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The Case of the Dramatic Emergence of Newfoundland & Labrador's Petroleum Industry

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ABSTRACT

The first oil discovery was made on the Grand Banks in 1979 and the first oil development project commenced in 1990. Since then the offshore oil and gas industry has, at an increasing pace, transformed the Newfoundland and Labrador economy. It has not simply provided government revenues and an additional economic sector, but has delivered: new industrial investment and capabilities, training and education, increased business confidence, innovation and entrepreneurship, and success working in other industries and other markets at local, national and international levels. This chapter summarizes the growth of the offshore oil and gas industry in Newfoundland and Labrador, describes its effects on the economy, and then outlines industry-related initiatives in the areas of infrastructure, education, training and R&D. This is followed by a description of the ways in which a number of Newfoundland and Labrador companies have prospered through work in this very demanding industry.

This chapter provides a dramatic and ongoing case study of the effects of megaprojects on one province, and thereby on Canada as a whole. Dependent as it was on the confluence of natural resource potential, private-sector enterprise and investment, and strategic government support for, and leveraging of, the economic benefits from industrial development, it is an excellent example of the creation of a high value-added innovation ecosystem from "big projects," resulting in the transformation of the economy and society of the host region.

Introduction

The history of Newfoundland and Labrador for the last 120 years has largely been concerned with addressing economic challenges. As the Dominion of Newfoundland (with similar jurisdictional status to its neighbour, the Dominion of Canada), then under rule by the Commission of Government after the Dominion became bankrupt in the 1930s, and finally as Canada's tenth province after 1949, the urgent priority has been to create employment, business and government revenues. This has been in response to a wide range of economic, social, health, demographic and other issues, including unemployment, poverty, poor nutrition and out-migration. The initiatives included investment in economic development studies and structures (e.g. royal commissions and the Economic Recovery Commission), transportation infrastructure (e.g. a trans-island railway and "roads to resources"), hydro developments (e.g. Churchill Falls), fisheries and forestry initiatives, and business attraction (e.g., a boot factory, a steel mill, the Come-by-Chance refinery, and a huge cucumber greenhouse complex near St. John's) (Letto 1998).

None of these initiatives brought more than limited or short-term economic growth to Newfoundland and Labrador. However, in 1977 the then Minister of Mines and Energy, Brian Peckford, laid the foundation for the establishment of an offshore oil and gas industry. Based on the Norwegian model, this saw an emphasis on benefits initially enacted in provincial legislation and then, after the settlement of a federal-provincial dispute as to jurisdiction over offshore mineral resources, in the 1985 Atlantic Accord. This set up a Canada-Newfoundland Offshore Petroleum Board (later renamed Canada-Newfoundland and Labrador Offshore Petroleum Board) with jurisdiction over offshore activity. One of the main requirements for the approval of any activity was the submission of a satisfactory Benefits Plan, designed 'to provide an opportunity for businesses and persons in Newfoundland and Canada to participate on a competitive basis in the economic opportunities generated by any offshore oil and gas activity' (CNLOPB 2006). These plans must commit to benefits-related policies and procedures in the areas of project management, procurement and contracting, employment and training, research and development (R&D) and diversity.[1]

[1] Since the 2000s, the Government of Newfoundland and Labrador has increasingly adopted aspects of this approach to the approvals process for large onshore resource development projects.

The first oil discovery was made on the Grand Banks in 1979 and the first oil development project commenced in 1990. Since then, the offshore oil and gas industry has, at an increasing pace, transformed the Newfoundland and Labrador economy. It has not simply provided government revenues and an additional economic sector, but has delivered: new industrial investment and capabilities; increased business confidence, innovation and entrepreneurship; training and education; and success working in other industries and other markets at local, national and international levels. As such, the offshore oil and gas industry provides a dramatic and ongoing case study of the effects of megaprojects on one province, and thereby on Canada as a whole.

