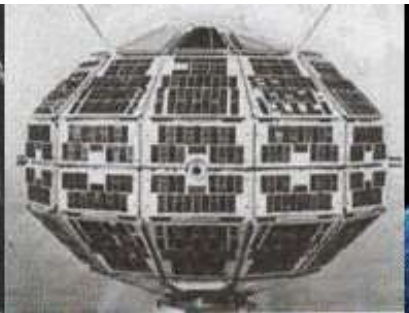
Submission to the Aerospace Review
Part 3 of 3

Creating an Indigenous, Canadian Small-Satellite Launch Capability

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

Canadian Space Commerce Association
Arny Sokoloff, President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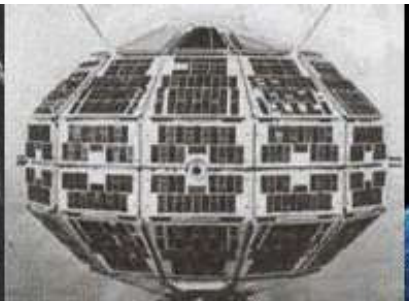
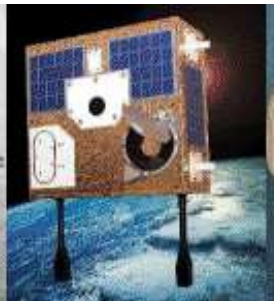



1. Summary of 3rd Set of CSCA Recommendations to the Aerospace Review

Canada is exceptionally large with long coastlines and large coastal waters and a small population concentrated along its southern border, which leaves large areas of territory and coastline unpopulated and not easily accessible.

These huge regions have the potential to be profitably exploited by Canadian interests over the coming decades if they can be properly inventoried and assessed.

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 space-based Earth observation is the most practical and lowest cost method to inventory the vast natural resources contained within this territory and appropriately administer and monitor activities of Canadian and foreign players in these regions.

It's fair to say that this capability is essential for Canada's sovereignty and economy.

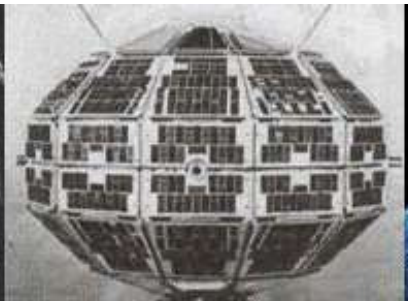
But in order to possess full control of any space-based observational capability and benefit from the accompanying research, development and commercialization benefits which would naturally derive from a program of this nature, Canada would also need to control the launcher and the launch operations.

We do not presently possess this capability. Therefore:

The CSCA recommends that the Federal government commit to specific steps towards the development of an indigenous small-satellite launch capability.

Section 1.1 of this document discusses the details of this recommendation. Section 1.2 of this document discusses the justification for these recommendations. Section 1.3 of this document discusses the practicality of these recommendations.

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


1.1. Creating an Indigenous Canadian Launch Capability

Section 1.1 of this document discusses the details of this recommendation.

As stated in the previous section, CSCA recommends that the Federal government commit to the development of an indigenous, small-satellite launch capability. Target capacities for such a launcher should be specified by the requirements of the Canadian Space Agency and the Department of National Defense.

But the devil in the details and the support for a program of this nature requires a series of specific, intermediate steps to keep costs within the existing budgets of the relevant federal departments and to maintain control over the program.

Therefore, the overall support would require these steps:

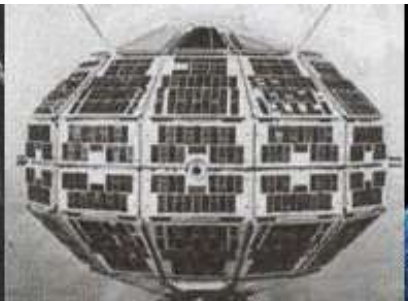
1. The first step is a specific Federal policy announcement that the Canadian government will broaden the scope of existing technology-development funding to support development of rocket propulsion and other launcher related technologies, equipment and systems.

   This is to counter a de facto Canadian government policy that has been entrenched since the 1960s, that Canada does not support rocket propulsion development work, which is completely counter to one of the main recommendations in the Chapman report (See Section 2.3 on Excerpts Related to Launcher Development in the Chapman Report) which has formed the basis for much of Canadian space policy since 1967.

   This first step should permit support for Canadian companies which have previously worked on rocket propulsion and other launcher components independently and under Canadian Space Agency supervision to resume their work in that area.

2. The second step is to support development of facilities for commercial space flight test and operations.

   A US model which could be copied is the Mojave Air and Spaceport (http://mojaveairport.com/), which is defined as a "*Civilian Aerospace Test Center"* by the US government. This designation allows private access for small players, new-space companies and small/medium businesses for flight


testing, launch systems development and facilities for maintenance and storage.

Mojave is also the first facility to be licensed in the United States for horizontal launches of reusable spacecraft, being certified as a spaceport by the Federal Aviation Administration on June 17, 2004.

