Working Group Report

Technology Development, Demonstration, and Commercialization

September 17, 2012

This report reflects the views of one of the six industry-led working groups created to provide advice to the Aerospace Review Head and the members of the Advisory Council. The recommendations therein may not reflect the findings of the Aerospace Review.

For more information on the Review process visit www.aerospacereview.ca.

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Executive Summary

The aerospace and space sector is different from other Canadian industries: it is heavily capital intensive, involves major investments in research, requires prolonged product development, and generates long-lasting products. Also, while most industries are strong in either innovation (as in pharmaceuticals) or manufacturing (as in automotives), Canada is fortunate to have indigenous strengths in both through a vibrant aerospace sector that is supported by a highly educated technical workforce, a proven aerospace research and development (R&D) collaborative environment, the availability of vast natural resources, and political stability. These strengths have resulted in Canada securing a convincing lead in world markets for: business and regional aviation products, turboprop and small turbofans engines, civil helicopters, flight simulation, landing gears, legacy platforms in secondary markets, satellites and satellite-based communication services, space robotics, and earth observation. This country is also in the enviable position of being the 'go-to' high-value-added supplier for the world's leading aerospace and space projects.

Canada's diverse geography and climate have forced innovation on existing platforms, resulting in a rich history of modifications by our maintenance, repair, and overhaul firms (MROs). For instance, legacy (pre-2000) procurements and the willingness of the Department of National Defence (DND) to outsource have built significant capabilities for in-service support (ISS) in the private sector. For example, firms such as IMP, L3 MAS, Cascade, Kelowna Flightcraft, and Discovery Air Services perform high-value tasks such as engineering, maintenance, planning, integrated logistics and support, and program management. These indigenous capabilities, especially in high-value complex tasks, will continue to develop in an environment that fosters innovation.

In 2011, aerospace generated $22.4 billion in revenues (73% of which were in exports), directly employed 87,000 highly-skilled people with an estimated payroll of $6.35 billion and generated $1.5 billion (2009) in revenues to federal and provincial governments. More than 77% of industry activities were in the civil sector, reflecting the reality of a relatively small internal military market, while 49.1% were in sales of aircraft, aircraft parts, and components. The space technologies sector, in turn, generated $3.4 billion in revenues using more than 8,200 highly-skilled workers, including approximately 3,100 engineers and scientists. There is a critical mass of large Canadian top tier original equipment manufacturers (OEMs) representing more than 33,500 employees[1] and maintenance, repair and overhaul (MRO) firms contributing to these impressive numbers. Medium and small sized firms employed respectively approximately 40,000 and 11,500 Canadians.[2] The evolution of the industry is tightly linked to consistent investment in R&D. Since new technologies that can be purchased by Canada can also be purchased by competitors, industry growth will come from our continued excellence in technology and intellectual property generation, as well as in the persistence of a substantial and efficient high-technology manufacturing base. Increasing fuel prices and environmental pressures create the need to replace existing products with more efficient ones. This, combined with the growing volume of air travel and a developing Asian market, has created a fiercely competitive global market where emerging aerospace nations are rapidly gaining a foothold due to their substantial cost advantage and a brisk expansion of their own indigenous skill sets and infrastructure. Like us, these competitors are positioning themselves to capitalize on a US$380 billion market that is expected to reach US$574 billion by 2020.

Our end-to-end indigenous strengths that run through large, medium and small firms make this nation a destination of choice for aerospace and space firms, particularly for complex work projects. The basic elements are already in place to continue this remarkable record—including strong research institutions, bright and motivated professors, students and employees, supportive policies and programs, and industry commitment to investing in research and development at all stages, right through commercialization and into the after-market. However, a more strategic, focused approach is necessary to continue to succeed in the current aggressive environment.

It is expected that the four recommendations offered in this report—to complete a coherent National Aerospace Vision 2030; optimize the Canadian technology funding strategy for aerospace; foster collaboration in the sector; and support the continued development of a highly educated and skilled workforce—in tandem with the political will expressed by this Aerospace Review, will usher in unprecedented levels of collaboration between industry, universities, research centers, and governments to achieve these targets.

1. Background

The Government of Canada has mandated a national Aerospace Review to be completed in 2012. Expert groups were established according to six themes in consultation with the Aerospace Industries Association of Canada (AIAC). This report is the product of the first group, Technology Development, Demonstration and Commercialization, the members of which are listed in Annex 1a.

2. Mandate

In addition to considering 40 broad research questions relevant to the overall Aerospace Review (Annex 2), the Group examined the following Terms of Reference questions:

1) Which drivers currently influence the need for technological development, and what technologies currently respond to these requirements?
2) How well is the Canadian industry positioned to meet these technological needs?
3) How well do current federal policies and programs support the industry's need to advance technologically?
4) What changes are recommended to address shortcomings/gaps in current federal policy and program support?

Based on these discussions, the Group was asked to offer advice to the Head of the Aerospace Review for consideration in preparing his final report to the Government of Canada.

3. Approach

The Group was divided into seven Sub-Groups, the members of which are listed in Annex1b.

Aerospace Funding	Reflections on Technology Needs	Scientific Research and Experimental Development (SR&ED)	Maintenance, Repair and Overhaul (MRO)[3]
▪ Map federal and provincial aerospace funding in Canada. ▪ Focus on direct support, leave out indirect support. ▪ Evaluate funding programs and identify overlap. ▪ Identify funding impact through agreed metrics and KPI. ▪ Compare global funding programs to Canadian programs.	▪ Synthesize recent reflections on technology and innovation in the aerospace sector. ▪ Identify common themes across these analyses in terms of: technological needs; strengths and weaknesses of Canadian industry; opportunities and challenges; strategies on moving forward. ▪ Create a strategy paper.	▪ Examine the cuts to SR&ED in Budget 2012. ▪ Understand the government's rationale for the cuts. ▪ Discuss the importance of SR&ED to the industry. ▪ Explain the adverse impact of the cuts.	▪ Review key trends in MRO. ▪ Examine factors that enable MRO companies to pursue high value programs that create a sustainable industry and promote growth. ▪ Examine investments, tools or process changes needed in Canada's aerospace sector to best support technology insertion (modernization) programs.

Small Firms[4]	Medium Firms[5]	Large Firms
From a Small Business technology perspective, examine the:	From a Medium-sized business technology perspective, examine the:	From a Large Firm technology perspective, examine the:

- Opportunities and challenges associated with each of Deloitte's growth approaches;
- Investments necessary to succeed under each approach;
- Capacities that would need to be built;
- Government support required; and
- Gaps relative to current support provided.

General themes such as the cyclical nature of the industry and constitutional limitations were considered in discussions. This report merges the findings of the seven sub-groups into a single cohesive response.

4. Competitiveness

The Opportunity: Canada can and should capitalize on the rapidly growing worldwide demand for Aerospace products and services.
The Problem: The industry in Canada is not rising to its full potential because the lack of support for Aerospace research and development is resulting in delays in innovation and commercialization.
The Risk: Canada will lose market share and jobs to competing nations.
The Solution: Leverage existing government policies and programs, and increase collaboration to allow a faster response to market demands.
Government of Canada Action: Develop an intentional national approach to Aerospace that will leverage resources, strategically target federal support, and facilitate collaboration to bring innovative Aerospace technologies more rapidly to market.

Canada's top tier OEMs are well positioned to remain world leaders in their respective market segments, thereby ensuring the growth and maturation of their respective supply chains over the next 20 years. By investing in collaboration, competitiveness and innovation, Canada can look forward to annual revenues exceeding $35 billion by 2030 and direct employment in excess of 120,000. In particular, participation of SMEs in Technology Demonstrator Programs[6] will increase the chances that Canada will be the 'go-to' suppliers for new domestic and international projects, while building a community of innovative thinkers, system integrators, and other highly trained personnel along the supply chain. This will generate a highly productive environment in design, development, manufacturing, and support of aerospace and space products. As a result of evolving OEM supply chain strategies, Tier 1 integrators are expected to represent a growing share of aerospace sales, employment, manufacturing and technology development in the future.

The Canadian aerospace industry is facing credible competition: Brazil, Russia, India, and China (BRIC), are emerging to challenge the incumbent players in North America and Europe, at the original equipment manufacturer (OEM) level and as suppliers. Mexico, Poland, China and others are emerging as highly capable, low cost regions where aerospace suppliers are investing. Poland and India are emerging as compelling resources for aerospace engineering expertise. OEM and Tier 1 companies are increasingly locating manufacturing and design operations around the world to support market entry strategies, to follow their customers, and to achieve cost improvements, while SME suppliers are adapting to respond to new OEM demands. In all of these cases, international support for aerospace at the national level is bolstering competitiveness. China, for instance, is already on its twelfth Five Year Aerospace Plan.[7]

The Canadian industry is firmly anchored by large, internationally competitive OEMs and has been positioning itself for several years on major new platforms such as 787, A350, C-Series, 737, and A320 re-engine programs, and a wide range of regional jets and civilian helicopters. Further, a wave of military procurement in the late 2000s led to new platforms and/or a change in cadence on existing platforms for OEMs. One of Canada's competitive advantages is its pockets of aerospace excellence across the country, elaborated in Annex 5. Several Canadian firms, many of which are SMEs, have carved niches for themselves on these programs, and if they can weather the chronic delays typical of major programs, will maintain or improve their positioning on them. This is especially important since it is very difficult to recapture a lost position in the supply chain. However, propagating a single-source strategy without procurement of intellectual property (IP) rights, as is traditionally the case, can lead to longer-term capability erosion, particularly in MROs, ISS, and at the system integration level which is where sector growth will originate. As OEMs continue to aggressively pursue an integrated supply chain, significant opportunities will appear in the secondary market on legacy platforms, and, provided IP is procured and made available, firms developing new support structures and processes to capitalize on this opportunity in Canada will become more attractive suppliers to OEMs in other countries. Firms that offer the best products, best technology, better program management, and the ability to provide a competitive solution for future platforms have the capacity to vastly increase their size through an engineering intensive approach complemented by advanced manufacturing techniques such as lean, high levels of automation. Through investments in product technology and manufacturing innovation, these supply firms have built sustainable competitive advantages in unique niches, including aircraft components, training, commercial unmanned systems, and space technologies.

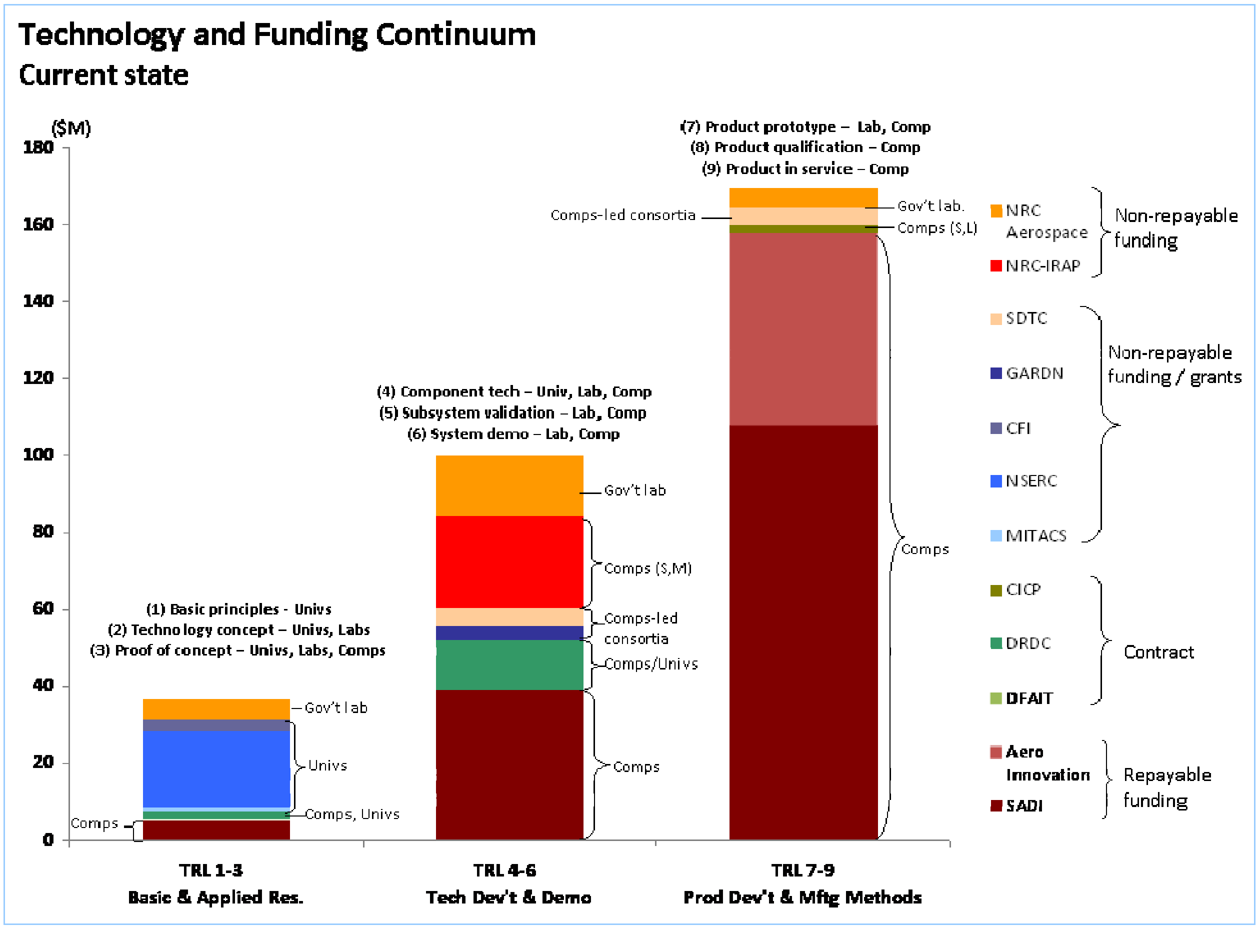
Canada's industry currently has an enviable international reputation for high standards and quality; our research institutions are first-rate and are keen to collaborate with industry in developing relevant programs, particularly for demonstration; and the graduates of Canadian science, engineering, and technology programs are perceived by industry to be bright and motivated. However, the time has come for all aerospace and space stakeholders in Canada—government, industry, research institutions, unions, and workers—to be more strategic if Canada is to develop aircraft that respond to future requirements of clients and regulators, notably more fuel efficiency, reduced environmental impact, greater component durability, and less expensive maintenance, as well as new satellite technologies for environmental and security monitoring, natural resource management, and telecommunications.

Although positioned for a great future, without the support warranted by a strategic sector of the Canadian economy, the aerospace industry will lose market share in its traditional markets and fail to capture new opportunities in emerging markets. This will result in decline of export revenues and loss of high-technology jobs and expertise, while the industry's ability to invest in innovation will further decrease. In addition, in the absence of significantly improved IP terms, tax credits, and funding opportunities, the multinational corporations with an aerospace footprint in Canada will decrease their levels of investment, leading to further erosion of the industry's global recognition and position.

5. Challenges

Technology follows a clearly defined path, from concept to testing to application, through various readiness levels for technology (TRL), system (SRL), and manufacturing (MRL).[8] All steps of these readiness levels and all firms involved in them require specific support mechanisms that must be sustained through a continuum with no gaps in funding.