This chapter summarizes the growth of the offshore oil and gas industry on Newfoundland and Labrador and goes on to describe its effects on the economy and on industry-related initiatives in the areas of infrastructure, education and training infrastructure, and R&D. This is followed by a series of case studies of Newfoundland and Labrador companies that have worked within the industry. Much of the material is drawn from studies of Newfoundland and Labrador's socio-economic benefits from the petroleum industry between 1999 and 2002 (Community Resource Services Ltd. 2003), 2003 and 2004 (Jacques Whitford 2005), 2005 and 2007 (Stantec 2009) and especially 2008 and 2010 (Stantec 2012). The preparation of an update for 2010 and 2012 is in progress.

It should be noted that the focus here is on the effects of offshore oil and gas activity itself; this chapter does not document the taxes and royalties the industry pays (for example, a total payment of $2.4 billion to the Government of Newfoundland and Labrador in the 2010-2011 fiscal year) or the major financial contributions oil companies make to local charities and community groups.

The Growth of the Offshore Oil and Gas Industry

Offshore petroleum activity in Newfoundland and Labrador began in 1963, and the first exploration well was drilled in 1966. In the 50 years that have followed this initial work, the industry has experienced fluctuating levels of exploration, development and production activity. In the first case, the pace of exploration has differed in response to varying levels of success, changing oil prices, and the availability of government support (e.g. federal Petroleum Incentive Plan grants in the 1970s). Exploration, including both drilling and seismic activity, peaked in the early-1980s, with minor other peaks in the mid-1990s and late 2000s. This exploration led to the discovery of the Hibernia oilfield in 1979, the Hebron field in 1981, and the Terra Nova and White Rose fields in 1984.

However, the first development activity did not occur until 1990, after the Hibernia Development Agreement was signed between Mobil Oil, its partners, and the federal and provincial governments. Because of low oil prices at the time, the development of the Hibernia field was not commercial; the Government of Canada intervened to facilitate the development of the Hibernia project and hence new industry as an economic development initiative. The agreement involved a federal contribution of $1 billion and loan guarantees, in exchange for an 8.5 percent working interest in the project. The stake in the project, held by the Canada Hibernia Holding Corporation, has proved to be a very remunerative federal investment.

Since then, three major Grand Banks oilfields have been successfully developed:

- **Hibernia:** The approximately $5.2-billion development of this field by Mobil Oil (now ExxonMobil), including the construction of a concrete gravity based structure (GBS) and some topsides components at Bull Arm, Trinity Bay, started in 1990. The GBS and topsides were mated in early 1997, and the complete platform was towed to the field in time for first oil production in November 1997.
- **Terra Nova:** In 1998, Petro-Canada (now Suncor) decided to develop the Terra Nova field using a floating production storage and offloading (FPSO) vessel with a South Korean-built hull, but with much of the topsides fabrication and installation occurring at Bull Arm. The FPSO arrived at the field in August 2001 and produced first oil in January 2002. The total Terra Nova pre-production capital expenditures were approximately $2.8 billion.
- **White Rose:** Husky Energy's work developing this field started in 2002. Like Terra Nova, White Rose uses an FPSO with a hull built in South Korea. However, much of the topsides fabrication and installation work occurred in Marystown, Placentia Bay, while some fabrication work and the testing of some sub-sea components took place at Bull Arm. The project had a total capital cost of approximately $2.35 billion and first oil was produced in late 2005.