Canada has no direct equivalent of Mojave, but there are a number of smaller airports in low-traffic locations that could be encouraged to develop in this direction. The most important form of encouragement would be a favorable regulatory environment: elaborate ground facilities are less important than reduced regulatory paperwork. Notably, the government should streamline procedures for making airspace available for commercial high-altitude testing and operations in suitable locations, so that such flights can become routine procedures, where currently they are complicated special cases requiring lengthy advance negotiation for every flight.

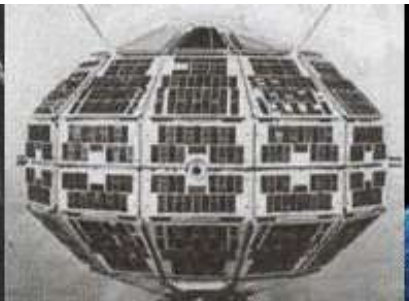
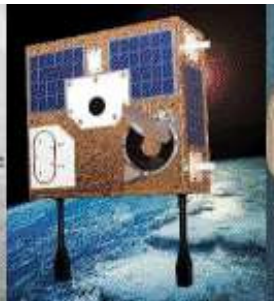
Such civilian facilities may take time to develop. As an interim step, the government should permit and encourage commercial use of existing government test facilities such as CFB Cold Lake and DRDC Valcartier. It might not be practical for commercial ventures to do operational flights from government facilities, but temporary access for development testing would be very helpful.

This second step establishes the good faith of the Federal government among private aerospace and space firms looking for permitted, accessible and indigenous testing facilities.

3. The government should explicitly commit to "*whenever possible*," buying launches from Canadian suppliers whenever such launches would be suitable technically.

   Ideally the Canadian government would commit to being an anchor customer, by either committing in advance to pre-purchase launches and/or committing to purchasing a minimum number of launches.

   This specific step is "*fiscally neutral*," since the government commits only to the purchase within Canada of launch services which would be required anyway. It will also encourage private funding of launcher development.

4. The fourth step is for the Federal government to implement a sector-specific plan (similar or as part of the existing Industrial Regional Benefits (IRB) program) for satellite launch, which would require foreign suppliers of foreign launches to reciprocate by buying launch services in Canada where suitable. Launch services should be explicitly designated as IRB eligible.

   This would bring money into Canada and could be implemented in conjunction with a program to improve IRB access for small companies.

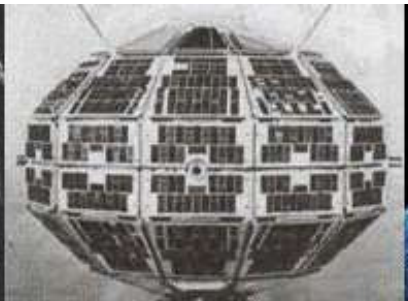
1.2. Justifications for Creating an Indigenous Canadian Small-Sat Launch Capability

Satellite launch capability is basic infrastructure for a modern nation. Canada is already dependent on satellites for a myriad of private and government functions, and we have developed and are continuing to develop indigenous capabilities in all other aspects of satellite technology and use – design, construction, instrumentation and operation. We even export our expertise in satellite technology. Following are some of the reasons for us to rectify this gap of satellite launch independence.

1.2.1. Security Concerns

Access to space is exceptionally critical to Canada vs. other countries, since Canada is exceptionally large but with a small population, concentrated on our Southern border, and therefore has large land area unpopulated and not easily accessible from the ground, much of it not even very practical to access by air. Canada has exceptionally long coastlines and large coastal waters, much of which is in remote areas. We have a huge Northern part of the planet that, due to projected climate change and new technology, is about to be exploited by Canadian and foreign interests. Space-based observation is the only practical way to monitor this enormous area for the activities both of Canadian and foreign players.

To have full control of this essential space-based observation capability would require Canada to have indigenous capability to build, launch, and operate earth observation satellites. Currently we have limitations only in launch capacity, for which we must rely on international partners that can, and in the past have, placed limitations on what Canada can do.


Radarsat-2 provides an instructive example of how foreign concerns can negatively impact Canadian satellite programs as outlined in Section 2.5, A Report on Radarsat-2 Build and Launch Delays.

It should be emphasized that this example is not atypical; launch slots as are often as not delayed and even cancelled for satellites of all types and sizes for reasons that are entirely external to Canadians' control.

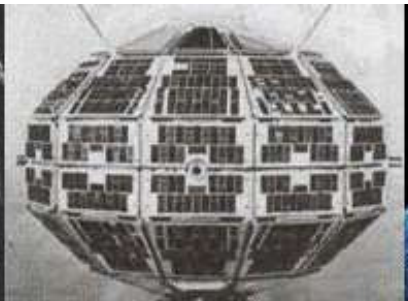
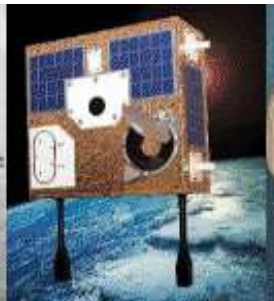
For Canadian sovereignty and to fill a gaping void in Canada's space capabilities, we would require an indigenous Canadian small satellite launch vehicle. Canada now has to buy or beg launch opportunities from foreign governments. This represents money that flows out of Canada and the limited availability of suitable launch slots has imposed restrictions on the timing and indeed practicality of our satellite programs. With respect to Northern Sovereignty (and this potentially could apply other national security issues) we have to beg for launch slots from the very countries whose activities we are most interested in monitoring. Additionally, the foreign provider of launch services has access to the Canadian satellite during the process of integrating it with their launch vehicle and therefore full security and confidentiality of the payload is impossible.