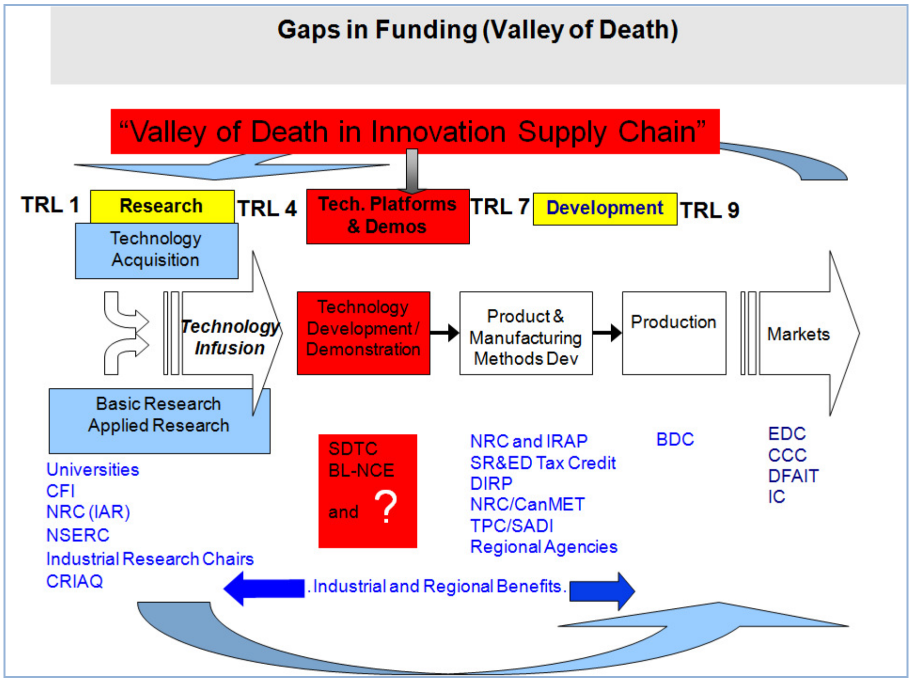
The picture below provides the current landscape of direct government funding for the aerospace industry and stakeholders by Technology Readiness Level (TRL), while indicating the type of recipients (companies of various sizes, universities, government laboratories) as well as the nature of the funding (repayable, non-repayable, contract, grant). Examples of support programs linked to aerospace are shown in Annex 6.



However, as shown below, these gaps, referred to as the 'valley of death', exist all too frequently.

The 'valley of death' lies in the area of technology demonstration, which carries a significant level of technical risk and requires considerably higher level of investment compared to the early stages of basic and applied research.

The above chart demonstrates that, although approximately $100 million of the existing government funding is designated to support technology development and demonstration, a large portion of it is either repayable funding (SADI) or contract-based and hence not necessarily addressing technology demonstration needs of the industry. In addition, small and medium-size companies have had an even lower rate of success in accessing technology demonstration funding in the absence of an integrated demonstration program led by an OEM or Tier 1 supplier.

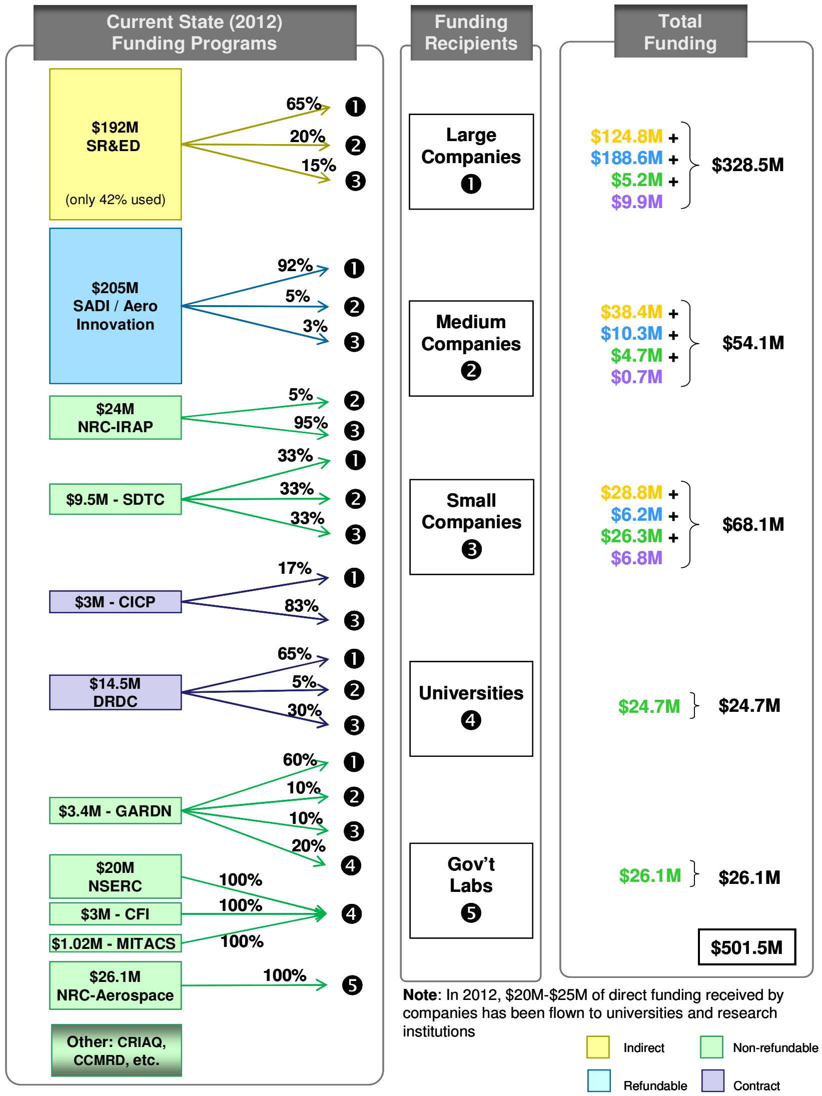


While federal programs have been an important resource for aerospace, funding is not supplied at all technology readiness levels, and not all stakeholders benefit as they should from this support, as shown in the next chart.

The chart includes additional information on baseline (2012) funding data, such as details on the distribution of funding and indirect governmental funding (SR&ED), assumed to be fully accessed by aerospace companies, although only 42% is utilize in reality.

All three charts were prepared for this report by the Group using data from sources listed in the bibliography.

Government Funding – Current State (2012)



Industry Funding = $2B

Annual levels of capital investment in large Canadian OEMs and MROs alone amount to over $600 million.[9] The scale, cost, technological, and schedule risks inherent in aircraft development programs limit market appetite and capacity for funding projects. Indeed, innovative technologies critical to new aircraft platforms require significant research and development expenditures well in advance—sometimes as much as ten years—of revenue-generating aircraft deliveries. Even after entry into service, new programs can take more than a decade to simply achieve breakeven delivery levels. Therefore, the sources of capital are low as no return is generated for many years and the risk level associated with the investment is high. This problem is compounded for smaller companies who have even less ability to invest for the future and are therefore unable to keep current with the technology. This limits their ability to capitalize when commercial opportunities come their way and causes a shift in global value chains away from SMEs to larger Tier 1 and Tier 2 suppliers. Given the significant role these SMEs play in the economy (generating 25% of manufacturing revenues in the sector) their emergence from the 'valley of death' is particularly important.

Technology demonstration as defined in Annex 3 is the final link in the R&D spectrum before application and commercialization. Demonstration programs help to reduce risk in downstream systems/product development, and generate valuable experience and capabilities in technology insertion. They help integrate the activities of industry, government, and academic research teams by providing the necessary link between research and commercialization projects. These programs build credibility with potential customers and partners, and are well used for these purposes by our competitors, particularly in Europe and the United States. A major weakness in the Canadian demonstration system is the lack of support for acquiring platforms such as aircraft and engines for demonstrating both novel technologies and the integration of complementary technologies. It is also difficult to obtain support from current federal funding programs which focus on market relevance and repayment. Since demonstration programs support a wide range of final applications, funding mechanisms must be better defined to include the intrinsic value of the technology itself if we are to bring our aerospace research to the next level of innovation.

In the military domain, the Group remains concerned with procurement strategies, in particular the single-source procurement philosophy and a gap in low-rate initial production (LRIP) of technologies developed by Canadian companies under strategic government incentives. There is concern over Canada's ability to maintain its equipment over the longer term through MROs and ISS given the fact that single source procurements often pre-determine the supply chain. In addition, the intellectual capital that must be procured for firms to enter from outside the supply chain functions as a barrier. In general, without a procurement strategy that either includes intellectual property rights, or a change from single-source procurement philosophy to a more flexible model that allows for top Canadian suppliers to enter along points in the supply chain, Canada's ability to maintain its equipment over the longer term will continue to be eroded. More disconcerting is the fact that while Canadian firms are developing leading-edge technologies under incentive programs such as SADI, there appears to be a missing link between government departments (Industry Canada and DND) to showcase and potentially procure low volumes of the most promising of these technologies in the early phases; this leads to the military version of the 'valley of death' described earlier for the commercial space, and exemplified in Annex 4. Lastly, the type of Industrial Regional Benefits (IRBs) making their way into the hands of Canadian companies remains of concern. More emphasis needs to be placed on the type of IRB in addition to financial considerations as explained in Recommendation 2.9 later in the report.

Since the physical infrastructure of industry and research institutions must be continuously improved as technologies and products evolve, high annual levels of investment must be made in process improvement technology for automation, control systems, machinery, software, and quality programs required by OEMs, which often puts smaller firms in a predicament as they need to stay relevant to compete. This is particularly important as lower cost countries are producing technologies to compete with those in Canada and are successfully managing the costs of modern development environments.

While fundamental technical trends are driven by OEMs who invest in key technologies, the lower end elements are often left to smaller firms who must then make investments in infrastructure and manufacturing technology to compete as part of the downward supply chain in order to qualify as a 'near to' integrator. This investment is often beyond the means of SMEs who are also unsure of where to target their limited resources as the R&D and procurement departments of large firms can be misaligned and have no influence on selecting a supplier.

Like the European and Canadian automotive sector models, more collaboration is needed between large and smaller firms, particularly for costly demonstration of new technologies that are mandated by the industrial support programs of other aerospace countries. There is a specific need, in the mid-spectrum stage of development, to have a connecting point for university and government basic research and the technology development and application efforts of industry. This is the point where multi-stakeholder collaboration takes hold. Importantly, it begins to shift the sharing of cost away from the predominant role of government in funding basic research to a more even split between the public and private sectors.

The opportunities in this industry and the potential for growth are tremendous, both for attracting foreign investment into Canada and for exporting worldwide. However, as Canadian companies struggle to rapidly link basic research with the transition to market application, technology development activities are becoming increasingly reactive or short term, mainly due to a lack of funding. The Canadian experience in meeting the requirement of generic costs of developing projects and managing their implementation is not strong: technical demonstrators have high risks in terms of both technology and investment, but are necessary to deliver mature new technologies to market. This is why other aerospace nations have stepped in and supported their aerospace supply chain through demonstrator funding programs.

An essential enabler for overcoming natural impediments to collaboration is funding that is adequate and sustained over a long period of time to cover the cost of pre-competitive, non-company specific development costs prior to the technologies being proven to be viable and cost effective for commercial applications. Since such technology development must take place ahead of product development and therefore has even longer lead times to a return on investment, some provincial governments in Canada and some national governments of competitor nations have been providing non-repayable funding to support this phase. To this end, there is a particular need in Canada for federal support to assist the industry in:

a) developing aircraft and systems that satisfy new requirements of customers and regulators, notably more fuel efficiency, reduced environmental impact, greater component durability, and reduced cost of operation and maintenance;
b) reducing design and production costs in light of the globalization of markets, the emergence of low-cost producers, and the high Canadian dollar;
c) revitalizing an aging manufacturing base in need of automation and having a shortage of Tier 1 integrators, both of which are leading to decreasing participation of Canadian suppliers in major new aerospace projects;
d) adapting to rapidly changing regulatory requirements, notably on noise and emissions;
e) amortizing investments in technology since the speed at which technology is matured and the pace at which products are refreshed in the global economy necessitate shorter amortization periods;
f) moving SMEs from ‘build-to-print’ operations to systems integrators given the high cost of establishing the modern development environment specified or mandated by prime contractors;
g) replacing a substantial number of experienced engineers and skilled workers who will retire in the coming years; and
h) commoditization of commercial carrier maintenance by MROs who must develop high valued-added and innovative services, which may include product life management.

In the face of these realities, governments play a constructive role in providing funding support – compliant with international rules – to their domestic aerospace and space industries, and the Government of Canada has been an invaluable partner in this effort through several important programs described in the following section on recommendations. If we are to succeed in future markets, a more targeted and intentional approach to such assistance is needed. This will not only compensate for insufficient market resources but also generate significant economic, trade, and security benefits for Canada in both domestic and international markets.

6. Recommendations

The following recommendations, detailed in the table below, will increase the intensity of aerospace and space R&D in Canada; maximize collaboration; and ensure adequate and sustained support for the sector well into 2030.

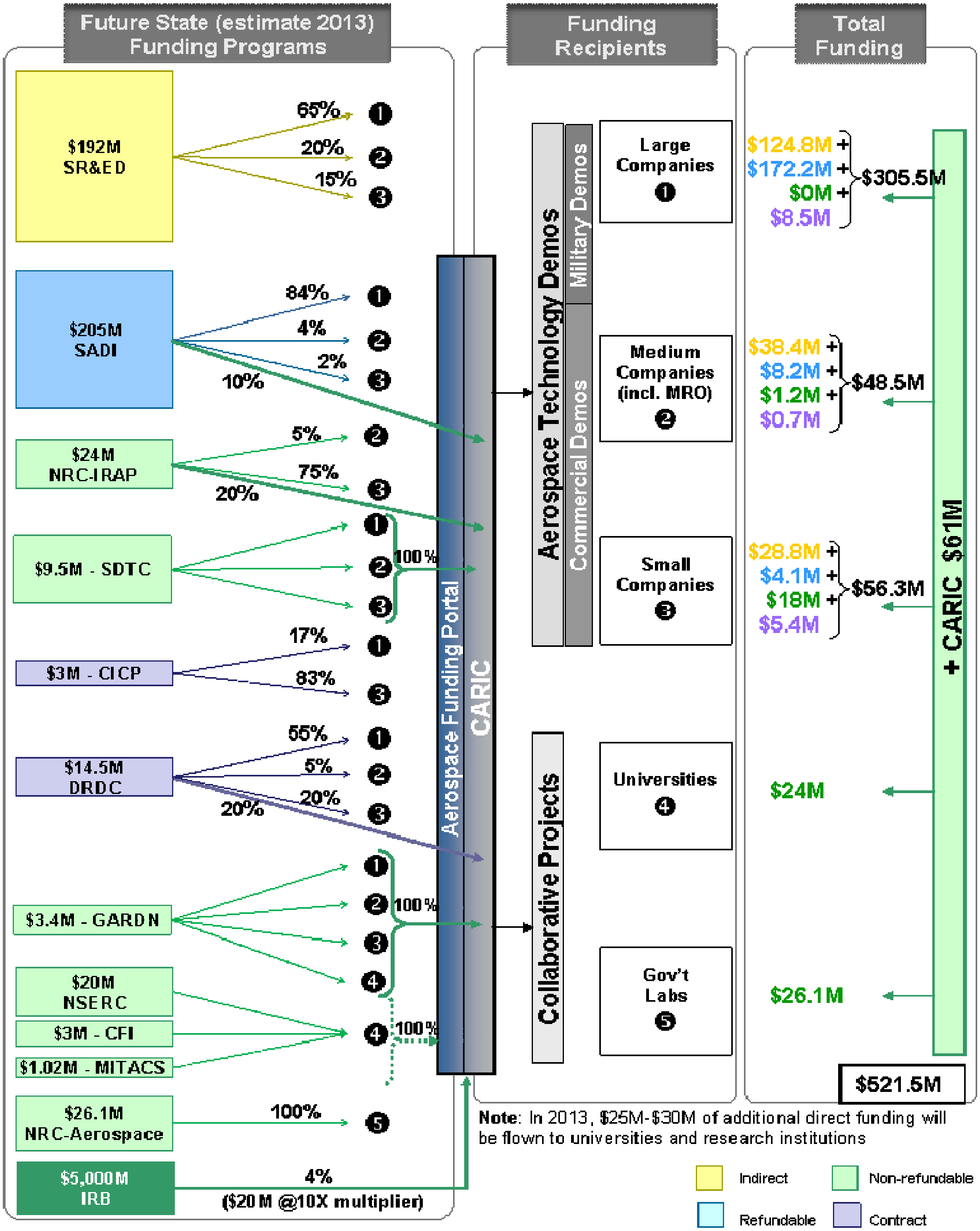
The key highlights are:

a) Increase the annual R&D intensity of the aerospace industry from 6.5% to a minimum of 10%
b) Simplify access to aerospace funding and training programs through one portal
c) Create a Canadian Aerospace Research and Innovation Consortium (CARIC)
d) Focus on technology demonstration programs to ensure the strengthening of the Canadian supply chain
e) Access Industrial and Regional Benefits (IRBs) program to fund technology demonstration

The aerospace funding map for 2013, included below, recommends the following changes over the 2012 baseline: reallocation of 10% of the SADI funding, 20% of IRAP funding and 20% of DRCD funding respectively towards collaborative technology demonstrators (commercial or military), establish the Aerospace Funding Portal and the Canadian Aerospace Research and Innovation Consortium (CARIC), as well as the implementation of the new IRB program to allow the utilization of a small (4-5%) portion of the unallocated offsets to fund demonstrators.

