing only on scientific research. Over time, the report became "*Canada's Original Blueprint*" for space activities.
- **Three presentations on extraterrestrial mining**:
    - **Technology Opportunities Related to Mineral Exploration and Mine Operations on the Moon and Mars** (http://mining.ubc.ca/faculty/meech/MINE290/minerals%20-%20space%20development.pdf) by John A. Chapman


- **A Lunar Geosciences Database – The Earth's Map Place Analog** (http://mining.ubc.ca/faculty/meech/MINE290/lunar%20geosciences%20database.pdf) by Gerald G. Carlson, John A. Chapman and Ward E. Kilby
- **Development and Operation of a Surface Mine in a Remote Location - South Polar Region of the Moon** (http://mining.ubc.ca/faculty/meech/MINE290/Chapman%20-%20Beijing%20-%20Surface%20Mining%20on%20the%20Moon%20-%20paper.pdf) by John A. Chapman and Marc Schulte.

- **Presentations from the Future In-Space Operations** (FISO) **Working Group** (http://futureinspaceoperations.com/) - These are archived and peer reviewed studies (some with audio visual and power-points) for a variety of NASA approved concepts related to future in-space operations and activities. This site includes Dan King's presentation on the MacDonald Dettwiler (MDA) on-orbit satellite servicing proposal (under the title, Space Servicing: The Future is Now) and a variety of presentations on asteroid mining techniques and tools. A fascinating overview of what could be accomplished today with the proper funding.
- **Historical Investment Financing of Exploration for New Worlds, Current Analogies to Other Industries, and Ideas for the Future** (http://evainterviews.wordpress.com/about/evas-conference-papers-and-presentations/paper-investment-financing-of-exploration-to-new-worlds/) - A discussion paper on how explorers historically have been financed.
- **ISRU Info: The Home of the Space Resources Roundtable** (http://www.isruinfo.com/index.php?page=about) - A non-profit corporation promoting the development of space resources. Recent meetings have been held in conjunction with the Planetary & Terrestrial Mining Sciences Symposium (PTMSS), which bills itself as "*the future of space mining*."
- **The Online Journal of Space Communication** (http://spacejournal.ohio.edu/about_ed.html) - Since 2001, this scholarly publication has bridged the world of the professional and the world of the academic to advance the purposes of satellite and space development. The publication invites submissions that documents and examines a broad range of issues and events in space and satellite communication, including their historical, technological, economic, policy, cultural and social dimensions.
- **The Orbital Express Project of Bristol Aerospace and Microsat Launch Systems** (http://www.amazon.ca/Orbital-Express-Project-Aerospace-Microsat/dp/1563471922) - An important case study for those wishing to study

the technology and business development issues surrounding a small satellite launch vehicle.

- **A Short History of Private Space Development** (http://www.hobbyspace.com/NewSpace/history.html) - Useful historical context from Clark S. Lindsey.
- Thirteen power point presentations on **Space, Cyber and Telecommunications Law** (http://spaceandtelecomlaw.unl.edu/lincoln_powerpoints.shtml) - From various public conferences held at the University of Nebraska - Lincoln and including presentations from top lawyers, international experts, FAA representatives and lobbyists.
- **The Space Report** (http://www.spacefoundation.org/programs/research-and-analysis/space-report) – The "*authoritative guide to international space activities*" published by the Space Foundation, one of the world's premier nonprofit organizations supporting space activities, space professionals and education. The Space Foundation Introduction to Space Activities is also worth taking a look at.
- **The State of the Canadian Space Sector Report (http://www.asc-csa.gc.ca/eng/industry/state.asp) –** A yearly series of reports tracking the 140 companies and organizations which together, comprise the Canadian space systems industry.
- **Who Owns the Moon? Extraterrestrial Aspects of Land and Mineral Resources Ownership** (http://www.amazon.com/Who-Owns-Moon-Extraterrestrial-Regulations/dp/1402091346) – by Virgiliu Pop. An investigation into the permissibility and viability of property rights on the celestial bodies, particularly the extraterrestrial aspects of land and mineral resources ownership. In lay terms, it aims to find an answer to the question "*Who owns the Moon?"*