In any future military involvement of Canadian forces in foreign theatres (of which our recent experience in Afghanistan can be considered an example) Canada will continue to be limited in its ability to acquire satellite military observation data and necessary satellite-based secure military communication facilities as long as we do not have full indigenous launch and satellite-build capability.

1.2.2. Environmental Concerns

As in the security situation arguments above, because of Canada's large land area, essential and time-critical satellite monitoring of our environment is or can be blocked by our reliance on foreign satellite launch capability. If we need a particular type of sensor in a particular orbit to observe a specific environmental problem, we cannot currently command a timely build and launch of the appropriate satellite. It should be emphasized that some satellites now wait years for a foreign launch opportunity, and some are never launched at all.

With the increasing natural resource development in the North and related increase in Northern ship traffic, which has been stimulated by new technologies and the apparent Northern climate warming, the vulnerable Arctic environment is of

particular concern. With limited local populations, plus few usable aircraft facilities or government ships in the area, satellite surveillance is the only way to fully cover these vast stretches. Without an indigenous launch capability our ability to respond in a timely fashion to both ongoing and crisis environmental concerns is limited.

1.2.3. Economic Concerns

Canada's economy has large components in natural resource and agriculture industries. Satellite observation is essential in these areas, and the discussion above about full independence for satellite build and launch capability applies.

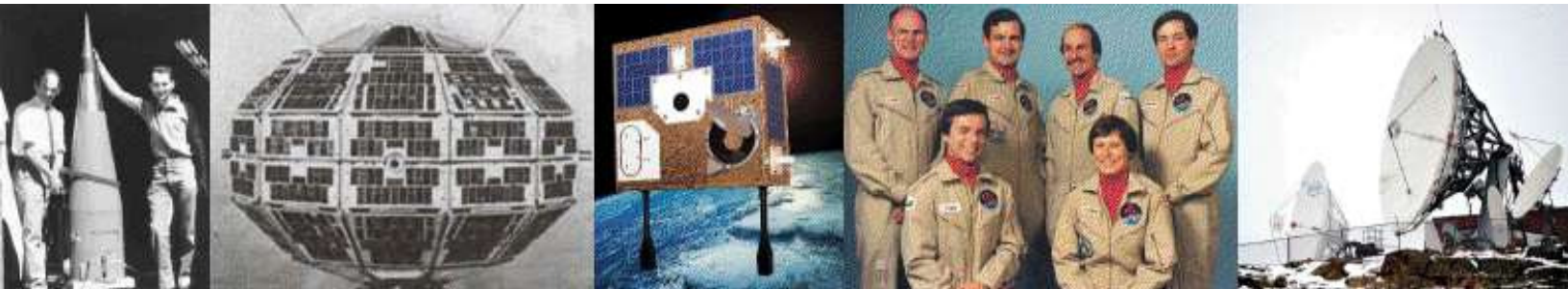
As an example of the essential role satellite observation plays in the economy (and environment too), note that the full extent of pine beetle invasion of Canada's forests can only be fully monitored by satellite. See http://www.for.gov.bc.ca/hts/rs/beetle_detection.html for a typical applicaton, where the infestation's progress is mapped by comparing satellite images over time.

A current major obstacle to existing Canadian space-systems companies is the difficulty of gaining “flight heritage” – international buyers are very reluctant to purchase any equipment that has not flown before. As can be seen in most other countries with competitive space industries, having a domestic launch capability will facilitate this first-flight opportunity and should thus be of significant benefit to the Canadian space industry as a whole.

It should be noted that the space sector in both Canada and worldwide is growing at a rate that exceeds that of the economy in general, and this trend will continue, so having a robust and fully-capable space industry is of growing importance to our future economy.

1.2.4. International Profile

Canada is the only member of the G8 which does not have its own (or is part of a consortium that provides) launch capability. Many other countries which are smaller, less economically developed, and with less of an indigenous space industry, have their own satellite launch capability or are actively developing it. For Canada to be considered a serious player on the world stage and successfully barter internationally on space-based assets and access, Canada needs a healthy space industry with broad



capabilities. Otherwise we will be, and be perceived as being, beggars at the table where international space regulation, allocation, and planning is made.

1.3. The Practicality of Developing an Indigenous Canadian Small-Sat Launch Capability

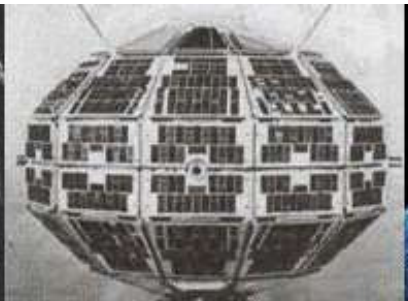
Historically, the prime argument against Canada's developing an indigenous launch capability has been the perceived high cost. Recent technical and business developments show this to no longer be the case.