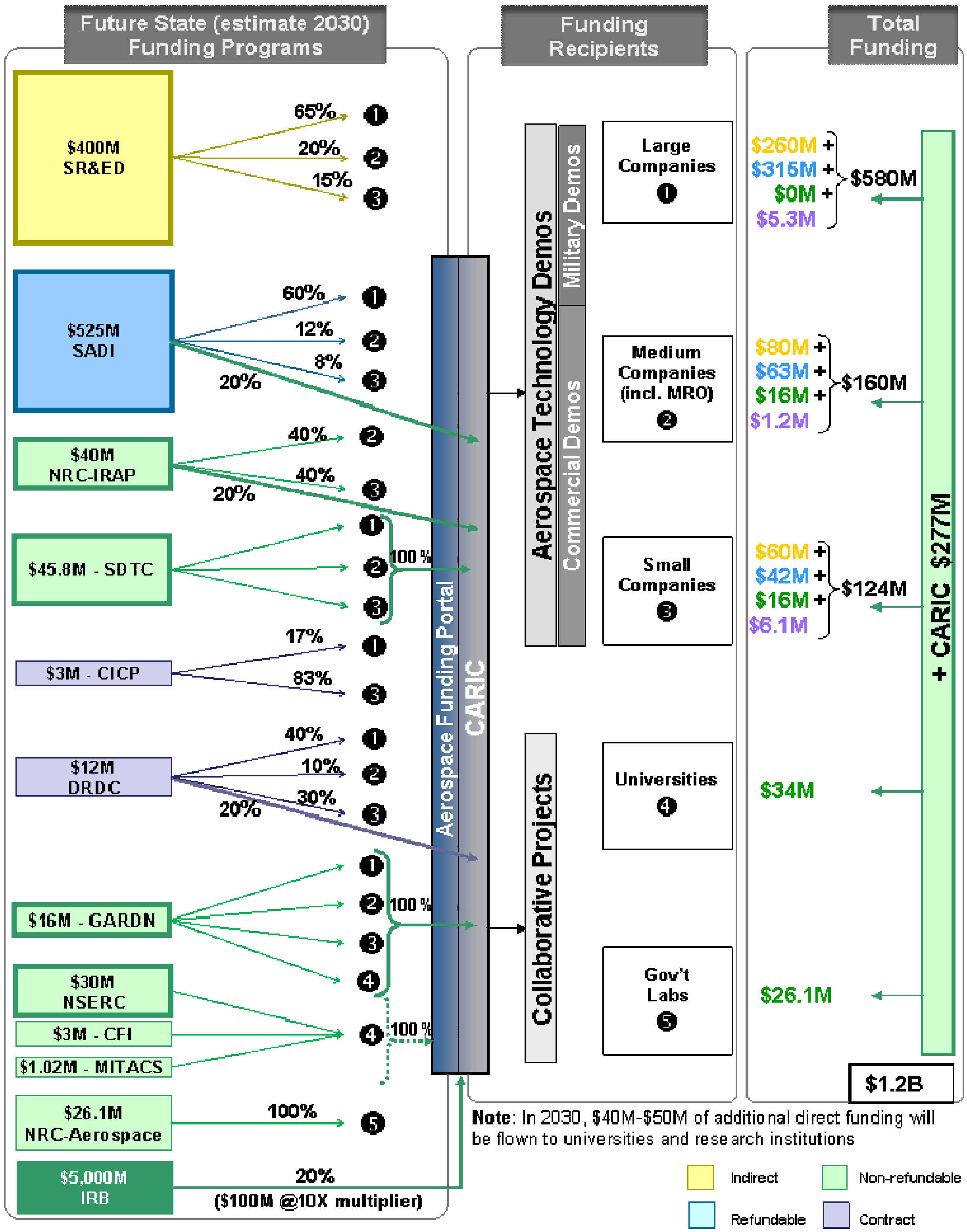
Further below, the 2030 funding map shows an increase in redeployment of funding towards collaborative technology demonstrators. It will be implemented gradually between 2013 and 2030, for a target budget of $277 million. Additionally, the estimated funding available should grow in line with increased sales and R&D intensity (details in Annex 8). The university funding for fundamental research should also increase (as a percentage of total available funding) to maintain a full pipeline of emerging technologies.

Government Funding – Future State (2013 estimate)



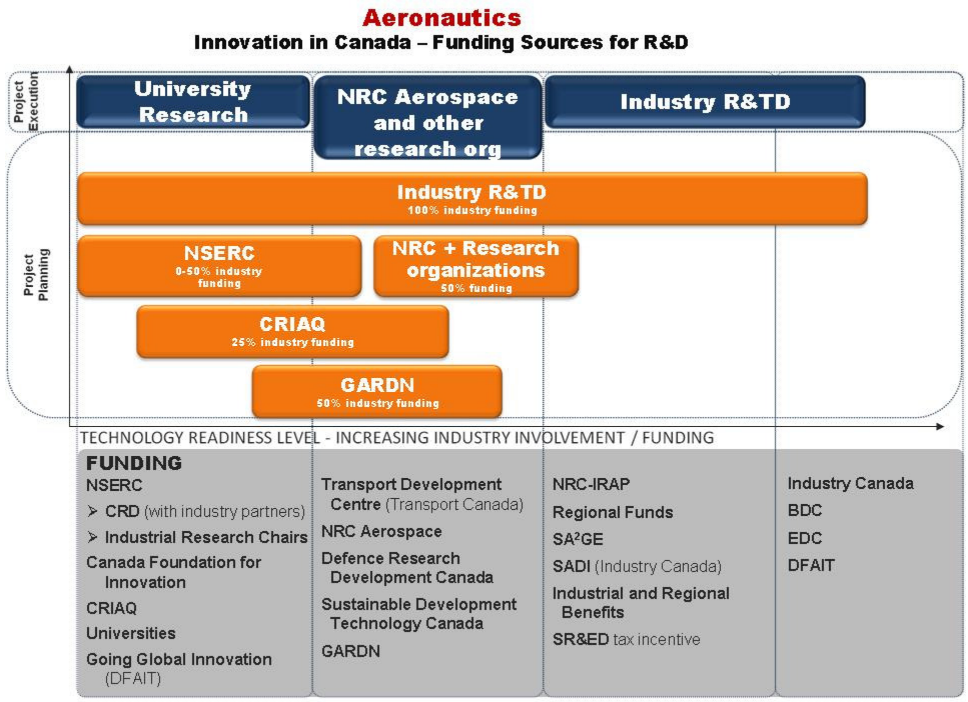
Industry Funding (2013 estimate) = $2.1B

Government Funding – Future State (2030 estimate)



Industry Funding (2030 estimate) = $3.5B

Recommendation 1	Complete a coherent National Aerospace Vision 2030
Rationale	Strengthening the position of top tier OEMs as world leaders in their respective market segments will ensure the growth and maturation of their respective supply chains over the next 20 years, with the final goal of delivering national wealth and sustaining a top five global ranking. Within Canada, Québec and Manitoba have intentional strategic research and innovation visions that include aerospace policies, with support for technology R&D and commercialization being a key component. The United States and mature aerospace nations in Europe, as well as several emerging competitors also have clearly defined national aerospace strategies. This approach is helping competitors to gain market share, and Québec and Manitoba to be recognized for aerospace excellence. A deliberate national approach to aerospace and space will ensure that knowledge generated by universities and research centers reaches industry and is embedded in the supply chain for commercial exploitation. The approach should address the various challenges facing the sector through adequate support to R&D clusters, innovation networks, technology-validation programs, and product development (Annex 9).
Action	The coordination of this approach should be done through a Technology Council of AIAC. This Council will reaffirm the Canadian strategic research and technology agenda as defined by the Canadian Aerospace Environment Technology Roadmap CAETRM (2009 and 2012)[10] establishing future technology needs, and the Future Major Platform FMP technology report (2008)[11] which defines the niche technologies that fit Canadian strengths.
Case Studies	Québec, Manitoba, US, UK, Europe, Brazil, China
Recommendation 2	**Optimize the Canadian technology funding strategy for aerospace**
Rationale	In order to be competitive, firms invest their own funds in R&D to develop their own technology or to have technology developed by partners that can give them exclusive rights for a sufficiently long time. There is also some technology that can only be developed by firms that are specialized in a market segment. Investments in new platforms will produce advanced new aircraft architectures, more efficient propulsion systems, and sophisticated communication, navigation and surveillance systems. Investments are also needed in advanced composite structures, more electric aircraft systems, solid state electronics technology, simulation, and knowledge-based decision making. Other developments that will increase the efficiency and overall competitiveness of the industry are: multi-platform technology development and insertion; off-the-shelf advanced technologies; concurrent and collaborative design; manufacturing automation; additive manufacturing; and machine-to-machine communications combined with 3D modeling. Some of these developments can also produce technological spillovers in other industrial sectors. The industry will also need to focus on aircraft end-of-life issues and optimize recycling strategies for all components and materials. The intensity of these investments, affected by the economic slowdown, is not sufficient to face current globalization and environment challenges. To support the new deliberate national approach to the sector, a technology and funding road map must be established with adequate and sustained funding across all technology readiness levels and stakeholders to cover R&D activities until 2030. Funding must be provided in four areas: infrastructure, projects, people and collaboration, with time to commercialization reduced by moving away from the linear model of innovation (where university, research centers, and industry work in sequence on technology maturation) to a collaboration model with nearly continuous interaction between stakeholders, as shown in the 'Future State' chart on page 16.
Case Studies	Successful technology funding strategies for the aerospace sector, including for demonstrator programs, were launched in Europe and the United States to support their OEMs and SMEs.
Action 2.1	**Increase the annual R&D intensity of the aerospace industry from 6.5% to a minimum of 10% to realize the 2030 vision**
	For Canada's aerospace technology to stay competitive, the level of investment by both industry and government must approach that of our competition, which stands at around 16%.[12] A 10% intensity appears reasonable for the moment although the defence sector will be looked to stimulate our growth and provide for increased sales (currently 77% of sales are commercial and 23% are defence).[13]
Action 2.2	**Simplify access to aerospace funding and training programs through one portal**
	Simplifying the approach to research funding by increasing accessibility and synchronization across programs would contribute to funding optimization. A single-window, internet-based funding portal specific to the aerospace industry could disseminate information about federal, provincial, and regional programs. Representatives from NSERC and SADI could assist companies in developing an optimized roadmap for all programs available at all levels of technology readiness, a sample of which is illustrated below[14].



Action 2.3	**Business Development Bank of Canada (BDC)[15]: Raise limit on capital term loan program**
	BDC promotes entrepreneurship through highly tailored financing, venture capital and consulting services to entrepreneurs. The limit for the working capital term loan program should be raised to $2 million with terms that are less demanding than those of a commercial bank. This is especially important to SMEs with limited asset bases.
Action 2.4	**Canada Revenue Agency: Streamline the SR&ED tax credit**
	Canada is enroute to eliminating tariffs on all imported manufacturing inputs by 2015, including chemicals, fibres, stone, glass, metals, tools, machinery and equipment. While this affects aerospace indirectly, the specific indirect incentive for aerospace R&D is the Scientific Research and Experimental Development (SR&ED) tax credit. This program is directed at projects that have: technology uncertainty; technological content; and technological advancement. It is the largest single source of Federal Government support for industrial research and development, giving claimants cash refunds and/or tax credits for their expenditures on eligible R&D work done in Canada. The 2012 Federal Government budget reduced this credit from 20% to 15% for non-Canadian controlled private corporations (CCPC) and made capital expenditures ineligible, among other changes. Prior to credit reductions, aerospace averaged 6% of the $3.5 billion SR&ED credits granted in 2010 although the sector performs 10% of all R&D performed in Canada. A limited survey conducted by this Group indicates that industry investment in R&D is significant and needs to be supported if Canada is to maintain a competitive edge in aerospace. For SMEs, these refundable tax credits are needed to offset labour costs and to support research activities executed as part of product development. For larger firms, the reduction in the tax credit rate and elimination of the credit on capital expenditures will affect short and medium term fiscal projections, slow down the overall intensity with which the sector functions, stifle collaborative relationships, and impede building of the supply chain through cuts to sub-contractors. There is great concern that the proposed cuts to SR&ED will lead to fewer R&D projects, and will create an even greater slippage in our position on the ranking of global aerospace nations. More encouragement is needed for collaborative R&D with stronger participation by government laboratories and universities, and better integration of all technology development performers. Because of the increasing move to international partnerships in product development in a global economy where increasing connectedness allows for work to be performed anytime-anywhere, eligible work performed outside of Canada by Canadian citizens should be increased from 10% to 100%. The Group strongly believes that government should redeploy the funding spared in recent budget cuts towards aerospace industry specific support. A more adequately funded SR&ED program with terms and conditions aligned to the needs of Canadian based aerospace companies is needed. Any changes to