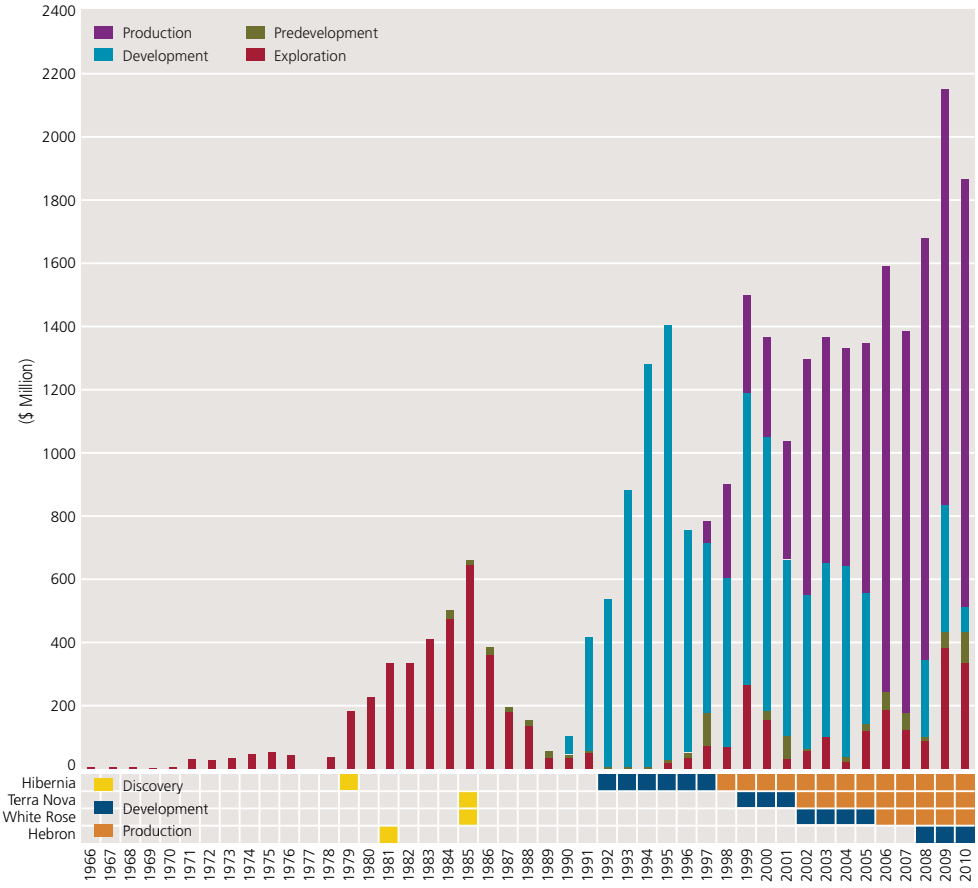
A fourth major oilfield and a satellite field are currently under development. The construction of ExxonMobil's Hebron GBS and topsides began at Bull Arm in 2013, with an estimated total cost of $14 billion. Production is targeted to commence in 2017 and expected to continue until at least 2047. Work on Husky Energy's $2.3 billion White Rose Extension Project, which will see the first North American use of a concrete well-head platform, recently started near Placentia in Eastern Newfoundland. The presence of this structure in the field will reduce the drilling and production costs, and thus increase the viability of various other satellite developments in the White Rose area. The fact that the graving dock for the platform construction is designed to be reusable would reduce the costs of any future similar well-head platforms.

The satellite field developments, such as North Amethyst (a satellite of the Husky's White Rose field) and Hibernia South (a satellite of the ExxonMobil Hibernia field), are often a lmost overlooked as components of Newfoundland and Labrador industry growth. The $1.3-billion North Amethyst development provides an example of how such a project can result in substantial benefits to the local industry. In addition to exceeding original estimates of 1.6 million person-hours taking place in Newfoundland and Labrador, all subsea engineering took place within the province. It is also noteworthy that, with less than four years between discovery and development, the North Amethyst project saw a drastic reduction from previous development timelines in the province.

The growth in the scale of total oil industry expenditures in Newfoundland and Labrador, as shown in Figure 1, has been impressive. Fluctuating exploration figures have been supplemented, post-1990, with very large but similarly variable development spending to construct and commission offshore facilities. Since 1997, production-related expenditures have seen a steady and relatively predictable increase. Total expenditures rose to a record $2.36 billion in 2011 and then jumped again to $2.89 billion, including $1.68 billion in production expenditures, in 2012.