1.3.1. Projected Costs

Completed in 2009, the CSA had commissioned two parallel studies (RFP No. 28-20070932) on the development of an indigenous Canadian small-satellite launch capability. These studies were managed by the CSA and jointly funded by the CSA and DND. Both studies, by two different Canadian space companies, concluded that a Canadian small-satellite launch vehicle could be developed at a very practical cost. The cost was projected to be much less than that of previous and current technical projects undertaken by these agencies such as the CSA's Canadarm development or any of the Radarsat missions, and very much less than the DND's cost for a frigate or icebreaker. In fact, a small satellite launch capability could be developed for a cost comparable to purchase of a single new-generation fighter aircraft. To put this in another perspective, an annual outlay of 1/10th of 1 percent of the current DND budget would be sufficient to develop such capacity.

1.3.2. Personnel and Industrial Capacity

The above studies concluded that Canada had personnel with sufficient technological and management expertise to carry out such a program, and also the industrial capabilities required. A subsequent DND study was conducted in the summer of 2011 by DRDC-Valcartier (Defence Research and Development Canada) to look at the practicality, and especially the industrial capacity required, for such an undertaking. We urge the government to look at these three studies and their conclusions (see Section 2.4 under the title Reference Information from 2011 DRDC Indigenous Launcher Development Capacity Study).


1.3.3. Justification for Improved Costing Projections

Decades ago, the cost for developing a satellite program would have been expected to be very much higher than these studies suggest.

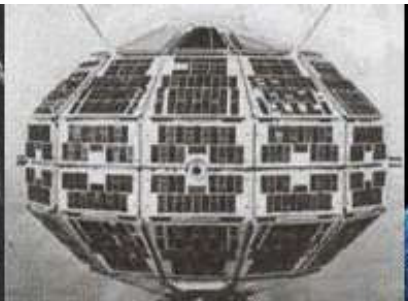
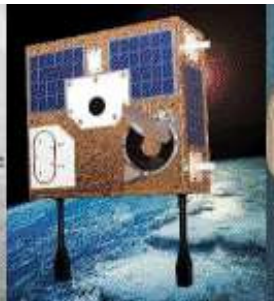
What has changed? In particular:

1. With newer electronic technologies the capabilities and utility of small, lightweight satellites has increased dramatically. Therefore a smaller launcher (launcher costs are closely related to the satellite mass they can place into orbit) can launch a much wider set of satellites than in previous decades and would be substantially more useful.

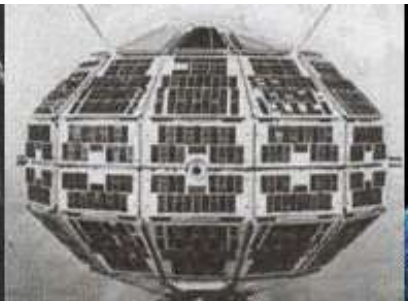
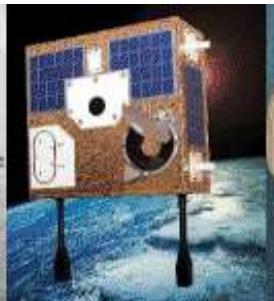
2. Canadian industrial capacity has matured to where specialized items, such as GNC (Guidance, Navigation, Control) equipment and aerospace composite materials, etc. are being produced by commercial Canadian suppliers. Canadian industries now have very substantial experience in space missions. Canadian academia (and the graduates they have trained) has produced experts with sufficient background in all relevant fields for launcher development.

3. While developing and maintaining a satellite launch capacity is not expected to be commercially profitable (currently the only aspect of space that is fully commercially supported is commercial telecommunications satellites), a launcher will have a positive effect on Canada's space industry. It will complete the missing link in our industrial space offerings, allowing Canada to offer a one-stop shop for small satellites, from design to build to launch to operation. The specific lightweight launcher contemplated would also represent a smaller size and therefore lower price-point than that available from other countries. That is likely to attract foreign commercial customers and should offset some of the ongoing costs of maintaining the launch capacity. Potentially we may even be able to barter this ability to launch small satellites at reasonable cost in exchange for the occasional large satellite launch we may require and for which we would now have to pay cash.

4. Finally, the examples of some newer launch system developers (particularly SpaceX in the U.S.), shows that new launch vehicles can be successfully developed for a fraction of the traditional cost if modern technologies and appropriate management techniques are applied. Specifically, SpaceX

developed its Falcon One launch vehicle, (which is larger than that we contemplate for an indigenous Canadian launcher) for a reported cost on the order of $100 million. We attach an article which examines the cost of SpaceX's subsequent development of a very much larger system, which was achieved at a cost of about 1/10th that of previous launchers developed for NASA (Section 2.1 under the title Why Can't NASA Estimate Costs for the Falcon 9). There is no reason why Canada, if it followed these best practices, could not enjoy similar savings.

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).