	SR&ED moving forward must recognize that nearly 58% of credits earned in a given tax year cannot be utilized by firms since they are not cash refundable. Funding in support of R&D and innovation should be upfront when the expenditure is made rather than as a credit on money already spent. To this end, the timing of the implementation for the proposed changes to SR&ED is detrimental as many firms have already made substantial R&D investments which, given the cuts, will lead to negative earnings projections for many firms. The transition time must be extended to a 5-year notification period (2012-2017) with a 5-year phase-in (2017-2022) to ease this burden. A balanced approach of tax incentives and improved direct funding support is suggested. Specifically with respect to tax incentives, the Group recommends ***making SR&ED ITCs refundable and non-taxable for both labour and capital expenditures at the new proposed rate of 15%***. Savings from the reduction of the ITC for non-CCPCs from 20% to 15% should be redeployed back into the program in order to make the SR&ED ITCs refundable starting in 2015 (or following the Group's proposed phase-in period if the government has not achieved a balanced budget by 2015). Due to the capital-intensive nature of the industry, even a moderate amount of capital expenditure is critical. In order to simplify the program, the credit would become non-taxable.
Action 2.5	**Support the Canadian Space Agency's Space Technology Development Program (SDTP)[16]**
	Greater support for the space program is needed, including through increased use of defence budgets to support space-related technological development in Canada. Procurement should be evened out over time to avoid volatility in demand.
Action 2.6	**Department of National Defence and Defence R&D Canada: Support integrator capabilities and exportable products**
	The Defence Industrial Research Program (DIRP) leverages industry-initiated research projects to introduce new and innovative technologies into the Department of National Defence and the Canadian Forces. This program cost-shares projects with a budget of between $3-5 million annually. DRDC also uses the Technology Demonstration Program (TDP) to impact future defence capabilities by demonstrating the military utility of emerging concepts and technologies. The TDP program has an annual budget of between $30-40 million with more than 70% contracted to industry partners. Early stage research projects designed to advance the defence science knowledge base and investigate novel and emerging technologies are funded through the Applied Research Program (ARP) with annual funding of approximately $50 million and 35% contracted out to industry partners. Funding will also be provided for university-based research, training and research-related activities carried out in collaboration with DND, NSERC-CRD, and Canadian-based companies in order to build strong linkages. The program seeks to capitalize on the complementary R&D capacity existing in universities and in DND in order to generate new knowledge and support the development of new technical capabilities relevant to the development and application of dual-use technologies in selected areas of interest. A significant portion of these investments, approximately 20%, should be directed towards supporting military technology demonstrators. As such, federal acquisition programs—DND in particular—should support the development of integrator capabilities as well as exportable products and services.
Action 2.7	**Expand the Green Aviation Research and Development Network (GARDN) [17]**
	This Business-led Network of Centres of Excellence (BL-NCE) supports competitive Canadian aerospace products and services, the economic success of member companies, and the development and training of highly qualified personnel in the aerospace environmental field. With a four-year investment provided by NSERC (90%) and the Social Sciences and Humanities Research Council of Canada (10%), GARDN is tackling research themes such as aircraft noise, emissions, materials, operations and manufacturing processes, alternative fuels, and product life-cycle management on a 50% non-refundable basis. With Pratt & Whitney Canada, Bombardier Aerospace, Esterline CMC Electronics Inc., eight Canadian universities, and four well-established SMEs collaborating on this project which is managed jointly by the AIAC and the Consortium for Research and Innovation in Aerospace in Québec (CRIAQ),[18] this is an excellent example of collaboration in the sector. The BL-NCE program was recently made permanent by the Federal Government and GARDN should be expanded as it applies for renewal and increased funding.
Action 2.8	**Industry Canada: Canadian Intellectual Property Office (CIPO)[19]**
	CIPO is responsible for the administration and processing of the greater part of intellectual property in Canada including patents; trademarks; copyrights; industrial designs; and integrated circuit topographies. In the future, the strategic significance of IP is expected to grow. The Group envisages increased interaction with CIPO, particularly for significant input to IP policies within federal contracts. On the one hand, the government needs to support industry in creating the constructs that allow for Canadian IP to be retained and procured, and on the other, the government must allow industry the flexibility of using IP strategically to

	increase sales, particularly in emerging markets. Greater flexibility in contract terms and conditions flowing from government to industry must be considered and CIPO has a role to play in communicating and sharing IP strategies and best practices with the whole of government.
Action 2.9	**Industry Canada: New program possible for Industrial and Regional Benefits (IRBs)**
	The IRB model has been adopted by more than 35 countries to create some level of demand for innovation of products and/or services as a result of defence procurements. While current IRB policies acknowledge the importance of directing funding to research and development activities, and to small business in particular, the policies themselves have not achieved significant results since most IRBs are still allocated to the purchase of off-the-shelf items from existing supply chains of prime contractors who have incurred the IRB obligations. Within the context of stimulating Canadian suppliers, integrators and service providers with high-value work, the IRBs should introduce significant multipliers for indirect offsets that involve technology transfers. In the wake of what can be seen as a re-shoring trend, the industry proposes a collaborative model to develop aerospace suppliers aimed at fostering manufacturing excellence and innovation across the entire Canadian aerospace supplier base to permit mastery of next-generation manufacturing processes and technology. The enabler of such a model would be a manufacturing development fund financed by Primes having offsets requirements through a not-for-profit organization based on the Canadian Composites Manufacturing R&D Inc. (CCMRD) model, in exchange for a special offset agreement on a pre-established (10x) multiplier package. In addition to ensuring financial support to projects from these Primes, this would also create new supplier value chains. As well, we advocate emulating this 'Excellence in Manufacturing' type of model for medium and large firms but under a theme of 'Innovation with Technology'. Such a model would also provide for a pre-established (10x) multiplier if a Prime subcontracts to a firm that is the recipient of a direct government incentive in the context of a technology program or demonstrator. Given that the objective of the direct government incentive program is to foster collaboration and engage with universities and research institutes as well as to stimulate SME activity within the supply chain, such a multiplier would provide added incentive to orienting the right type of IRB into the high value chain. It is envisioned that by 2030 the aerospace industry will access approximately $1B in IRBs, with a 10x multiplier, resulting in $100M of direct funding to be mostly allocated to technology demonstration. The model should be implemented in the near future (2013), allowing the industry to capture a small percentage (4-5%) of the unallocated offsets. Finally, the combination of significant military procurement, the support of PWGSC's Office for Small and Medium Enterprises, and an established IRB policy framework represent a significant opportunity for the utilization and enhancement of innovative SME aerospace companies in Canada.
Action 2.10	**Industry Canada: Streamline and stabilize funding for the Strategic Aerospace and Defence Initiative (SADI)[20]**
	As indicated within Action 2.4, the Group advocates an effective combination of indirect (SR&ED) and direct programming as the optimal funding mechanisms to stimulate growth over the next 20 years. SADI is undersubscribed due to a number of factors, including the administrative burden, more limited risk sharing than was available under TPC, restrictions on the use of intellectual property and the location of manufacturing activities, broader economic conditions and low awareness. The program's financing terms are structured in a risk avoidance way, which is inconsistent with the fact that some level of inherent risk is associated with achieving innovation. The application and negotiation process can be overwhelming for a small business, even for companies with over 50 employees. Finally, the repayment terms are onerous for SMEs and would likely stymie attempts by them to commercialize any R&D performed under the program. A review of SADI reveals that SMEs are under-represented among users of the program. The SADI program, or the vehicle ultimately chosen for direct funding, should be made into a longer-term, predictable financial tool to encourage firms in Canada to stay on a long-term basis, and to attract foreign firms into making Canada the base for their R&D headquarters. By 2030, a streamlined and simplified SADI should have the capacity to support the growing industry that will have almost doubled its sales and R&D intensity. Hence the recommendation is to grow SADI's capital in a similar fashion, to approximately $565M annually. A portion of this capital will be re-allocated to initiatives dedicated to greening the aerospace industry, mostly in the area of technology demonstration and commercialization, such as SDTC ($30M) and GARDN ($10M). The remaining budget should support Research & Technology projects (TRL 1 to 6) with non-refundable grants (50% industry, 50% SADI) and product development (TRL 7 to 9) with WTO-compatible refundable aids. A particular focus should be on technology demonstration and integration (TRL 5 to 7), with a dedicated budget of $100M annually by 2030, to be allocated as various levels of non-refundable funding depending on the nature and size of the

	recipients (e.g 100% for research institutions, 50% for small and medium companies, 30% for large companies). This will remove the 'valley of death' in the innovation chain and level the playing field with Europe and the United States in mitigating high technology maturation risks. This will result also in increased collaboration with Europe through joint technology calls as advocated by the CANNAPE initiative and currently supported, with very limited coverage, as shown in Annex 7. It should be noted that stable, predictable and balanced funding, across both TRL levels and recipients, is essential for this program, as for all funding programs discussed in this report. Moreover, full implementation of the recommendations targeting the improvement of funding programs will be critical to the continued success of the aerospace industry. Although most recommendations refer to the 2030 landscape, there are several immediate changes that could deliver improvements even within the next 12 to 18 months (both scenarios are captured in the charts included in this section of the report on pages 15 and 16 respectively).
Action 2.11	**Introduce an Aerospace Technology Demonstrator Program**
	An Aerospace Technology Demonstration Program that centers on technologies for the future (lowering costs, improving the environmental footprint, and increasing the safety of citizens) is needed. This should be a sub-component of an existing program like SADI. This program is essential for Canada to keep up with massive technology investments in competing countries. It should be non-repayable like it is in competing programs in the United States and Europe, and support both labour and material. Non-repayable assistance would facilitate the transition of companies towards more integration capabilities, develop systems engineers, and increase cooperation between companies at a research level reasonably close to commercialization. However, it must be managed without the cumbersome bidding structure that is in place for the FP7 European model. It must be accessible to firms of all sizes, not just small firms, since large and medium sized firms often lead demonstrations. Particular and urgent support is needed for a flying test bed to demonstrate integrated technologies; an engine test bed; a cognitive environment test laboratory; and next-generation simulation platforms. As well, SMEs need support to help them achieve the required level of 'technical standing order' for placing their products on OEM equipment. Support is needed across the board to increase Canadian content in integrated programs through 'Made in Canada' technology platforms and demonstrators, and programs involving all stakeholders, including OEMs, SMEs, research centers, and universities. In addition, a military variant of the technology demonstration program must become a place to join R&D and defence procurement in a seamless continuum, allowing for research programs to be showcased internally and for low-rate initial production (LRIP) to take place where promising technologies have been demonstrated.
Action 2.12	**National Research Council (NRC): Consult with Industry on NRC Aerospace[21]**
	NRC Aerospace is Canada's national aerospace laboratory which operates significant infrastructure and undertakes strategic R&D, and technical services. It has about $500 million worth of existing infrastructure to support aerospace R&D and conducts a substantial amount of collaborative research, primarily focused at mid-TRLs on the design, manufacture, performance, use, and safety of aerospace vehicles. This research is currently funded at 55% by industry. NRC is a catalyst for aerospace innovation and competitiveness, and an independent scientific and technical service provider and advisor to other Canadian government departments and agencies. NRC Aerospace is therefore particularly well-placed to contribute to the actualization of any federally supported technical demonstration program. To optimize its use and encourage maintenance of this national resource, NRC Aerospace must align their research agenda closely with overall industry plans. The transformation of NRC may have already started with the change in approach to a mission organization, but the Group would like to contribute to defining the best avenue for the redeployment of NRC Aerospace.
Action 2.13	**NRC: Stabilize funding and target collaborative projects with SMEs in the Industrial Research Assistance Program (NRC-IRAP)**
	NRC-IRAP was recognized in the Jenkins report[22] as providing valuable support to industry for R&D projects. It is estimated that 10-12% of its budget goes toward aerospace-related technologies. To help offset the changes to SR&ED, an additional $110 million has been allocated to this program. NRC-IRAP is only accessible to firms under 500 employees and part of its success is due to its delivery model whereby it provides business and technical mentoring to guide firms along the innovation process. NRC-IRAP is also involved with other government departments by delivering the Youth initiative for HRSDC and assessing the technical value and readiness of proposals for PWGSC's Canadian Innovation Commercialization Program (CICP). NRC-IRAP has also been asked to deliver the Digital Technology Adoption Pilot Program (DTAPP) until March 2014 with a total non-reimbursable budget of $25 million per year. The recommendations for this program are threefold. First, stable funding for NRC-IRAP is necessary, with

	a clear commitment to support SME participation in collaborative projects with top tier companies; as such, the budgeting process should be revised to give a clear commitment for multi-phased projects. Second, since NRC-IRAP is increasingly involved in collaborative projects (CRIAQ, CCMRD, RIADI) and there is very good potential for more of these, contractual terms and conditions such as 'stacking rules' must not inhibit further collaboration. Third, while NRC-IRAP is by nature non-sectoral, a sub-program, IRAP-Aerospace, could be created specifically to support the growth of the aerospace sector, including specific allocation of funding to support collaborative technology demonstrators. Terms and conditions should be tailored to the unique needs of aerospace.
Action 2.14	**SDTC: Evolve Sustainable Development Technology Canada (SDTC)[23] into an aerospace 'Clean Sky-like' program**
	SDTC funds groundbreaking technologies and fast-tracks their progress, helping entrepreneurs connect with partners, formalize business plans, and qualify for venture-capital financing. Specifically, SDTC funds the demonstration of innovative technological solutions that address climate change, air quality, clean water, and clean soil; and has supported the establishment of first-of-kind large demonstration-scale facilities for the production of next-generation renewable fuels. This program could feed into a model for aerospace that is similar to the European Clean Sky[24] program to fund a framework of environmental technology demonstration projects.
Action 2.15	**NSERC: Designate aerospace as a new Strategic Sector for Strategic Project and Network Grants; and change the CRD contribution to 3:1**
	NSERC programs are viewed as highly effective, and industry and research institutions would welcome broader and more strategically targeted assistance from this source. These programs have seen a strong increase in demand from the sector in recent years and NSERC has responded with matching funds. Two recommendations are proposed to improve NSERC support to the aerospace sector. First, CRD grants should be set at a 3:1 matching ratio. The sector relies on NSERC as the primary source of funding for pre-competitive research (TRL 1-4). Both CRDs and IRCs require a significant cash contribution from industry at up to a 2:1 ratio, but by combining an NSERC-CRD with a CRIAQ contribution, industry has been able to leverage its cash contributions to a 3:1 level. This ratio should become the CRD standard. Second, while these programs are excellent forms of support, it is noted that more fundamentally, aerospace is not targeted as a strategic area by the Federal Government and this limits the amount of benefits available through them, particularly for the Strategic Project and Network Grants. In 2007, the Government of Canada, through a consultation process facilitated by the Council of Canadian Academies (CCA), identified four Science and Technology (S&T) strategic target areas for Canada that would benefit from these grants; aerospace was not among them. These target areas "embody the key challenges and opportunities in research and training deemed to have the greatest potential to strengthen Canada's future development. These investments are intended to lead to innovations in industry (wealth creation) and to help to set policy, standards and regulations (public policy), thereby strengthening our economy and improving the quality of life of Canadians." Like these four strategic areas, aerospace also offers significant opportunities for social and economic benefit to Canada; has a critical mass of research expertise in Canada; has a need for that expertise to be strengthened to improve on Canada's leading global position; faces a pressing need for more qualified personnel in Canada; and has a strong potential to bring the country to new levels of prosperity. As a result, aerospace firms will increase the intensity of their collaborative programs with Canadian universities and consequently by 2030 university aerospace collaborative research will access more of the programs and funding opportunities offered by NSERC, in excess of $30M / year. Even though Strategic Projects Grants do not require industry cash and only a small portion of aerospace research falls under the designated strategic areas, the sector needs access to these grants to ensure that Canada's top aerospace researchers are funded at a level where they can make significant contributions to the industry's competitiveness. It is proposed that when the S&T Strategic Areas are reviewed by the CCA, a Sector approach is considered with aerospace recognized as one of the target Sectors. In this way, special access to the valuable Strategic Project and Network Grants will be facilitated.
Action 2.16	**Public Works and Government Services Canada (PWGSC): Continue support for Office for Small and Medium Enterprises (OSME)[25]**
	A valued resource to aerospace SMEs, the OSME works to reduce barriers in an effort to ensure fairness and assist SMEs in building relationships as they seek out new opportunities. OSME actively promotes a culture of engagement between industry and various federal government departments. As previously mentioned, the combination of significant military procurement, OSME, and an established IRB policy framework represent a significant opportunity for the utilization and enhancement of innovative SME