Figure 1
Newfoundland and Labrador Offshore Petroleum Activity and Area Expenditures, 1966-2010

Source: C-NLOPB



Since 2008, the Government of Newfoundland and Labrador has become directly involved in the industry by taking an equity position in a number of projects. In that year the province, represented by Nalcor, finalized the purchase of a 4.9 percent working interest in the Hebron project, and in 2009 it took a 5.0 percent interest in the White Rose Growth Project, which includes the North Amethyst, West White Rose and South White Rose Extension fields. In 2010, Nalcor acquired a 10 percent working interest in the Hibernia Southern Extension project, which includes two new licences, as well as an area of the main field covered by a separate licence.

The pace of Newfoundland and Labrador offshore oil and gas activity is expected to continue, especially given Statoil's Bay du Nord oil discovery in the Flemish Pass Basin in 2013. The estimated recoverable reserves of between 300 and 600 million barrels make it comparable in size to, or larger than, the fields already in production. Bay du Nord, in conjunction with Statoil's earlier Mizzen and Harpoon discoveries in the same basin (the former with an estimated 100 to 200 million recoverable barrels, the latter still under evaluation), led the company to make an early 2014 commitment to a new multi-year drilling program. In 2013 Husky Energy also made major commitments in terms of both drilling (taking a five-year lease of the rig West Mira commencing in 2015), and its onshore presence (becoming the anchor tenant for the new 351 Water Street office tower in downtown St. John's).

Companies have also acquired land rights to large amounts of offshore acreage. This involves them making exploration activity commitments and, as of March 31, 2013, there were $1.2 billion in commitments, secured by deposits valued at $291 million (CNLOPB 2013).

In June 2013, Scott Tessier, Chair of the CNLOPB, indicated that the Board was expecting a 33% increase in the number of applications for approvals and authorizations in 2013, making it the busiest year on record, with a further approximate 25% increase expected in 2014.

It is worth noting that the industry is also looking at using Newfoundland and Labrador as a centre for activity in more northerly and Arctic waters, an area of increasing interest to the oil industry given large reserve estimates and the shrinking of the ice surface. For example, Husky Energy is using St. John's as the operational centre for its exploration work in Western Greenland.

Economic Benefits

Total offshore petroleum industry expenditures (i.e., capital plus operating costs) in Newfoundland and Labrador over the 2002-2010 period peaked at $2.2 billion in 2009, comprised of over $1.4 billion in capital costs and over $0.7 billion in operating costs. Operating costs have generally grown steadily, from $230 to $280 million between 2002 and 2005, $600 to $620 million in 2006 and 2007, and about $700 million from 2008 to 2010. As was noted above, total expenditures reached a record $2.89 billion in 2012.

A substantial portion of the local benefits from the offshore petroleum industry activity accrues to companies providing goods and services to oil companies. On average, these indirect linkages account for total annual direct and indirect nominal GDP impacts of approximately $7.6 billion, and annual direct and indirect employment impacts averaging approximately 9,200 person-years.

Data on direct and indirect economic impacts provide key inputs to simulations of the overall effects of the offshore petroleum industry on the economy of the province, using the Department of Finance's Newfoundland and Labrador Econometric Model (NALEM) (Table 1).

Over the 2002-2010 period, the GDP impacts (i.e. the business and labour income earned within the geographic boundaries of the province) increased steadily to a peak in 2008 and then decreased sharply from 28.3 percent of the total GDP (Real GDP chained) to 25.1 percent in 2010 as a result of the global economic downturn. Aside from these impacts, the overall pattern of change in total impacts reflects the increased development activity and relatively stable production costs.

Much of the business income earned in Newfoundland and Labrador's offshore petroleum industry accrues to non-resident companies. Therefore, business income directly related to the industry generally would not accrue to residents and is not reflected in the personal income impact. Personal income impacts, primarily wages and salaries, reflect only income received by provincial residents. Consequently, the personal income impacts are smaller than the GDP impacts.