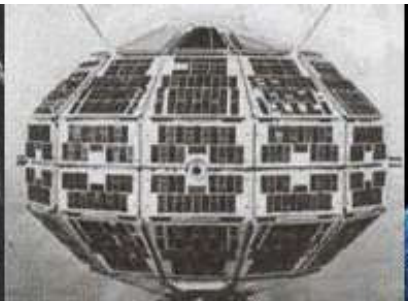
Over the last five years, total revenues generated by the Canadian space sector have increased by 38% which is comparable to the 41% increase reported by the Space Report for the larger, international market.

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. Why Can't NASA Estimate Costs for the Falcon 9?

Why is NASA simply unable to compete with SpaceX development cost for the Falcon 1 and Falcon 9 rockets?

That's the question asked by the article "*Why is NASA's cost modeling and estimation so off when analyzing SpaceX's development methodology in comparison to NASA's own?"* on the Quora website at http://www.quora.com/Why-is-NASAs-


cost-modeling-and-estimation-so-off-when-analyzing-SpaceXs-development-methodology-in-comparison-to-NASAs-own.

The article was written in response to the August 2011 presentation by the NASA Associate Deputy Administrator for Policy focused on the US government initial estimate of the Falcon 9 vehicle development costs available online at http://www.nasa.gov/pdf/586023main_8-3-11_NAFCOM.pdf.

It used the standard "*NASA – Air Force Cost Modeling*" methodology (with its estimate of between $1.7 and $4 Billion USD's to develop the Falcon 9 rocket) and developer Space Exploration Technologies public statements indicating that the true costs were approximately $300 Million USD plus an extra 90 Million USD "*spent developing the Falcon 1 launch vehicle which did contribute to some extent to the Falcon 9.*"

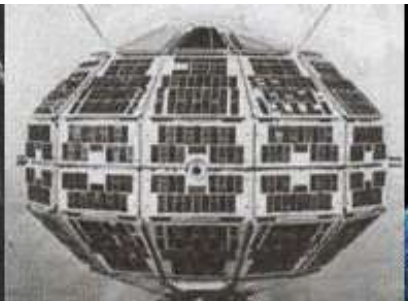
According to the article "*NASA has verified these costs*" as provided by SpaceX, which suggests that the NASA cost modeling has gaps and errors.

The article is posted below in its entirety.

Why is NASA's cost modeling and estimation so off when analyzing SpaceX's development methodology in comparison to NASA's own?

NASA recently conducted a predicted cost estimate of the Falcon 9 launch vehicle using the NASA-Air Force Cost Model (NAFCOM). NAFCOM is the primary cost estimating tool NASA uses to predict the costs for launch vehicles, crewed vehicles, planetary landers, rovers, and other flight hardware elements prior to the development of these systems.

NAFCOM is a parametric cost estimating tool with a historical database of over 130 NASA and Air Force space flight hardware projects. It has been developed and refined over the past 13 years with 10 releases providing increased accuracy, data content, and functionality. NAFCOM uses a number of technical inputs in the estimating process. These include mass of components, manufacturing methods, engineering management, test approach, integration complexity, and pre-development studies.


Another variable is the relationship between the Government and the contractor during development. At one end, NAFCOM can model an approach that incorporates a heavy involvement on the part of the Government, which is a more traditional approach for unique development efforts with advanced technology. At the other end, more commercial-like practices can be assumed for the cost estimate where the contractor has more responsibility during the development effort.

For the Falcon 9 analysis, NASA used NAFCOM to predict the development cost for the Falcon 9 launch vehicle using two methodologies:

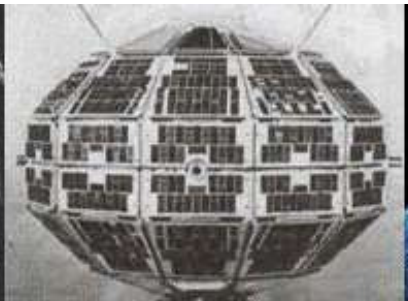
1) Cost to develop Falcon 9 using traditional NASA approach, and
2) Cost using a more commercial development approach.

Under methodology #1, the cost model predicted that the Falcon 9 would cost $4.0 billion based on a traditional approach. Under methodology #2, NAFCOM predicted $1.7 billion when the inputs were adjusted to a more commercial development approach. Thus, the predicted the cost to develop the Falcon 9 if done by NASA would have been between $1.7 billion and $4.0 billion.

SpaceX has publicly indicated that the development cost for Falcon 9 launch vehicle was approximately $300 million. Additionally, approximately $90 million was spent developing the Falcon 1 launch vehicle which did contribute to some extent to the Falcon 9, for a total of $390 million. NASA has verified these costs.

It is difficult to determine exactly why the actual cost was so dramatically lower than the NAFCOM predictions. It could be any number of factors associated with the non-traditional public-private partnership under which the Falcon 9 was developed (e.g., fewer NASA processes, reduced oversight, and less overhead), or other factors not directly tied to the development approach. NASA is continuing to refine this analysis to better understand the differences.

Regardless of the specific factors, this analysis does indicate the potential for reducing space hardware development costs, given the appropriate conditions. It is these conditions that NASA hopes to replicate, to the extent appropriate and feasible, in the development of commercial crew transportation systems."
--pg. 40, http://www.nasa.gov/pdf/543572ma..