	aerospace companies in Canada.
Action 2.17	**Provide sustained support for MROs**
	There is a significant market for updating and upgrading existing transport, military and general aviation aircraft over the next decade. These programs use a highly skilled labour force of engineering, program managers and certified mechanics to complete freighter conversions, missionize commercial aircraft, convert commercial platforms to aerial fire-control tankers, modify aircraft into high fidelity trainers, update avionics and sensor suites and re-engine aircraft. These opportunities represent over $20 billion of potential business with over 1,500 aircraft needing work over the next decade. Our technology roadmap should ensure that Canadian firms are prepared to capture this high-value market that extends the traditional MRO capabilities. MROs need support, including through government procurement programs, to successfully transition from overhaul & maintenance to value-added solution providers that build IP protection through Supplement Type Certificate (STC) portfolios and process/product development. MRO employment has been hard hit by the off-shoring of commercial carrier narrow-body and wide-body work to low cost regions. In the wake of several recent MRO bankruptcies (AVIOS, Exeltech), a focused effort must allow for the remaining MRO providers to reposition their businesses to compete on the world stage, particularly for: Hardware Technologies such as: ▪ Composite and bonding repair; ▪ Advanced non-destructive testing; ▪ Coating and surface modifications; ▪ Advanced joining and machining; ▪ Advanced inspection process; ▪ Green cleaning, stripping, painting and processing methods; ▪ Additive repair and manufacturing. Information and Integration Technologies: ▪ Health and usage monitoring; ▪ Life predication and simulation technologies; ▪ Advanced cabin entertainment and management system integration; ▪ Advanced sensor integration; ▪ Program management and systems engineering.
Action 2.18	**Provide sustained support for SMEs**
	As important members of the supply chain, technology support programs such as SADI and NSERC need to be properly scaled for small business, since a 'one size' government policy does not fit all. Specifically: ▪ Programs and policy initiatives must respond to the particular realities of small business. ▪ Programs such as CICP should include a portion dedicated to small business. ▪ For small manufacturing aerospace firms, programs to support non-recurring costs of taking on major new business contracts are needed. ▪ Funding support should include favourable interest rates; slow repayment; and government-backed security to help secure funding from commercial sources. As well, a government-backed venture capital facility should be made available. ▪ Providing loan guarantees and removing restrictive conditions for these loans to allow access to commercial financing facilities. ▪ Also needed are EDC programs that allow for a reasonable portion of company growth based on new international contracts as small business credit should not be tied as strongly as it is now to current revenues. ▪ Programs to provide 'gap' financing, especially on major programs and platforms such as new aircraft (C Series and F35), and other fixed-maturity plans are desperately needed by small firms. ▪ SME investments in process and capital equipment should be considered equally with investments in R&D, and the applications evaluated on business metrics rather than employment metrics. Programs and policy initiatives must respond to the particular realities of SMEs and must ensure that support for conventional R&D is relevant over a range of technology readiness levels. This support would ideally consist of financing with a risk mitigating non-repayable factor, no encumbrance on information technology, and willingness to be a first purchaser. Technical demonstrator programs should financially encourage inclusion of small business. Canada has only recently begun to broaden its programs to include this type of support through procurement programs similar to CICP,[26] and it has typically used this sort of model through a variety of programs offered by the Canadian Space Agency. However, funding for these initiatives still lags far behind other nations. Some countries use set-aside programs to further social and economic goals within their country, the one managed by the Small Business Administration in the United States being the most extensive program of its kind in the world.[27]
Action 2.19	**Transport Canada: Provide adequate staff support**
	Transport Canada must ensure that its staffing is maintained at a level that will help the industry to be

	internationally competitive. This is necessary for both product development and MRO support.
Recommendation 3	**Foster collaboration in the sector**
Rationale	As the aerospace sector becomes increasingly global, international partnerships and joint ventures are becoming more relevant, which means that Canadian companies can capitalize on their ideas and projects; infrastructure and labs; and collaboration and networks. However, most research occurs within the OEMs and large suppliers, while not enough innovation is taking place in smaller firms which are often unable to absorb the risk, delays, and costs of a long-term investment. Even if this investment results in a new product or service, smaller companies might still not have the necessary resources to commercialize and exploit their success. To this end, Canada needs more collaboration as in the GARDN model where SMEs work closely with OEMs on technology development, leverage infrastructures and university resources, and increase the number of highly qualified personnel in the regions.
Action 3.1	**Create a Canadian Aerospace Research and Innovation Consortium (CARIC)**
	Canada needs a business-led consortium to support the competitiveness of its national aerospace industry through the execution of pre-competitive collaborative R&D and innovation programs in TRLs ranging from 1 to 7. CARIC should be: a) Effective & inclusive: an open innovation model involving all levels of industries including SMEs, universities, and research organizations; b) Comprehensive: active in a wide range of technologies and accessible to Canadian airport operators and airlines; c) Pertinent: a strong OEM leadership; d) Agile and efficient: a lean structure, able to leverage efforts, capabilities, and financing from existing networks and from provincial governments; in addition CARIC should strongly interact with funding programs whose mandate is to support collaborative programs, such as SDTC, GARDN, NSERC, CFI, MITACS, etc. e) Facilitating: through the establishment of blanket IP agreements and project financing strategies; f) International: fostering the participation of Canadian companies and institutions in international R&D collaborative programs such as the E.U. Framework Programs. Talent development will also be part of CARIC's mandate especially as it will help implement a network of aerospace campuses. Under strong OEM leadership, these campuses will offer shared research and innovation infrastructures to companies, universities and other research organizations and plan to deliver TRL 4-7 technology demonstrators linked to OEM and Tier 1 company needs. CARIC will accelerate the path to commercialization as it will facilitate the long steps of turning excellent results from university research into knowledge and know-how actionable in industry. CARIC will be responsible to translate a strong Canadian aerospace strategy into a technology roadmap, to be executed through collaborative pre-competitive projects and technology demonstrators, with dedicated financial support leveraged from existing and improved funding programs. CARIC model will be based on features from proven collaborative consortia such as CCMRD, CRIAQ, GARDN, etc. CRIAQ, a pioneer in collaborative pre-competitive research in aerospace, owes its success to consistent governmental support, strong industrial leadership and effective governance.
Case Studies	The Automotive Partnership Canada initiative allows collaborative research consortia to access the resources of five different agencies under the Industry Canada portfolio (NSERC, NRC, CFI, SSHRC, and CERC) through a single proposal and review process. This streamlined approach could be adapted to the aerospace sector to facilitate collaborative research under CARIC.
Action 3.2	**Support Innovation Centres**
	Innovation centres are a significant boost for SMEs as they bring them closer to OEMs. Continued support for existing infrastructure such as NRC facilities and additional support for new centres where industry, university, and government laboratories will collaborate, would be a means to entice companies to come to Canada. Existing support programs for production capital investment as done by Investissement-Québec should be broadened. To support the growing investment in aerospace collaborative technology development, the prime companies are developing networks of innovation centers. For example, Boeing Phantom Works develops and transitions advanced programs into the business units prior to their reaching the system design and development phase; and EADS Innovation Works operates a global network of technical centers to manage their corporate research and technology laboratories.
Case Studies	Several excellent Canadian programs are in place to address collaboration. In Québec, CRIAQ has been a successful model in connecting stakeholders and acquiring funding to support project activities. The Composites Innovation Center in Manitoba (CIC) [28] has, since its establishment in 2003, completed 268 projects and transferred 37 new technologies into the aerospace, ground transportation, and infrastructure

	sectors by collaborating with 101 different industry and research partners. In addition, the CIC has created 3 not-for-profit spin-offs, including the aerospace focused Canadian Composite Manufacturing Research and Development Consortium (CCMRD). The CCMRD was established in 2010 and works with 14 industry members and partners on TRL 3-7 technology demonstrator projects to leverage IRB, NRC-IRAP and partner funding opportunities. The Composites Research Network (CRN) was established in April 2012 and is a Western Canadian network based at the University of British Columbia. It has as its mandate the creation, documentation, and dissemination of composite knowledge by linking academic and research organizations to industry. CRIAQ, CIC, CCMRD and CRN have different operating models, TRL targets, and funding mechanisms but all would be helpful in developing a national aerospace collaboration model. To support infrastructure enhancement for innovation centres, the Knowledge Infrastructure Program,[29] completed in 2011, is an example of a successful joint federal and provincial government initiative for infrastructure enhancement at universities and colleges to enhance research capacity; help attract new students; and provide a better educational experience for the highly skilled workers of tomorrow. It is expected that aerospace will benefit from this investment through improved quality of research and development at universities; strengthened ability of colleges and polytechnics to deliver advanced knowledge and skills training; and business incubators that were established to support the transfer of new technologies from universities to the Canadian marketplace. Other models such as SA2GE[30]could also be used, expanding them to firms at higher levels of technology readiness and to areas in Canada with an aerospace presence. This would help to align programs and projects, and to develop a national technology road map and funding road map. The work done through the Canadian Aerospace Environmental Technology Road Map (CAETRM) and the Future Major Platforms initiative (FMP) has been successful in defining programs, projects, and a funding road map with levels appropriate to projects of varying scopes.
Action 3.3	**Ensure that conditions attached to federal funding are not unduly restrictive**
	Support programs should enable companies to exploit their intellectual property globally. Conditions on funding programs should be broad enough to cover process improvements and not just product innovation. Support should be at all levels to include SMEs and OEMs in a ratio that is acceptable to all stakeholders, and targeted specifically to successful firms to help them become global winners. Demonstration of new technologies should be supported at the mid-spectrum level with government sharing part of the costs, as is done for the Clean Sky program in Europe. Without consideration to the follow-on from basic research, particularly in mid-spectrum technology development, government will lose wealth and the opportunity to create employment, industry will lose market relevance and opportunity, and universities will have fewer opportunities to help graduates apply their knowledge through highly skilled employment.
Recommendation 4	**Support the continued development of a highly educated and skilled workforce**
Rationale	It is recognized that this issue is covered by a People and Skills Group in the Review, but it is important to note here that there is an urgent need to: improve the training of engineers by emphasizing systems integration and the management of multidisciplinary teams; encourage university-industry exchanges by facilitating training through internships; integrating professors in sabbatical leave in industry; increase participation of industry representatives in teaching and university research; and conduct joint research projects in co-located innovation centers. More young people must be encouraged to consider a career in aerospace engineering by promoting the sector to primary and secondary school students. This can be done by setting-up aerospace technology exhibition and learning centers.

7. Advice to the Review Head

Canada's competitive advantage related to technology development, demonstration, and commercialization has to be clear, focused and effective. The industry will take ownership in sustaining and upgrading its technologies and facilities, and to do so as rapidly as possible. Such a strategic initiative from the industry should be supported by Canadian policies and programs at the federal level.

Therefore, with a view to nurturing Canadian technological innovation and supporting companies at all sizes and technology readiness levels, the Technology Development, Demonstration and Commercialization Group has carefully selected four major recommendations that will increase the intensity of aerospace research and development in Canada; maximize collaboration in the Canadian aerospace sector; and ensure adequate and sustained support for aerospace over the next 20 years. In summary, these are:

Recommendation 1: Complete a coherent National Aerospace Vision 2030

Recommendation 2: Optimize the Canadian technology funding strategy for aerospace

- Action 2.1 Increase the annual R&D intensity of the aerospace industry from 6.5% to a minimum of 10%
- Action 2.2 Simplify access to aerospace funding and training programs through one portal
- Action 2.3 Business Development Bank of Canada: Raise limit on capital term loan program
- Action 2.4 Canada Revenue Agency: Streamline the SR&ED tax credit
- Action 2.5 Support the Canadian Space Agency's Space Technology Development Program (SDTP)
- Action 2.6 Department of National Defence and Defence R&D Canada: Support integrator capabilities & exportable products
- Action 2.7 Expand the Green Aviation Research and Development Network (GARDN)
- Action 2.8 Industry Canada: Canadian Intellectual Property Office (CIPO)
- Action 2.9 Industry Canada: New program possible for Industrial and Regional Benefits (IRBs)
- Action 2.10 Industry Canada: Streamline and stabilize funding for the Strategic Aerospace and Defence Initiative (SADI)
- Action 2.11 Introduce an Aerospace Technology Demonstrator Program
- Action 2.12 National Research Council: Consult with Industry on NRC Aerospace
- Action 2.13 NRC: Stabilize funding and target collaborative projects with SMEs in the Industrial Research Assistance Program (NRC-IRAP)
- Action 2.14 SDTC: Evolve Sustainable Development Technology Canada (SDTC) into an aerospace 'Clean Sky-like' program
- Action 2.15 NSERC: Designate aerospace as a new Strategic Sector for Strategic Project and Network Grants; and change the CRD contribution ratio to 3:1
- Action 2.16 Public Works and Government Services Canada: Continue support for OSME
- Action 2.17 Provide sustained support for MROs
- Action 2.18 Provide sustained support for SMEs
- Action 2.19 Transport Canada: Provide adequate staff support

Recommendation 3: Foster collaboration in the sector

- Action 3.1 Create a Canadian Aerospace Research and Innovation Consortium (CARIC)
- Action 3.2 Support Innovation Centres
- Action 3.3 Ensure that conditions attached to federal funding are not unduly restrictive

Recommendation 4: Support the continued development of a highly educated and skilled workforce

This focused support is appropriate to the importance of aerospace to the Canadian economy, would help to raise the profile of the sector, and would foster an industry that is globally competitive into 2030.

Annex 1: Technology Development, Demonstration, and Commercialization Group Members

a) Members of the Working Group

	Name	Title	Organization
Chair	John Saabas	President	Pratt & Whitney Canada
Alternate Chair	Roxana Zangor	Manager, Tech. Collaboration Office	Pratt & Whitney Canada
Vice Chair	François Caza	VP & Chief Engineer	Bombardier
Alternate Vice Chair	Fassi Kafyeke	Director, Strategic Technology	Bombardier
Secretary	Steven Gonzalez	Senior Analyst	Aerospace Review Secretariat
Writer	Rosanna Majeed	President	RMA Writers Inc.
AIAC	Maryse Harvey	VP, Public Affairs	AIAC
Industry	Jacques Giroux	Business Development Manager	ABB
	Marc-André Soucy	Director, Remote Sensing Industry	ABB
	Kevin Russell	VP & General Manager	Asco
	Mark van Rooij	CEO	Avcorp
	Pierre Rioux	Manager R&D	Bell Helicopter
	Eddy Morin	VP, Canada Business Development	Boeing
	Christyn Cianfarani	Director, Gov. Programs, R&D, and IP	CAE
	Nathalie Bourque	VP, Public Affairs and Global Comm.	CAE
	Justin Currie	Chief Operating Officer	Cascade
	Tony Stajcer	VP, Corporate R&D	COMDEV
	Garry Venman	VP Government Services	Discovery Air Innovations
	Brian Bower	VP Fleets and Engineering	Discovery Air Innovations
	Chris Nelson	VP Corporate Development	Discovery Air Innovations
	Patrick Champagne	VP, Cockpits & Systems Integration	Esterline CMC Electronics
	Brian Love	VP, Operations	Field Aviation
	Dave Ibbetson	General Manager	General Dynamics Canada
	Patrice Gauvin	VP, Business Development	Héroux-Devtek
	Larry Fitzgerald	ISC Site Leader	Honeywell
	André Lamarre	Executive Vice President	Hypertec
	Richard Ackerman	VP, Business Development	L-3 Electronic Systems
	John Bagan	Senior Manager, Business Development	Bristol Aerospace Limited, Magellan
	Don Asquin	Engineering Manager, Ottawa	Magellan
	Phil Murphy	VP, Government Relations	MDA
	Wagdi G. Habashi	President and CEO	Newmerical Technologies
	Martin Bélanger	Directeur des Méthodes et R&D	Sonaca
	Kim Olson	Senior Vice President, Technology	StandardAero
	Tony Burgess	Principal	TDM Technical Services
	Philippe Molaret	VP, Engineering	Thales
Stakeholders	Suzanne Benoit	CEO	Aéro Montréal
	Francois Chagnon	General Manager	AQA
	Clément Fortin	President	CRIAQ
	Gene Manchur	Executive Director	Canadian Composites Manuf. R&D (CCMRD)
	Sean McKay	Director	Composites Innovation Centre (CIC)
	Mike Hudek	Manager, Business Dev. and Ops	Composites Innovation Centre (CIC)
	Sylvain Cofsky	Executive Director	GARDN
	Moira Harvey	Sr.Marketing, Comm. & BDM	OCA (Messier-Bugatti-Dowty)
	Dave Kroetsch	President	Unmanned Systems (Aeryon Labs)
	Martin Vézina	Aerospace lead analyst	Deloitte
Academia	Dr. Hany Moustapha	Director	Ecole de Technologies Supérieures
	Dr. Christophe Guy	Director General	Ecole Polytechnique
	Dr. Anoush Poursartip	Director, Composites Research Network	UBC
	Dr. Wayne St. Amour	Director, Applied Research	Nova Scotia Community College
	Dr. David Zingg	Director and Canada Research Chair in Computational Aerodynamics	University of Toronto Institute for Aerospace Studies (UTIAS)