Personal income from the offshore petroleum industry was $955 million per year higher during the 2002-2010 period and represented 6.7 percent of total personal income in Newfoundland and Labrador. Personal income from the industry declined between 2004

Table 1
Total Economic Impacts Related to the Offshore Petroleum Industry in Newfoundland and Labrador

	2002	2003	2004	2005	2006	2007	2008	2009	2010	Average
GDP ($ Millions)	4,144	5,138	5,833	7,267	8,141	10,261	12,875	7,668	8762	7,788
Share of Total (%)	27.7	31.1	32.8	35.8	35.2	38.6	44.3	33.3	33.3	34.8
Real GDP Chained ($ Millions)	4,088	4,710	4,439	4,537	4,641	5,356	5,117	4,345	4,365	4,622
Share of Total (%)	27.3	29.6	28.2	28.1	27.9	29.4	28.3	26.4	25.1	27.8
Personal Income ($ Millions)	663	957	979	930	935	866	986	1152	1130	955
Share of Total (%)	5.6	7.7	7.6	7.0	6.7	5.9	6.3	6.9	6.5	6.7
Labour Income ($ Millions)	497	718	734	698	701	650	739	864	848	717
Share of Total (%)	6.9	9.4	9.2	8.4	8.1	7.0	7.5	8.0	7.5	8.0
Other Income ($ Millions)	166	239	245	233	234	217	246	288	283	239
Share of Total (%)	3.5	5.0	5.0	4.7	4.5	3.9	4.3	4.8	4.6	4.5
Disposable income ($ Millions)	522	752	766	726	738	681	779	923	911	755
Share of Total (%)	5.6	7.7	7.6	7.0	6.7	5.9	6.3	6.9	6.5	6.7
Retail Sales ($ Millions)	292	421	429	407	413	381	436	517	510	423
Share of Total (%)	5.4	7.3	7.5	7.0	6.9	5.8	6.2	7.3	6.9	6.7
Housing Starts	104	150	153	145	148	136	156	185	182	151
Share of Total (%)	4.3	5.6	5.3	5.8	6.6	5.1	4.8	6.0	5.1	5.4
Employment ('000s)	11.0	14.5	13.6	13.4	13.5	12.0	12.9	14.0	12.8	13.1
Share of Total (%)	5.3	6.9	6.4	6.3	6.3	5.6	5.9	6.6	5.8	6.1
Labour Force ('000s)	7.5	10.8	9.7	1.0	10.6	9.1	9.8	10.9	9.8	9.8
Share of Total (%)	3.0	4.3	3.8	4.0	4.2	3.6	3.9	4.3	3.8	3.9
Unemployment Rate (%)	-2.0	-2.3	-2.3	-2.1	-1.9	-1.7	-1.8	-2.0	-1.8	-2.0
Population ('000s)	12.6	18.0	16.1	16.6	17.7	15.1	16.4	18.2	16.4	16.3
Share of Total (%)	2.4	3.5	3.1	3.2	3.5	3.0	3.2	3.6	3.2	3.2

and 2007, partially due to completion of White Rose project construction activity. However, it increased after 2007 due to strong wage growth and increased activity related to the development of North Amethyst and Hibernia South, and in 2010 the total personal income attributed to the offshore petroleum industry was $1.1 billion, or 6.5 percent of total income.

Personal income effects mainly reflect the boost to labour income resulting from the offshore petroleum industry's high-wage jobs, as well as labour income from spinoff employment (indirect and induced). Annual disposable income increased from $497 million in 2002 to $848 million in 2010, an increase of 71 percent. Consumer spending in the form of retail sales also increased by approximately 75 percent between 2002 and 2010.

The estimated annual employment impact averaged approximately 13,000 person-years over the 2002-2010 period, representing 6.1 percent of all provincial employment. On average, the unemployment rate was 1.9 percentage points lower as a result. The decline in unemployment would have been greater except that increased employment, higher average wages and higher population encouraged more labour force participation. The rise in the labour force was approximately two-thirds as large as the gain in employment. The increased demand for labour also contributed to a substantial population increase as a result of diminished out-migration and some in-migration, with the latter including large numbers of returning Newfoundlanders and Labradorians.

The offshore petroleum industry is thus making a very substantial contribution to the Newfoundland and Labrador economy, particularly in relation to GDP and employment. The GDP contribution from oil production will likely decline in the near future as the most productive current reserves have been depleted and overall production levels are expected to fall in the medium term. However, other production-related benefits such as employment and personal income are not expected to be affected by the production declines. In addition, development and then production impacts are expected to increase as construction activity ramps up as a result of the Hebron and satellite field developments.