For more information on NAFCOM, check out this 2002 document (http://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/20020048607_2002079472.pdf) from Science Applications International Corporation (http://en.wikipedia.org/wiki/SAIC_%28company%29) on the appropriate parameters and proper uses of the modeling tool.

2.3. Excerpts Related to Launcher Development from the "Chapman Report"

In 1967 the seminal "*Chapman Report*," which has since formed much of the basis for Canadian space policy, stated:

Page 109:

The field of space activities should, in Canada, include all activities directly associated with rockets and other launch vehicles, with spacecraft, and with those ground-based activities which relate directly to upper-atmosphere and space phenomena.

Page 110:

Canada will, within the next decade, need to launch small scientific satellites at a rate which will justify supply from Canadian sources.

Therefore we recommend:

(a) the initiation of a design and cost study for a small-satellite launch vehicle and related facilities for Canadian use.

Page 112:

The domestic need for launch vehicles and space hardware is growing. Developments of this nature in other countries are fully supported by government on military on other grounds.

Therefore we recommend:

(a) that industrially based, study and research and development programs, fully funded, be undertaken on launch-vehicle systems and components to meet Canadian needs.

(b) that systems management and prime contract activities be awarded to Canadian industry for the development and supply of the major hardware portions of the Canadian space program.

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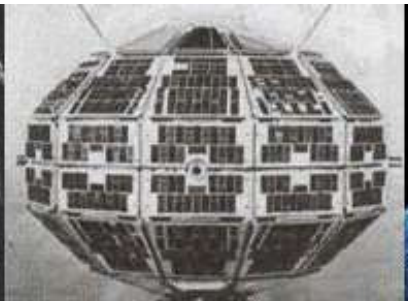
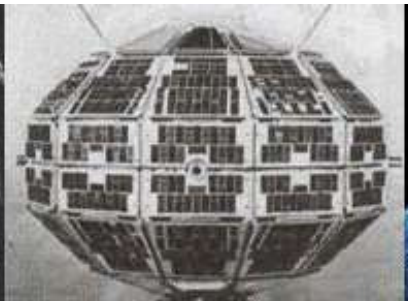
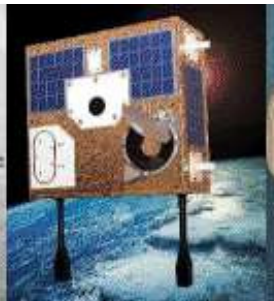



In 1967 it was clear to the authors that developing an indigenous space launch capability was a basic component of any comprehensive space program. Almost all the other Chapman Report recommendations (such as the creation of a national space agency), have been followed in the subsequent years. Since that time Canada has become increasingly dependent on satellites for economic, military, transportation, weather, communications, navigation and other needs. Since that time many countries, including many with fewer resources than Canada, have developed their own satellite launch capability, understanding that this is a basic infrastructure requirement for a first-rank country. It is the view of the CSCA that it is long overdue that Canada also have this capability and finally be free of its dependence on foreign suppliers and no longer be constrained by foreign governments for satellite launch access.

Canada needs this satellite launch capability for sovereignty and security, environmental, economic, and international status reasons. Past governments may have believed that attaining this capability was unrealistic based on domestic industrial capacity and the expected cost of such a program. In 2012 these perceived obstacles are no longer present.

2.4. Reference Information from 2011 DRDC Indigenous Launcher Development Capacity Study

Recherche et développement pour la défense Canada | Defence Research and Development Canada

RDDC Valcartier
2459, boul. Pie-XI Nord
Québec (Québec)
G3J 1X5 CANADA

DRDC Valcartier
2459 Pie-XI Blvd North
Québec, Québec
G3J 1X5 CANADA

www.valcartier.drdc-rddc.gc.ca

June 1, 2011

To whom it may concern,

Defence Research and Development Canada (DRDC) Valcartier has mandated Alexander Harmsen to research and create a paper which is briefly described as the following:

A national level public policy paper on the feasibility, benefits, risks and industrial capacity of an indigenous Canadian launcher project as it applies to industry, government, and various other stakeholders. The project has been created and administered through DRDC-Valcartier, with Rocco Farinaccio as a co-author, and will be internally available to individuals within the CSA and DND once completed and reviewed at the end of the August 2011.

To gather insight from as many facets of the aerospace community as possible, Mr. Harmsen will be speaking with and engaging a wide variety of people who will be able to contribute to the project. These will include but are not limited to members of industry, commercial enterprises, research centres, governmental agencies, manufacturing centres, universities, etc.