In addition, participants from the following federal organizations participated as ex officio members:

Defence R&D Canada	NSERC
Industry Canada	Transport Canada
FedDev Ontario	Sustainable Development Technology Canada (SDTC)
NRC-IRAP	
NRC-Aerospace	

b) Members of the Sub-Groups

Aerospace Funding	Reflections on Technology Needs	Scientific Research and Experimental Development (SR&ED)	Maintenance, Repair and Overhaul (MRO)[31]
▪ Sylvain Cofsky, GARDN ▪ Philippe Molaret, Thales Canada Inc. ▪ Hany Moustapha, École de technologie supérieure ▪ Martin Vézina, Deloitte ▪ Roxana Zangor, Pratt & Whitney Canada ▪ Mark Van Rooij, AVcorp ▪ Government representatives from Industry Canada, NRC-IRAP, NRC-Aerospace, NSERC, SDTC	▪ John Bagan, Magellan ▪ Tony Burgess, TDM ▪ Suzanne Benoit, Aero Montreal ▪ Martin Lafleur, Aero Montreal ▪ Clement Fortin, CRIAQ ▪ Fassi Kafyeke, Bombardier ▪ Philippe Molaret, Thales ▪ Tony Stajcer, Comdev ▪ Dave Zingg, UTIAS	▪ Nat Ferlaino, Pratt & Whitney Canada ▪ Denise Deriger, Pratt & Whitney Canada ▪ Martin Vezina, Deloitte ▪ Micheline Chaar, Thales ▪ Nina Devito, Thales ▪ Christyn Cianfaranii, CAE ▪ Martin Lavoie, CME ▪ Iain Christie, Neptec ▪ Pilippe Morel, Bombardier	▪ Justin Currie, Cascade Aerospace ▪ Kim Olson, StandardAero ▪ Brian Love, Field Aviation ▪ Patrick Champagne, CMC Electronics

Small Firms[32]	Medium Firms[33]	Large Firms
▪ Tony Burgess, TDM Technical Services ▪ Francois Chagnon, NegoConsult ▪ John Maris, Marinvet ▪ Pat Mann, Patlon Aircraft & Industries ▪ Keith Donaldson, Apex	▪ Philippe Molaret, Thales ▪ Paul Stafiej, Martin Bélanger Sonaca ▪ Larry Fitzgerald, Honeywell ▪ Patrice Gauvin, Héroux-Devtek ▪ Patrick Champagne, Esterline CMC Electronics	▪ Pierre Rioux, BHTC ▪ Fassi Kafyeke, BA ▪ Dan Breitman, P&WC ▪ Christyn Cianfarani, CAE ▪ Philip Murphy, MDA ▪ Sylvain Cofsky, GARDN ▪ Clement Fortin, CRIAQ ▪ Government representatives from Industry Canada and the NRC

Annex 2: Aerospace Review Research Questions

1. How has the aerospace industry evolved in Canada and what role has the Government of Canada played in this evolution?
2. Where are the most likely growth areas (specific sectors, products, services, regions, etc.) for the global aerospace industry, and what are the projected growth patterns over 5-, 10-, 20- and 30-year timelines?
3. What are the likely impacts for the global aerospace industry of the following key trends:
    a. the emergence of new economic powers, notably China, but also India, Brazil, and others
    b. new security and national sovereignty concerns, including the protection of maritime borders and territorial waters
    c. growing concerns about carbon emissions and other environmental impacts
    d. expanding natural resource extraction activity and pressure to intensify agricultural yields
    e. the rapid expansion of global telecommunications and connectivity
    f. What opportunities and challenges do these trends present for the Canadian industry? More specifically, what comparative advantages does (or might) the Canadian aerospace sector have, whether these stem from, for example, a “head-start” in certain areas, the country’s geography or human capital, or existing advantages in other sectors?
4. How will globalization, climate change, commodity demand, transportation patterns, and security considerations shape the development of Canada’s North over the next 30 years? What role can the aerospace sector play in this context? What sorts of technologies, facilities, and human capital will be required for it to fill this role?
5. What sectoral structure is likely to produce the greatest benefits for the Canadian economy over the long term? Will clusters have the same positive effects in an increasingly globalized industry as they had in the past? What role does the presence of OEMs play in “anchoring” the Canadian aerospace industry? Would more tier 1 companies jump-start expansion of the sector? And is the greatest potential for growth found among SMEs?
6. To what extent can the Canadian aerospace sector be considered a “strategic industry” whose benefits radiate well beyond the jobs and shareholder value it directly generates, and to what degree can these benefits be quantified?
7. Given the comparatively long-term, high-risk nature of aerospace-related research, product development, and manufacturing, what options exist for ensuring that there is sufficient investment capital available to allow the industry to take risks, innovate, and remain globally competitive?
8. What are the most important provincial and territorial policies and programs that affect the aerospace sector? What can be learned from them for the purposes of improving federal policies and programs? Is there room for better FPT coordination in this area?
9. Which countries have recently conducted “aerospace reviews” and what were their key findings?
10. What drives innovation and what is the role of the state in stimulating it? What have we learned from, and to what extent can we build upon, previous efforts, including the Jenkins report and Budget 2012?
11. What are the relative benefits of public support for basic versus applied research? Does government investment in applied research tend to leverage or suppress private sector investment in it?
12. How does the investment of Canadian aerospace companies in research and development compare with investments of Canadian companies in other sectors, and investments by aerospace firms in other countries? If there are gaps, what explains them? Internationally, what public policy instruments are used to stimulate innovation, particularly in the aerospace sector? What is the level of support by country?
13. How effective are the major federal policies and programs designed to stimulate innovation/R&D from the perspective of the aerospace sector (e.g.; SADI, SRED, NRC)? How do they compare with historical programs that have been wound down, such as TPC? Do current programs support companies in all tiers sufficiently? What are the barriers to use? Might greater benefit for the Canadian economy be derived from changes to the programs’ terms and conditions?
14. In what ways has the CRIAQ model succeeded and fallen short, and are there elements of this initiative that could be applied nationally?
15. What is meant by “technology demonstration”? Why is support for this considered important? What would be the expected uptake? What would be the likely costs to the public purse and benefits to the aerospace sector and Canadian economy?
16. What challenges does the intermittent nature of defence and space procurement create for industry? Are mitigating strategies required?
17. What is the net economic impact to Canada of the Industrial and Regional Benefits Policy (IRB)? To what extent is it achieving its stated goals? Have recent changes to the policy had any measurable impact?
18. What are the various tools used by offset authorities globally? How might they be used within the Canadian defence procurement environment?
19. Assuming that there is a continuing desire to have major public procurements produce benefits for Canadian industry, what alternatives to the IRB policy exist? Are there lessons to be learned from the JSF industrial participation approach, the OAG’s report on the JSF and the Government’s response to that report, the National Shipbuilding Strategy, EDC’s approach with recipients of significant export financing, and/or the offset policies of other countries?
20. What are the pros and cons of having in-service support (ISS) contracted to primes versus ISS performed by Canadian MRO companies? Why has the former been preferred for recent procurements? What would be the mechanisms, the benefits, and the costs of a shift towards the latter?

21. What are the current trends and issues influencing growth in the global MRO industry? What are the implications for independent firms offering MRO?
22. The nature of global supply chains in the aerospace industry has changed significantly in recent years with the responsibility, and associated risk, for technology development and system integration being transferred throughout the supply chain. This shift requires different marketing strategies on the part of aerospace firms. What are these strategies? How can the Government of Canada facilitate?
23. How do Canada's trade agreements (including national security exemptions) facilitate or hinder the Canadian aerospace's industry ability to conduct business internationally? What is the current status of export controls and how are they impacting the Canadian aerospace industry? Can Canada learn from other countries (e.g., Australia, France, Germany) that may take a looser approach to export controls? Is some loosening possible without creating intolerable risks to national security risks and relations with the United States?
24. What are industry's concerns regarding aircraft certification and aircraft safety requirements in emerging markets? What are the public policy implications?
25. How does Canada's approach to export financing for aerospace products compare with the approaches of other major players? Compared to companies in other countries, do Canadian companies face a financing gap in developing their business in foreign markets? Are international rules for financing aerospace exports likely to change in the coming decade and if so, what are the implications for Canadian companies and public policy?
26. To what extent does gaining foreign market access require – explicitly or implicitly – manufacturing in, or procurement from, those markets? What are the implications for Canadian companies and public policy?
27. What are the current and future human capital needs of the aerospace industry? In what occupations/professions will there be shortages in 10, 15 or 20 years? How can the government better assist the industry in tapping into underutilized segments of the Canadian workforce that would help them meet their human capital needs (women, aboriginal persons). In addition, what support can be provided to industry in accessing skilled workers that have been downsized in other sectors and who just need retraining to participate in this industry? Are there best practices used by governments or industry elsewhere?
28. The aerospace industry is cyclical and, therefore, it is challenging to develop, attract and retain a skilled workforce. What strategies are used by other cyclical industries to overcome this problem, and how can governments assist the industry in navigating this issue? Are there practices used by governments in other mature aerospace nations that we can draw on?
29. Compared to other OECD countries, is Canada succeeding in encouraging young students to pursue maths and sciences in general, and in attracting high-potential students into programs with a specific aerospace orientation?
30. What strategies are used by governments in other mature aerospace nations and/or with respect to other industries to ensure that training programs for students are well-aligned with industry requirements?
31. How do other mature aerospace nations support skills development (internships, research programs) for the aerospace sector? How does this compare with Canadian investment, and is there a demonstrable result in more skilled workers? For instance, what do the National Science Foundation (US) or the Engineering and Physical Sciences Research Council (England) provide to the industry?
32. What do other mature aerospace nations do to facilitate the recruitment of foreign workers? Are changes required to improve the efficiency and effectiveness of Canada's policies and programs in this area?
33. Given that education and training are largely provincial responsibilities -- but also considering the strategic importance of the aerospace industry to the national economy -- what labour market and learning strategies can the federal government use to help address some of the industry's skilled workforce needs?
34. What are the key SME / supplier development initiatives underway in other jurisdictions that could serve as a model for Canada?
35. What are the financing needs of aerospace SMEs? Is this readily available in Canada? Where are the gaps? What are the public policy implications?
36. What are the current and emerging commercial opportunities stemming from new and maturing space technologies, and how can public policies and programs help Canadian companies take better advantage of domestic and global opportunities.
37. In what ways, and to what extent, are space-based assets becoming critical infrastructure for public and private sector activity? What are the implications for Canadian companies and public policy?
38. Is there rationale for Canada to support a domestic space capacity that includes industry, research centres and the academic community? What are the defence and industrial policies and programs used by other countries to support their domestic space capacity? What are the synergies between civil and military space programs in those countries?
39. What are the models used internationally to fund space-related activity, and how do they compare with the Canadian model? What are the levels of public investment (civil and military) in space-related activities in Canada and among other major players?
40. Would investments in space-related infrastructure (e.g., a launcher or high-risk test facility) yield tangible benefits for Canadian companies? Can those benefits be estimated against investment costs?

Annex 3: Definitions

Demonstration: There is no common, accepted definition of what constitutes a Technology Demonstrator (TD). The general Canadian definition is to target and/or validate technological solutions to new or emerging operational and/or systems concepts. Proof-of concept investigations based upon new or emerging technologies are conducted, in addition to narrower risk reduction initiatives for equipment acquisitions under advanced development. The following definition, mainly for military use may be used for the purposes of this report. Further details can be obtained from the source mentioned below.

- To demonstrate whether advanced technology can enhance significant equipment/functional capability in defined military capability areas.
- To demonstrate and validate the efficacy of novel technology to new or emerging military forces operational and/or systems requirements.
- To act as a focus and catalyst for the integration of complementary technologies in a system context. Key aims and objectives are to assess and demonstrate successful and effective integration into a system solution. Technologies from within a single Group and across Groups should be considered.
- To act as a vehicle for the identification and reduction of technical risk and the quantification of residual risk in taking through the TD product to full development, production and eventual operational deployment.
- To construct a demonstrator system of military relevance and application, allowing interoperability with the participating nation's existing equipments to be assessed.
- To provide a co-ordinated technology set that can be demonstrated and assessed by military users. This will assist in the pull-through of research into possible future projects.

Source: The Technical Cooperation Program. (2012). *TTCP Overview*. Retrieved June 22, 2012, from http://www.acq.osd.mil/ttcp/overview/

Technology Readiness Levels (TRLs)

Level 1: Basic principles of concept are observed and reported
Level 2: Technology concept and/or application formulated
Level 3: Analytical and experimental critical function and/or proof of concept
Level 4: Component and/or validation in a laboratory environment
Level 5: Component and/or validation in a simulated environment
Level 6: System/subsystem model or prototype demonstration in a simulated environment
Level 7: Prototype ready for demonstration in an appropriate operational environment
Level 8: Actual technology completed and qualified through tests and demonstrations
Level 9: Actual technology proven through successful deployment in an operational setting
Post - TRL Level 10 & 11: Production and Market Development

Source: Public Works and Government Services Canada. (2012). *Technology Readiness Levels*. Retrieved June 14, 2012, from buyandsell.gc.ca: https://buyandsell.gc.ca/initiatives-and-programs/canadian-innovation-commercialization-program-cicp/program-specifics/technology-readiness-levels

Annex 4: Valley of Death Case Study (CAE)

Context/Overview

Operating military helicopters in arid desert conditions is a challenging undertaken which is particularly true during helicopter landing and take-off. Blowing sand dust that severely restricts the pilot's situational awareness is generally described as 'brownout' ('whiteout' in snowy conditions). The resulting loss of situational awareness can severely hamper the pilot's ability to safely control the aircraft within the environment causing crashes.

Helicopters crashes in theatres of military operations in desert climates are examples of the many accidents that have occurred not only in military but also in civil aviation. Authorities reacted to the alarming numbers of accidents by bettering pilot training for low or zero visibility conditions.

In response to a perceived market need, CAE launched an R&D project to provide a technical solution that assists the pilot to safely maneuver the helicopter in extreme situations. The resultant proof-of-concept/product, CAE's onboard Augmented Visionics System (AVS), combines in-house CAE avionics, database and display technology with a novel lidar sensor known as OPAL, developed by Ottawa-based Neptec, a small Canadian company. The AVS allows pilots to operate under conditions of low to zero visibility.

Lack of Support from the Canadian Government

Both CAE and Neptec invested private R&D funds to bring AVS to the Technology Readiness Level 6 (TRL 6 - prototype demonstration in a relevant environment). In CAE's case, funding from the Strategic Aerospace and Defence Initiative was used to offset the cash flow required to bring the technology to a readiness level whereby the first flight trials would demonstrate the merits of the investment. The Neptec sensor development was funded partially through internal R&D funding (offset to some extent by SR&ED funds) and through funded R&D projects with both CSA and DRDC.

CAE conducted first flight trials of the integrated AVS on a Bell 412 at the National Research Council in Ottawa end of 2009, which was presented to DND's Department of Flight Safety (DFS) and Directorate of Air Requirement (DAR). Both departments attended CAE's second flight demonstration in Yuma, Arizona in early 2010 and commented positively about the performance of AVS.

Boeing Helicopter, also represented at the Yuma demonstration, described CAE AVS as "best of breed" as a brownout solution. While the Canadian DND has a need for a solution such as AVS, as confirmed by recent serious helicopter accidents due to brownout, the representatives of DND at the AVS demonstration stated that no development funds were available to support the AVS solution.