Infrastructure, Education and Training, and Research and Development

Infrastructure

The ongoing development of the Newfoundland and Labrador offshore petroleum industry is supported by, and has made a substantial contribution to, infrastructure development in Newfoundland and Labrador. Over the long term, the availability of such infrastructure reduces the costs of development, increases the likelihood of additional petroleum industry investment in Atlantic Canada, increases the province's ability to be involved in the industry's construction, fabrication and operations activities, and ultimately increases Newfoundland and Labrador's participation in the industry. Some of this infrastructure has also contributed to the diversification of Newfoundland and Labrador's business community. For example, many Newfoundland and Labrador companies have successfully leveraged harsh environment engineering expertise developed in provincial facilities to gain additional experience by working in Arctic environments.

This section illustrates this development of new infrastructure, based primarily on examples reported in a study of the effects of the offshore petroleum industry during the 2008-2010 period. This timeframe saw continued development and growth in supporting infrastructure for the Newfoundland and Labrador offshore petroleum industry. This was in support of increased production, exploration, and drilling activity, and is evident in activity among local companies, as well as the supporting government, institutional and transportation infrastructure.

For example, in 2010 Memorial University opened an Autonomous Ocean Systems Laboratory to advance harsh environment research capacity. The laboratory provides uniquely designed space to researchers, including undergraduate and graduate students, providing a catalyst for research on autonomous ocean systems in ice-covered and otherwise harsh environments. The laboratory was established with support from the Research and Development Corporation of Newfoundland and Labrador (RDC) Canada Research Chair program and the Canada Foundation for Innovation. Also in 2010, a partnership between Chevron Canada, Memorial University and the RDC resulted in the announcement of an agreement to build a new Process Engineering Design and Research Laboratory on Memorial University's St. John's campus.

The 2008-2010 period also saw the Marine Institute of Memorial University open a new marine base in Holyrood. It was designed to be a focal point for a variety of oil and gas

industry-related research and educational activities, including such areas as ocean technology, fisheries, marine environment, diving, offshore safety and survival, oil spill response, oceanography and marine biology. The same period saw the Marine Institute purchase new ocean-mapping equipment in support of its ocean technology programs. The equipment, including multi-beam sonar, a sub-bottom profile, will support programs such as the new joint Diploma of Technology/Bachelor of Technology in Ocean Mapping and enable the Marine Institute to conduct applied research in ocean mapping. Applications include determining pipeline routes for offshore oil production and identifying safer routes for vessel traffic. In 2010, the Marine Institute purchased a wave piercing catamaran, the MV Atlanticat, to provide a marine platform to deploy research equipment. This vessel was funded through a $1.5-million investment from the provincial government and Memorial University, and has increased research and training capacity for the Marine Institute.

The period also saw continued private-sector investment in infrastructure. For example, Pennecon Energy Marine Base invested more than $3.5 million in infrastructure development at its Bay Bulls facility. In addition to the installation of a concrete caisson that expanded its dock space from 60 m to 90 m, Pennecon increased warehouse space by approximately 1,021 m2 (11,000 ft2) and expanded its secure laydown area.

Photo courtesy of Memorial University

Education and Training

The 2008-2010 period saw further advances in education and training, in addition to the infrastructure investments described above. For example, C-CORE, a separately incorporated research and development (R&D) corporation at Memorial University specializing in cold oceans engineering, matched funding from the provincial government's Department of Industry, Trade and Rural Development to provide work-terms and internships to new graduates pursuing careers in geotechnical engineering. In total, C-CORE employed 33 work-term and other undergraduate students and the organization's total 2008-2010 investment in students was $323,429. C-CORE's contribution to develop the province's base of expertise in this field also extended to a partnership with Memorial University to cost-share a Chair in Geotechnical Engineering, allowing Memorial University to attract a senior Professor to the province to develop new academic programs within the Faculty of Engineering.