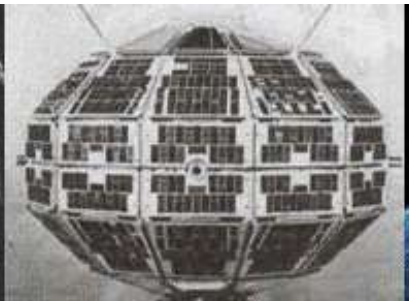
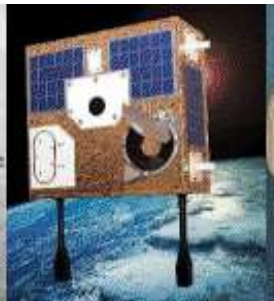
We look forward to your input, please feel free to contact me if there are any concerns or questions that you may have regarding this project,

Sincerely,

Rocco Farinaccio
Defense Scientist
Propulsion Group

Canada

DEFENCE R&D DÉFENSE

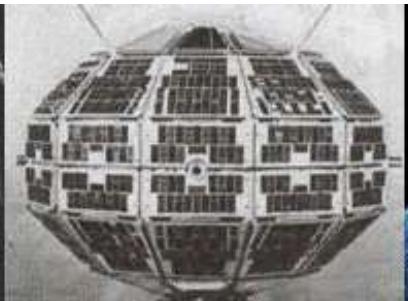
2.5. A Report on Radarsat-2 Build and Launch Delays

Radarsat-2 provides an instructive example of how foreign concerns can negatively impact Canadian satellite programs given that we are dependent on others for launch capability. Please note that this example is not atypical, launch slots are often as not delayed and even cancelled for satellites of all types and sizes for reasons that are entirely external to Canadians' control.

In the Radarsat-2 case, because of U.S. objections, both the satellite bus and subsequently the launch supplier itself had to be changed from U.S. sources.

From the CSA report (http://www.asc-csa.gc.ca/eng/publications/mcp-5702-7823.asp) "*Evaluation of the RADARSAT-2 Major Crown Project*" - Projet # 570-2782-3, September 2009

> *…there were two key issues that resulted in project scope changes and subsequent additional costs and a long delay in the launch of the satellite, both of which were outside of the control of the CSA (a Force Majeure situation existed with respect to the bus sub-contract, and a change in launch supplier).*
>
> *Due to the delays caused by the Force Majeure, the subsequent switch in launch supplier from NASA provider to CSA provider, and delays in the launch decision, the project timelines were revised with a new launch date of March 2003 (16 months late). On-going technical issues (e.g., with the SAR payload transmit / receive modules and bus module development) resulted in further delays to the launch date (December 2005). The eventual launch, in December 2007, followed additional delays during the integration and test phase and a second change in launch vehicle. These issues resulted in an overall project delay of six years.*
>
> *...However, launch delays prevented Canada and Canadian industry from being first to market with a new generation of commercial SAR offerings. By the time RADARSAT-2 was launched, there were other similar systems in operation, although perhaps with less powerful capabilities.*
>
> *The Technical Assistance Agreement (TAA) for an Orbital Sciences Corporation (OSC) supplied bus was delayed until August 1999 when a partial TAA was offered. The partial TAA contained restrictions unacceptable to the CSA and the federal government. The CSA requested MDA to investigate a non-US bus supplier. Subsequently, a contract was given to Alenia Aerospazio of Italy for the*


supply of the RADARSAT-2 bus. The termination of the OSC contract, coupled with project delays, resulted in an increase in CSA costs.

In 1998 NASA back out of an agreement to provide the launch in return for data. Since the launch is a CSA responsibility, it had to be procured at additional expense to the CSA, although a 2005 decision to switch from a Delta II to a Starsem launch, resulted in a net reduction in project costs.

2.6. Continuum Aerospace Briefs AIAC on the Advisability of a Canadian Satellite Launch Vehicle

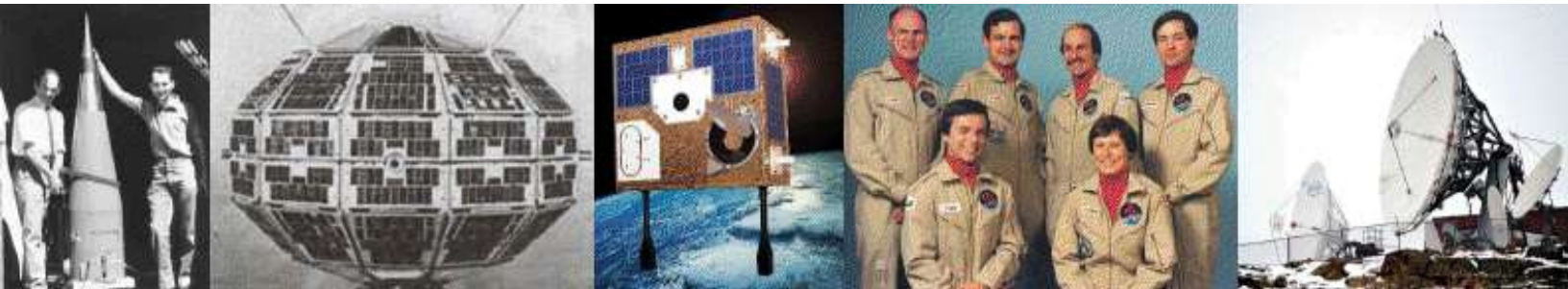
The following document was presented by CSCA President Arny Sokoloff in his capacity as President of Continuum Aerospace to the Aerospace Industries Association of Canada in 2010.

A Brief to the AIAC concerning a Canadian Satellite Launch Vehicle

Is it feasible for Canada to develop a launch capability?