In order to pursue final product development to qualify the AVS system for operational use and ascertain adequate production release, actual end-user involvement is required to ensure specific requirements, such as flight qualification and user interface, are satisfied. In addition, because the cost of the development that would lead to the productization of AVS for military helicopters has turned out to be prohibitive, CAE was forced to put the AVS program on hold for 2 years while it sought funding outside of Canada. Ideally, this "technological valley of death" would have been bridged by a low-rate initial production (LRIP) made by the Department of National Defence.

Contrast - US Development Programs

The US Government is supporting its aerospace industry in the development of solutions similar to AVS.

In May 2007, Sikorsky announced a contract award from the Defense Advanced Research Projects Agency (DARPA) to develop and demonstrate a system for guiding safer landings in situations where pilots cannot see the ground due to degraded visibility. Flying the RASCAL JUH-60 Black Hawk helicopter outfitted with the prototype 'Sandblaster' system, pilots executed landing approaches in a variety of terrain, including slopes containing potentially dangerous obstacles to safe landings.

The US Government is expected to tender for a purchase of a solution for the problem of "Degraded Visual Environment (DVE)".

US Government as "First Customer" of Canadian Technology

The prototype 'Sandblaster' system is likely the frontrunner for the US Government tender due to its incorporation of DARPA's preferred approach to the sensor (Sierra Nevada Corporation's sensor) and due to the US-based composition of the "Sandblaster "team.

This notwithstanding, Boeing is convinced that the CAE solution is the best technology available today to address the issue of “Degraded Visual Environment (DVE)”. As such, CAE and Boeing are collaborating to showcase CAE’s AVS on an aircraft platform; this would position CAE for the upcoming tender.

Key US stakeholders will be invited to view future technology demonstrations. The Canadian Government may be invited as one of Boeing’s potential “foreign customers” to view the technology at a later date.

In the event that CAE’s AVS is successful through to tender, the US Government may become the “first customer” of Canadian technology leveraged through Canadian taxpayer research and development incentive programs. It is most likely, however, that a US-based company that has accessed DARPA funding will be the recipient of the procurement, with the US Government acting as “First Customer”.

Conclusion

CAE invested private R&D funds to bring AVS to the Technology Readiness Level 6 (TRL 6 - prototype demonstration in a relevant environment). Funding from the Strategic Aerospace and Defence Initiative was used to offset the cash flow required to bring the technology to a readiness level whereby the first flight trials would demonstrate the merits of the investment.

While the Canadian DND has a confirmed need for AVS, no development funds were available to support taking the AVS solution into the domestic market through support by DND as “First Customer”. Using the domestic market as entry point would have better positioned CAE to be a competitor in the upcoming US tender.

Significant funding and support from US services provides US companies a net advantage over foreign products such as the CAE AVS. It is imperative that the Canadian Government review how it functions with respect to its aerospace industry to better policy in the direction of domestic procurement.

From Neptec’s perspective, the AVS initiative is also representative of the significant and substantial gaps in the Canadian government’s approach to technology development and procurement. Through the CSA and DRDC, the government leveraged Neptec’s own early R&D investment in the breakthrough OPAL technology. Given Neptec’s size as a SME, the company’s R&D investment was relatively large. The risk associated with this large initial investment was mitigated to a large extent by the strong and constructive relationship with CAE, which helped Neptec develop a flight worthy version of its OPAL sensor. Neptec believes that this partnership between the two companies should be a model of how a large OEM and a SME should work together to combine their strengths. However, the government’s unwillingness or inability to continue supporting the technology development past TRL 6 meant that this level of collaboration could not be sustained. The OPAL technology still compares favourably with the best technologies available and its worldwide commercialization in the defence market would benefit from having DND as a “First Customer”. The government’s failure to provide support beyond the initial concept development phase of the project has meant that the benefits of its earlier investment have largely gone unrecognized so that the program has been a net cost to the government. If CAE and Neptec had been able to secure support for the next phase of development and commercialisation of the system, it is Neptec’s opinion that the resulting economic benefit of the eventual export sales might very well have turned the project into a net gain.

Annex 5: Aerospace Activities by Province

Alberta: Alberta's aerospace industry contributes $1.3 billion in annual revenue to the provincial economy and is responsible for over 5,000 jobs exclusive of airlines and airports. The industry exports 40 percent of its output. Alberta offers competitive strengths in robotics and unmanned vehicle systems, space science, geomatics and navigation systems, and maintenance, repair and overhaul. More than 50 aerospace companies are located in and around the city of Calgary, with strong clusters in maintenance, repair and overhaul, and information communications technology. Major Alberta companies involved in aerospace include ATCO Frontec, Field Aviation, ITRES, Iunctus Geomatics, Pratt & Whitney, NovAtel, and Raytheon.

British Columbia: Aerospace companies in the greater Vancouver region, such as Avcorp Industries benefit from their proximity to Boeing, located in neighbouring Washington State. British Columbia's aerospace strengths include helicopter services, aircraft engine overhaul, multi-role aircraft maintenance, repair and overhaul, space systems and advanced composite aircraft structures. The industry in B.C. is also supported by one of Canada's largest aerospace training centres, located at the British Columbia Institute of Technology. Leading B.C. aerospace firms include ASCO Aerospace, Avcorp Industries, Cascade Aerospace, CHC Helicopter, Kelowna Flightcraft, MDA (MacDonald, Dettwiler and Associates), MTU Maintenance, Vector Aerospace and Viking Air.

Manitoba: Winnipeg is the largest aerospace cluster in Western Canada and a major centre in North America for the manufacturing of composite aircraft components and aircraft maintenance, repair, and overhaul. The aerospace cluster in Manitoba directly employs some 5,300 people and is led by three major global firms: Boeing Canada Technology, Magellan Aerospace and StandardAero. Winnipeg is the location of one of Boeing's composite manufacturing plants, one of the largest such facilities in North America, and home to one of Boeing's 10 major global sites for commercial aircraft design and manufacture. StandardAero, also located in Winnipeg, is one of the largest independent engine maintenance, repair, and overhaul aerospace firms in the world. Magellan Aerospace (Bristol) has both military and commercial metallic and composite manufacturing capabilities, as well as Space satellite and rocket divisions.

Ontario: Southwestern Ontario is the location of Canada's second-largest aerospace cluster, with over 200 firms employing more than 20,000 skilled employees. The Greater Toronto Area (GTA), the core of this cluster, has key strengths in aircraft parts manufacturing, aircraft systems development, maintenance and overhaul, and its universities. The GTA also hosts many world-leading aerospace firms, such as Bombardier, Pratt & Whitney Canada, Honeywell Canada, MDA Space Missions, Magellan Aerospace, Northstar Aerospace, and COM DEV. The University of Toronto Institute for Aerospace Studies and the Ryerson Institute for Aerospace Design and Innovation collaborate with industry on many R & D projects.

Québec: Montréal is the hub of Canada's largest aerospace cluster and is renowned for its expertise in aircraft assembly, engine manufacturing, maintenance, repair and overhaul, avionics.

Saskatchewan: Saskatchewan's aerospace companies operate in satellite technology, wireless communication systems, atmospheric research and testing, synchrotron research and development, micro-electromechanical devices, building structures, cases and harnesses, mini unmanned aerial vehicles, and training programs. The province's industry employs approximately 2,500 people. Saskatchewan's aerospace companies, located near Saskatoon, include SED Systems, Vecima Networks, Scientific Instrumentation, Summit Structures, SBC Case, and Draganfly Innovations.

Source: Department of Foreign Affairs Canada. *Invest in Canada: Aerospace: Canada's Competitive Advantages*. (2012). Retrieved June 22, 2012, from http://investincanada.gc.ca/download/830.pdf

Annex 6: Examples of R&D Support Programs Linked to Aerospace

Basic and Applied Research	Technology Development and Demonstration	Product and Manufacturing Methods Development	Production	Market Development
1. Canada Foundation for Innovation (CFI) 2. Natural Sciences and Engineering Research Council of Canada (NSERC) 3. Canadian Space Agency 4. Natural Resources Canada-CANMET	1. National Research Council- Aerospace Portfolio 2. Green Aerospace Research and Development Network (GARDN) 3. Strategic Aerospace and Defence Initiative (SADI) 4. Defence R&D Canada (DRDC) - Technology Demonstration Program - Defence Industrial Research Program 5. Sustainable Development Technology Canada	1. National Research Council - Industrial Research Assistance Program (NRC-IRAP) 2. Scientific Research and Experimental Development Tax Credit (SR&ED) 3. SADI 4. Regional Agencies	Business Development Bank of Canada	1. Export Development Canada 2. Canadian Commercial Corporation 3. Foreign Affairs and International Trade Canada 4. Industry Canada

Annex 7: Support programs for CORDIS

<table>
<tr><th colspan="4">Seventh framework programme (FP7) of the European Commission's Community Research and Information Development Service (CORDIS)</th></tr>
<tr><th>Canadian participant</th><th>Funding Available</th><th>Provided by</th><th>Comments</th></tr>
<tr><td>▪ University Researcher
▪ Private Canadian small and medium sized enterprises (SMEs)
▪ Non-government research centres</td><td>Going Global</td><td>DFAIT</td><td>Covers up to 75% of travel costs</td></tr>
<tr><th colspan="4">Direct participation in a FP7 proposal</th></tr>
<tr><td rowspan="2">University Researcher</td><td>FP7</td><td>European Union</td><td>There can be direct funding for Canadian researchers when the expertise they bring is not available in Europe and is considered essential to the project</td></tr>
<tr><td>Discovery grant or IRC (if available)</td><td>NSERC</td><td>Tavel costs, exchange students, direct costs of research for Canadian operations</td></tr>
<tr><th colspan="4">Linked Canadian collaborative project in parallel with a FP7 project <u>OR</u>
Stand-alone Canadian collaborative project parallel but independent of FP7 funding</th></tr>
<tr><td>University Researcher
(with Industrial partners)</td><td>CRD Grant</td><td>NSERC
+CRIAQ funding in Québec</td><td>▪ Travel costs, exchange students, direct costs of research for Canadian operations.
▪ CRIAQ may allow for international expenses and/or funding of services provided by NRC-Aerospace.</td></tr>
<tr><td>Canadian SME</td><td>NRC-IRAP</td><td>NRC</td><td>Provides financial support to qualified small and medium-sized enterprises in Canada to help them develop technologies for competitive advantage</td></tr>
<tr><td>Canadian SME or Large Canadian Company</td><td>SADI</td><td>Industry Canada Industrial Technologies Office (ITO)</td><td>▪ SADI provides Canadian aerospace and defence (A&D) industries with repayable contributions for strategic R&D projects.
▪ ITO calculates the contribution amount for each project on the basis of it being the minimum amount of assistance required to ensure that the project proceeds successfully and generates benefits for Canadians.</td></tr>
<tr><td>Canadian SME or Large Canadian Company</td><td>SR&ED Tax Credits</td><td>CRA</td><td>Encourages Canadian businesses of all sizes, and in all sectors to conduct R&D in Canada.</td></tr>
</table>

Annex 8: Details on recommended funding map for 2030 (estimate)

The following calculations provide details on the recommended amount of funding available with the funding agencies in 2030, taking into consideration three multipliers based on: (a) revenue growth from $21B* to an estimated $35B by 2030; (b) R&D intensity growth from 6% to10% in 2030; (c) specifically for SR&ED, credit decrease from 20% to 15%.

The additional assumptions are: (a) redeployment of SADI funding towards technology demonstrator and other underfunded programs; (b) allocation of funding from existing programs towards technology demonstrator; (b) increased access to 10X multiplier IRB funding; (c) increased access of NSERC existing funding

SR&ED: $192M x sales $35B:$21B x intensity 10%:6% x credit 15%:20% = $400M

SADI: $205M x sales $35B:$21B x intensity 10%:6% = $565M

Allocation: SADI 75% = $425M, Tech Demo = $100M, STDC = $30M, GARDN = $10M

NRC – IRAP: $24M x sales ratio $35B:$21B = $40M; 20% allocated to Tech Demo

DRDC: $12M, 20% allocated to Tech Demo

SDTC: $9.5M x sales ratio $35B:$21B + $30M from SADI = $45.8M

GARDN: $3.4M x sales ratio $35B:$21B = $6M + $10M from SADI = $16M

NSERC: $30M

IRB: $5,000M unallocated, 20% to be accessed at 10X multiplier = $100M

* $21B represents the aerospace industry revenue in 2010, the data available to the working group at the time of performing these calculations

Annex 9: Canadian Aerospace Technology and Funding Strategy

1. Introduction

The Canadian aerospace industry is a vibrant high technology sector strategic to the Canadian economy. The industry plays a critical role in generating national wealth: 21B$ of revenues in 2010, 15.3B$ or 73% on the export market. The industry activities were mostly in the civil sector (19.7B$ revenue or 93.8%), reflecting the reality of a relatively small internal military market. 11B$ or 52.8% were for sales of aircraft, aircraft parts and components. In 2010, the industry supported 81,050 direct jobs, for a 7.2B$ total payroll. Canada's space technologies sector is knowledge-intensive and at the forefront of the global industry. In 2010, total revenues for the space sector reached $3.439B. With 8256 highly workers, including 3,103 engineers and scientists, Canadian space firms have acquired world-leading capabilities in satellite-based communication services, space robotics, and earth observation.
The Canadian aerospace industry comprises a variety of small, medium and large corporations, with a critical mass of top tier platform Original Equipment Manufacturers (OEMs), each serving a diversified, global customer base, offering comprehensive, in-service support solutions over the complete product life cycle. This enviable position of Canada in the 400 B$+ world aerospace market is threatened today by several factors that need to be mitigated through a comprehensive aerospace strategy.

2 - Challenges and Opportunities

The aerospace industry possesses a number of unique characteristics that impact the financing profile of the sector. In particular, the scale, cost, technological, and schedule risks inherent in aircraft development programs limit market appetite and capacity for funding these projects and necessitate a government role. Indeed, innovative technologies critical to new aircraft platforms require significant research and development expenditures well in advance – sometimes as much as ten years – of revenue-generating aircraft deliveries. Even after entry into service, new programs can take more than a decade to simply achieve "break-even" delivery levels. Therefore the sources of capital are low as no return is generated for many years and the risk level associated with the investment is high. This problem is compounded for smaller companies who will have even less ability to invest for the future so when the commercial opportunity arises they are not current with the technology. This causes a shift in global value chains away from Small and Medium Enterprises (SMEs) to larger tier 1 and tier 2 suppliers. In the face of these realities, governments then play a constructive role in providing funding support – compliant with international rules – to their domestic aerospace industries. Government assistance to the aerospace industry not only compensates for insufficient market resources but also produces significant economic, trade, and security benefits for both domestic and international markets.
Technology development must take place ahead of product development and therefore has even longer lead times to the return on the investment. This is the reason why most governments have been supporting this phase with non-refundable funding.
The industry is facing today several challenges, amongst which:

- The need to develop aircraft and systems that satisfy new requirements of customers and regulators, notably more fuel efficiency, reduced environmental impact, greater component durability and reduced cost of operation and maintenance;
- The need to reduce the design and production costs in light of the globalization of markets, the emergence of low-cost producers, particularly the BRIC countries (Brazil, Russia, India and China) and the high Canadian dollar;
- An aging manufacturing base in need of automation and a shortage of tier 1 integrators, both leading to decreasing participation of Canadian suppliers in major new aerospace projects.
- The need to adapt to rapidly changing regulatory requirements, notably on noise and emissions. Also, the speed at which technology is matured and the pace at which products are refreshed in the global economy lead to shorter times to amortize investments in technology.
- The need to move SMEs from "build-to-print" operations to "systems integration"; for midsize companies, the high cost of establishing the modern development environment specified or mandated by prime contractors.
- The demographics of the Canadian workforce and the need to replace a substantial number of experienced engineers who will retire in the coming years.