Undergraduate enrollment in the Faculty of Engineering and Applied Science at Memorial University grew steadily over the study period, with 1,039 students in 2008, 1,128 in 2009 and 1,203 in 2010. During this period, the Faculty awarded 480 undergraduate engineering degrees and there was a rapid increase in the number of graduate students, many engaged in petroleum industry-related work. Approximately 400 Memorial co-op students are placed with oil and gas companies each year. These are mostly engineering students, but also include business students.

Also during this period, the College of the North Atlantic vocational school increased the intake into the Process Operator Engineering Technology Program at its St. John's campus through its oil and gas funding. This three-year program has an annual capacity of 20 students and previously had an alternate year intake. In 2010, a new three-year co-op program in Chemical Process Engineering Technology was introduced with an annual capacity of 24 students.

Research and Development

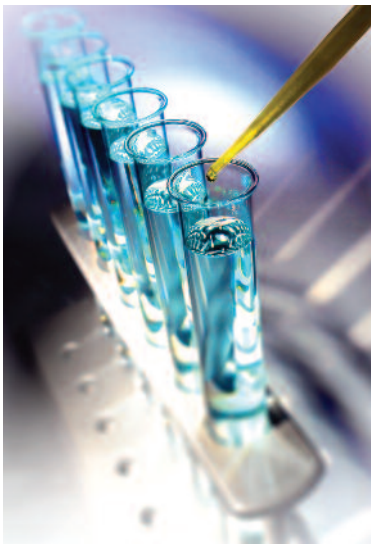
Research and development is an area of high activity in the provincial offshore petroleum industry, with industry, educational institutions, and research organizations providing support for the advancement of industry locally, as well as providing a mechanism for the transfer of local expertise into international markets.

The 2008-2010 period saw this continue with a number of major R&D initiatives. For example, in 2009, Memorial University announced a partnership with the American Bureau of Shipping to create a new Harsh Environment Technology Centre. Responding to a demand for ice class guidance for offshore structures in harsh environments, the new centre is designed to support the development of technologies for ships and offshore structures operating in harsh environments, particularly the Arctic. Applied research will be conducted to study vessels and units operating in ice covered waters, low temperature environments, and severe wave and wind climates.

The Institute for Ocean Technology (IOT), now part of the National Research Council's (NRC's) Ocean, Coastal and River Engineering Institute, was involved in a number of projects either directly related to, or with applications in, the offshore petroleum industry. For example, working with Memorial University and other NRC institutes, the IOT took the lead in the Escape, Evacuation and Rescue Project. This has tested different lifeboat hull designs in pack ice and wave conditions as well as conducting tests of marine safety systems in extreme environments to update safety equipment guidelines, while transferring research data and new technologies to the private sector. With funding from Transport Canada and Natural Resource Canada's Program on Energy Research and Development, the IOT has also been involved in a survival research project concerning the effects of wind and waves on the thermal regulation of people in immersion suits. The results of this study will be incorporated into any future review of regulations for marine safety and survival equipment.

Petroleum Research Newfoundland and Labrador (PRNL) (formerly Petroleum Research Atlantic Canada [PRAC]) is an industry-funded federally-incorporated not-for-profit agency that facilitates R&D development projects with application in both the Newfoundland and Labrador offshore sites, and in Arctic areas such as Greenland, where Newfoundland and Labrador companies have begun to operate in support of exploration activities. During the 2008-2010 period, PRNL awarded approximately $1.8 million in funding to companies and institutions undertaking research with application in the offshore petroleum industry. With PRNL funding, Memorial University's Ocean Engineering Research Centre (OERC) and the IOT became engaged in a project building on a related undertaking Ice Data Analysis and Mechanics for Design Load Estimation previously funded by industry (Husky, Petro-Canada, and Chevron Canada Resources), NRC, PRAC, and the National Sciences and Engineering Research Council of Canada (NSERC). This project studied ice composition, structural design, and iceberg impact modelling to examine ways of minimizing the risks of damage caused by icebergs. The study also incorporated risk analysis and probability into the larger challenge of operating offshore structures in iceberg-busy waters.