Recent work indicates that an unmanned microsatellite launcher of the type recently studied by the CSA (150 kg to 800 km orbit) is both technologically feasible and economically viable for Canada. This is hardly surprising, as orders of magnitude larger rockets carrying astronauts were built using 1960's technology. Using best practices available today, Canada can build a system at much less expense, lowered risk, and with minimal environmental impact. Not only is a microsatellite system smaller in scale than that possessed by a growing host of nations, in the years since orbital rocket propulsion was being pioneered there have been decades of advances in areas such as structures, propulsion, GNC, and operations. By specializing in smaller payload missions, Canada can become a leader in a currently underserved niche (dedicated small satellite launch) while avoiding contention for the heavier launch market currently dominated by American and Russian incumbents.

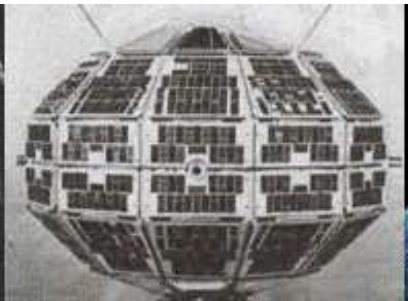
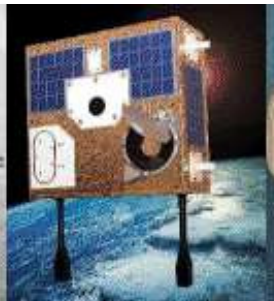
What benefits would such a capability bring to Canada as a whole?



Nations around the world are heavily dependent on space-based assets, and countries without independent access to space are at risk of being marginalized in critical aspects of their national interest. At present, Canada's concern for maintaining Arctic sovereignty is particularly immediate, as is ensuring accurate climate and environmental data for establishing and enforcing domestic policy and international agreements. As existing space-based assets age and satellite technology races ahead, many applications from navigation, communication, and scientific research to maritime and agricultural monitoring would benefit from an indigenous launch capability that gave priority to Canadian payloads.

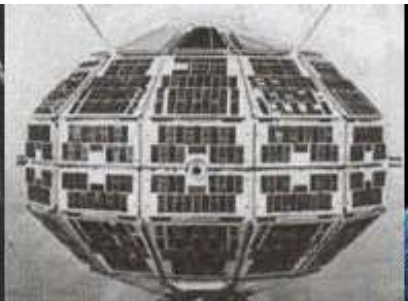
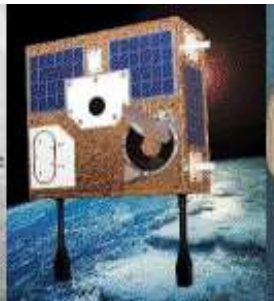
What benefits would such a program bring to Canadian aerospace and related industries?

A microsatellite program would provide considerable opportunities for companies with expertise in ground operations and atmospheric flight, traditional strengths of Canada's world-leading terrestrial aerospace companies and institutions. There are similarly opportunities for our leading satellite and space companies, including orbital payload deployment, mission management, and guidance of the launch vehicle outside the atmosphere, to name just a few areas. Moreover, as this program also calls for significant R&D in a number of critical aerospace technologies, it represents an opportunity to build new capacity and infrastructure while attracting top research and engineering talent for fundamental aerospace R&D in Canada. In the long term, it is hard to imagine a program that would better energize upcoming ranks of engineers and retain within Canada our most talented aerospace professionals and researchers. Such a result would go a long way in ensuring that Canadian aerospace remains innovative and competitive in the global market. Indeed, without such a program, Canada is in danger of becoming, or at least being of perceived as, a second-class supplier of space services versus those countries that can provide the complete package of satellite development, satellite launch, and satellite operation. Thus, in addition to the national benefits, we believe an indigenous launch capability is essential to the long-term competitiveness of the Canadian aerospace industry.

2.7. 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.
- **LEO on the Cheap** (http://www.dunnspace.com/leo_on_the_cheap.htm) - By Lt. Col. John R. London III. A fascinating read on methods to achieve drastic reductions in launch costs. It's hosted on the Dunn Engineering website (http://www.dunnspace.com/index.htm) and serves as a useful companion piece to the 1993 John Walker article "*a Rocket a Day Keeps the High Costs Away*" at http://www.fourmilab.ch/documents/rocketaday.html.
- **The Wikipedia List of Space Agencies with Launch Capabilities – At** http://en.wikipedia.org/wiki/List_of_space_agencies#List_of_space_agencies_with_launch_capability.
- **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.
- **Space Mission Analysis and Design** (http://search.barnesandnoble.com/Space-Mission-Analysis-and-Design/James-R-Wertz/e/9780792359012) - By James R Wertz and Wiley Larson and known as SMAD. A textbook quality publication for engineering and space activities providing what you need to speak the language of space.
- 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.

- **Space Launch Canada** (http://www.spacelaunch.ca/) – A federally incorporated, private initiative dedicated to building a space launch facility in British Columbia.
- **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.
- **The University of Alberta Institute for Space Science, Exploration and Technology** (http://www.isset.ualberta.ca/) – A pioneering interdisciplinary centre for planetary and space research in Canada at one of Canada's largest research-intensive universities. Also organizes the Canada-Norway Student Sounding Rocket (http://www.rocketrange.no/?page_id=246) exchange program.