 In the military domain, the main challenges remain Canada’s single-source procurement philosophy, a gap in low-rate initial procurement of technologies developed by Canadian companies under strategic Government incentive initiatives and the type of Industrial Regional Benefits (IRBs) making their way into the hands of Canadian companies.
The Maintenance, Repair and Overhaul (MRO) industry is also facing several challenges amongst which: commoditization of commercial carrier maintenance and emergence of competition from low-cost regions; customers looking for integrators – one stop shop providers; high capital investments required to support new platforms or technologies.
There are, however, significant opportunities in the secondary market on legacy platforms.
Increasing fuel prices and environmental pressures create the need to replace existing products with more efficient ones. This, combined with the growing volume of air travel and a developing Asian market, creates opportunities for expanding markets. To take advantage of these opportunities, Canada can count on several strengths: political stability, access to a highly educated technical workforce, a proven aerospace R&D collaborative environment and the availability of vast natural resources.

3 – Vision 2030

Strengthening the Canadian aerospace top tier platform OEMs position as world leaders in their respective market segments will ensure the growth and maturation of their respective supply chains over the next 20 years, with the final goal of delivering national wealth and sustaining a top 5 global ranking. By investing in collaboration, competitiveness and innovation, Canada can look forward to annual revenues exceeding 35B$ by 2030 already and direct employment in excess of 120,000.
In particular, Canada should maintain its lead in specific markets (business and regional aviation, turboprop and small turbofans engines, civil helicopters, flight simulation, landing gears, satellites and space products) and be the high-added value supplier for the world’s leading aerospace projects. The growth will mainly come from excellence in technology and intellectual property generation, with the need to maintain an efficient and substantial high-technology manufacturing base. In this respect, it is important to ensure participation of SME’s in Technology Demonstrator Programs. Not only this will increase the potential of selection of Canadian Suppliers on new domestic and international platforms; it will as well build a community of highly trained human personnel all along the supply chain, innovative thinkers and system integrators. This will generate a highly productive environment in design, development, manufacturing and support of aerospace products. The example is set by technology demonstrator programs that were launched in Europe and the USA to support to their OEMs, SMEs and Equipment Manufacturers.
The evolution of the industry is tightly linked to consistent investment in R&D. The annual R&D intensity of the aerospace industry is relatively low at 6.5%. It should increase to a minimum of 10% to realize the 2030 vision. New platforms will benefit from advanced new aircraft architectures, more efficient propulsion systems and sophisticated communication, navigation and surveillance systems. Investments are needed in advanced composite structures, more electric aircraft systems, solid state electronics technology, simulation and knowledge-based decision making. Other developments that will increase the efficiency and overall competitiveness of the industry are: multi-platform technology development and insertion, off-the-shelf advanced technologies, concurrent and collaborative design, manufacturing automation, additive manufacturing, machine-to-machine communications combined with 3D modeling, etc.
The industry will need to focus also on aircraft end-of-life issues and optimize recycling strategies for all components and materials.

4 – Aerospace Strategy

Canada needs a long term aerospace industrial and innovation strategy, involving all stakeholders. Aerospace must be an agreed priority for both the industry-economic development and research-technology related departments at the federal as well as provincial levels.
The technology strategy is to ensure that knowledge generated by universities and research centers reaches industry and is embedded in the supply chain for commercial exploitation. The strategy should address the various challenges through adequate support to R&D clusters, innovation networks, technology-validation programs and products development. The coordination of this strategy should be through a Technology Council of the Aerospace Industries Association of Canada AIAC. The council will reaffirm the Canadian strategic research and technology agenda, as defined by the Canadian

Aeronautics Environment Technology Roadmap CAETRM (2009 & 2012), establishing the future technology needs, and the Future Major Platform FMP technology report (2008) which defines the niche technologies fitting Canadian strength.

The Technology Council will ensure that innovation strategies are coordinated through all public and private stakeholders, a network of multi-disciplinary innovation centers, the necessary infrastructure properly maintained and its use maximized. It will also take steps to attract bright students to careers in aviation and ensure that high quality aerospace education is available and closely matched to the industry needs.

New technology that can be purchased can typically also be purchased by the competitors. It is not therefore sufficient to differentiate a new product on the market. For that, it is necessary for Canadian firms to develop their own technology or have technology developed by partners that can give them exclusive rights for a sufficiently long time to be a factor of competitiveness. There is also some technology that can only be developed by the firms that are specialized in a market segment.

It is necessary here to reaffirm the key contribution of the National Science and Engineering Research Council (NSERC) in the Canadian Innovation system. NSERC has directed considerable research dollars at conceptual and pre-competitive research in universities contributing to the availability in Canada of a highly educated technical workforce. The key factor that has been limiting business R&D in Canada is the lack of financial incentives for high “technology readiness level” demonstrators. As a result, many worthwhile new ideas have been developed in academic circles to the level of concept validation and remain there. Businesses that can develop these ideas further to the level required for investment in a product have only been able to address a small number of them. In the USA, many such technology demonstrators are developed under the umbrella of defense technology procurement. In Europe, governments and the European community have recognized this need and set programs to assist Original Equipment Manufacturers and their suppliers to carry out technology demonstrators.

NSERC recognized this need in 2009 when they began funding business-led networks of centers of excellence (BL-NCEs), in particular, in the aerospace field, the Green Aviation Research and Development Network (GARDN).

The other important resource and factor of competitiveness is the National Research Council of Canada (NRC). NRC alone has around $500M of existing infrastructure required to support Aerospace R&D and conduct a substantial amount of collaborative research, currently funded at 55% by industry. NRC is therefore a catalyst for aerospace innovation and competitiveness and an independent scientific and technical service provider and advisor to other Canadian government departments and agencies. The industry plans, as defined by the AIAC technology council should include an optimal use and maintenance of this national resource. NRC Aerospace will have to align their research agenda closely with the overall industry plans.

The Aerospace strategy will only be complete if attention is paid to developing the best possible technical workforce for this sector. Among recommendations made by industry at a recent aerospace education summit, we find:

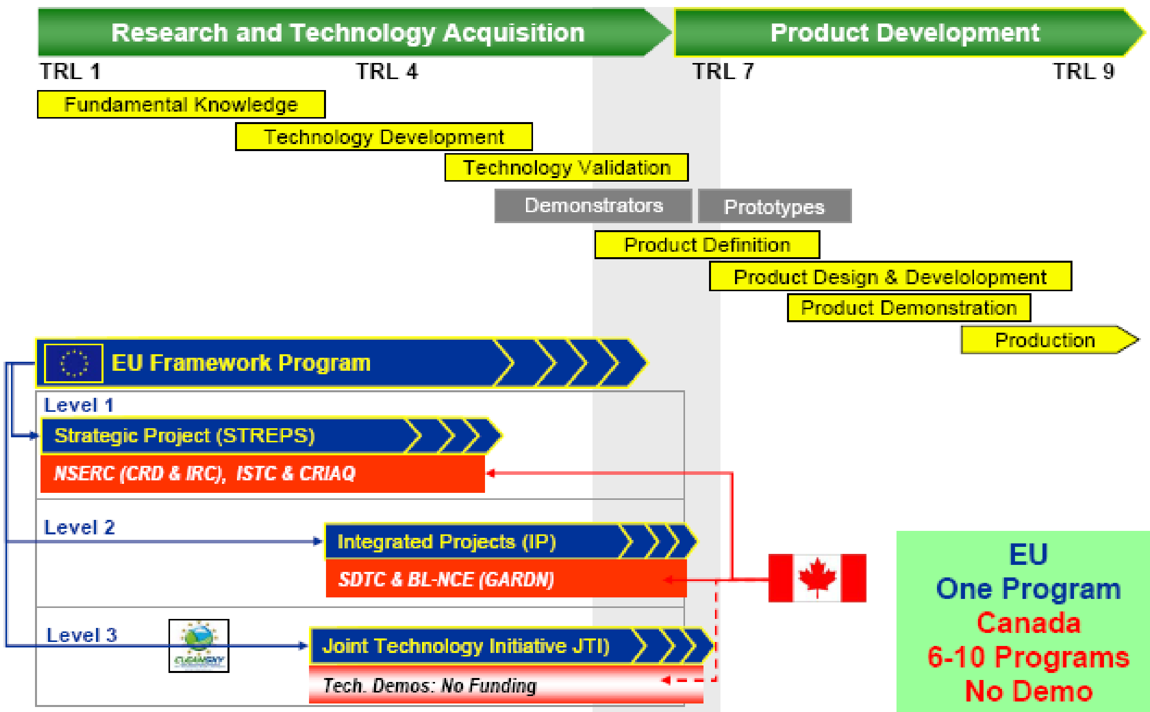
- Improving the training of engineers by emphasizing systems integration and the management of multidisciplinary teams. Encouraging university-industry exchanges by facilitating training through internships, the integration of professors in sabbatical leave in industry, the participation of industry representatives in teaching and university research and the conduct of joint research projects in co-located innovation centers.
- Encouraging more young people to consider a career in aerospace engineering by promoting the sector to primary and secondary school students. This can be done by setting-up aerospace technology exhibition and learning centers.

5 – Funding Strategy

The Canadian aerospace industry invests its own funds in R&D. The intensity of these investments, affected by the economic slowdown, is not sufficient to face current globalization and environment challenges. To support the strategy, a clear technology and funding road map must therefore be established with adequate and sustained funding to cover the various programs and projects until 2030. Similar to the successful European Frame Work programs, funding has to be provided into four areas: infrastructure, projects, people and collaboration.

It is first recommended to streamline or regroup the various funding programs, in order to provide a common structure and single interface for industry and university, to access all funding categories: OEMs and SMEs, single company application, collaborative consortia, research, development, refundable, non-refundable, infrastructures, international, etc. Federal and provincial programs need to be aligned around Canadian aerospace strategic priorities.

NSERC should continue its important mission of supporting conceptual and precompetitive collaborative research in universities. The aerospace community would like to see Aerospace identified as one of the Science and Technology priorities of the federal government of Canada. This is necessary in order to maximize funding for fundamental aerospace research. The industry recommends as well the continuation and expansion of its BL-NCE initiative that brings together industry and university in technology development and validation. Sustainable development will be the defining issue for future aerospace technology. The BL-NCE Green Aviation Research and Development Network (GARDN) is an ideal format for collaborative environmental research and should be supported.



Specific measures should cover the whole R&D spectrum from Technology Readiness Level ("TRL") 1 to 9.
Canada needs a closely-knit, business led, "Canadian Aerospace Research and Innovation Consortium" to support the competitiveness of its national aerospace industry. To achieve this, it is recommended that the Canadian Government fund a coordinating organization based on a consortium model to support precompetitive collaborative R&D and innovation programs. The overall mandate of this consortium would be to align all the compatible forces in the country in research and innovation and to provide a combined focus for greater competitiveness of the aerospace industry. The SR&ED program should be streamlined to provide maximum benefit to companies of all sizes: simple enough to allow SME easy access, comprehensive enough to support the true R&D needs of large corporations. A balanced approach of tax incentive and direct support should be developed.
A streamlined and simplified SADI Program should support products development (TRL 7 to 9) with WTO-compatible refundable aids. Canada needs a national framework program for technology demonstration and integration (TRL 5 to 7). This will remove the valley of death in the innovation chain and level the playing field with Europe and the USA in mitigating high technology maturation risks. A national framework program will result also in increased collaboration with Europe through joint technology calls as advocated by the CANNAPE initiative. A portion of the SADI program should be directed to supporting these Research and Technology projects with non-refundable grants (50% industry, 50% SADI). This could be coupled with some conditions in terms

of a percentage of the funding of the receiving companies going to Universities and SME's. It is necessary to ensure stable and predictable funding for this program. Stable funding to IRAP (Industrial Research Assistance Program) is also necessary, with clear commitment to help SMEs accessing this support and allow them to participate in collaborative projects with top tier companies.
Canada will have to ensure that funding exists to assist MRO companies make the shift from overhaul & maintenance to value added solutions providers that build IP protection through STC portfolios and process and/or product development. There is a need also to leverage government procurements and other assets/infrastructure to maximize benefits to MRO providers.

Transport Canada (TC) will have to ensure that its staffing is maintained at a level that will help the Canadian aerospace industries in being competitive internationally. This is necessary for both product development and MRO support. Recommendations for funding of space-related research will be specified by the Space working group.

These streamlined programs will usher in unprecedented levels of collaboration between industry, university and research centers. This interaction can be optimized by carrying out these projects in innovation centers where resources can be shared. Time to commercialization can be reduced by moving away from the linear model of innovation where university, research centers and industry work in sequence on technology maturation to a model of collaboration with nearly continuous interactions between the stakeholders.

6. Conclusion

The Canadian aerospace industry is well positioned for growth over the next 20 years and to maintain its status as a leading contributor to the Canadian economy. The Federal government has a key role as a risk-sharing partner in this journey. Key strategies and actions, alongside a clear global vision, must be taken today to ensure execution:

- Complete a coherent National Aerospace Vision, through the AIAC Technology Council and the establishment of a Canadian Aerospace Research and Innovation Consortium.
- Optimize the Canadian technology funding strategy for Aerospace, focusing NSERC contributions on fundamental and pre-competitive research and supporting industrial research and development through an appropriate balance of tax credits and direct research and development aids (refundable for products development, non-refundable for technology demonstration)
- Reinforce the aerospace R&D clusters through collaborative consortia, innovation centers and an OEM-led Canadian aerospace Technology Demonstration, Integration and Validation Program.

The final outcome will be a vibrant aerospace industry making substantial contributions to the Canadian GDP well beyond 2030.

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Sources and Notes

[1] Bombardier Aerospace, Pratt & Whitney Canada, CAE Inc., Bell Helicopter Textron and MDA were considered OEMs in the context of this working group. Small firms account for firms which employ 100 and less while medium-sized firms include all others.

[2] Aerospace Industries Association of Canada, Aerospace Performance, 2011.

[3] MROs in Specialty Aerospace-Airframe Engines Avionics

[4] A truly small Aerospace sector business is defined, for the purpose of this document, as being under 100 employees. At this size the reality is that their technology scope will be either concentrated in product development or manufacturing production, but very rarely both. Therefore this document will examine both of these scenarios. The Deloitte report uses a time scale of near term, 5 years, and long term of 15-20 years. However for small firms the only time scale that is meaningful is the next 5 years.

[5] These include companies in Tier 1; the high end of Tier 2; and those which provide, or aspire to provide, significant integration capability. Small and medium-sized enterprises at Tier 3 and aircraft OEM are not included.

[6] See Annex 3 for the definition of Demonstration

[7] China Civil Aviation Report. Brief Introduction of the 'Twelfth Five-Year Plan' for China's Civil Aviation", Spring 2012, *China Civil Aviation Report, Volume 14, Issue 1.*

[8] Technology Readiness Level (TRL) is a metric that was initially pioneered by the National Aeronautics and Space Administration (NASA) Goddard Space Flight center in the 1980's as a method to assess the readiness and risk of space technology. Definitions for TRL 1-9 are found in Annex 3. System Readiness Level (SRL) is a quantitative method providing insight into system maturity. Manufacturing Readiness Level (MRL) provides insight into manufacturing process maturity of a technology. Source: Nazanin Azizian, Dr. Shahram Sarkani, Dr. Thomas Mazzuchi (2009): "A Comprehensive Review and Analysis of Maturity Assessment Approaches for Improved Decision Support to Achieve Efficient Defense Acquisition," *Proceedings of the World Congress on Engineering and Computer Science 2009*, Vol II, WCECS 2009, October 20-22, 2009, San Francisco, USA.

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[27] Although there are exceptions, most procurement over $3,000 and under $100,000 is automatically set aside for small business. In addition, there are small disadvantaged business set-asides including veteran owned, service disabled veteran owned, women owned and HUBZone small business set asides. With these set-asides, the non-discriminatory provisions of the North American Free Trade Agreement do not apply.

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[33] These include companies in Tier 1; the high end of Tier 2; and those which provide, or aspire to provide, significant integration capability. Small and medium-sized enterprises at Tier 3 and aircraft OEM are not included.