Petroleum Research Newfoundland and Labrador also funded studies in reservoir characterization and health, safety and environment. The latter included funding provided to Virtual Marine Technologies, in partnership with OERC, and Marine Institute's Centre for



Marine Simulation (MI-CMS), to develop a virtual trainer and curriculum to expand upon the existing live boat training program.

The Research and Development Corporation (RDC) of Newfoundland and Labrador also made important R&D investments, funding several projects through the Industrial Research and Innovation Fund (IRIF). In 2008, a five-year, $3.7 million, Advanced Exploration Drilling Technology project was initiated by a partnership that includes ACOA, RDC, Husky Energy and Suncor. This applied research project is undertaking an experimental and numerical investigation of vibration-assisted rotary drilling leading to the development of a prototype drilling tool.

In 2010, RDC invested more than $400,000 in research into the use of underwater vehicles in extreme environments, such as the Arctic. This funding was provided through the Leverage R&D component of the IRIF which enables researchers to leverage additional funding from other sources such as NSERC. Additional funding for research in the design, navigation and control of Autonomous Ocean Systems was provided through the Ignite R&D portion of the IRIF.

In 2009, with a $500,000 investment from the Wood Group, an Aberdeen-based energy services company, and an additional $500,000 in support from RDC through the IRIF, Memorial University established the Wood Group Chair in Arctic and Cold Region Engineering. The objective of the chair is the development of technology for application in Arctic and cold region oil and gas development, specifically pipeline design, construction and operations in northern regions.

Early in 2010, Chevron Canada announced that the Chevron Corporation had selected Memorial University to join its University Partnership Program (UPP). Memorial is the first university in Canada selected for this program, which includes approximately 100 universities and colleges worldwide. In late 2010, Chevron and RDC also announced the creation of the Chevron Chair in Petroleum Engineering with a $500,000 investment from Chevron and an additional $500,000 in support from RDC through the IRIF. The chair establishes, promotes and focuses research and teaching in petroleum engineering with the objective of petroleum engineering capability within the current undergraduate programs.

Additional R&D work undertaken by such private-sector and non-profit companies as Oceanic, C-CORE, PAL and VMT is described in the company case studies that follow.

Company Case Studies

The success of the offshore petroleum industry in Newfoundland and Labrador is both a result of, and exemplified by, the success of local companies. This section summarizes the involvement of a range of such companies with this very demanding industry, and explains how this has led them to develop new goods and services, hire new personnel, provide them with further training, acquire new facilities and equipment, and improve quality, health, safety and environmental policies and practices. It also demonstrates the ways in which the resultant increases in experience and capabilities have led to them winning petroleum industry work in other jurisdictions, and undertaking work in other industries at local, national, and international levels.

One of the most striking examples is the **Cahill Group**. Founded in 1953, it grew out of a small electrical company, focused on residential work. In 1991, it successfully bid on electrical work on the initial Bull Arm Hibernia construction site work camp. Building on that opportunity, it went on to work on the construction site swimming pool and gym, the Hibernia topsides, and the final Hibernia hook-up, and it is still undertaking offshore work on the Hibernia platform. It has expanded into a range of electrical, mechanical installation, industrial mechanical and pipe fabrication work, including the construction of a White Rose FPSO topsides module, additional Terra Nova FPSO accommodations, and subsea manifolds for the North Amethyst satellite development. The Cahill Group now provides a wide range of electrical and instrumentation, mechanical, piping and instrumentation services.

Based on its success in Newfoundland and Labrador, 2005 saw the company make a strategic decision to expand to Alberta. It has successfully bid sophisticated work on oil sands projects, benefitting from the rigorous quality and other systems it had put in place in Newfoundland and Labrador to address exacting offshore petroleum industry requirements, and allowing the company to build its capacity, resources and balance sheet and to help deal with cyclical variations in demand in both provinces. The company has also undertaken a range of oil industry work in the Maritimes, including on ExxonMobil's Sable Gas project and the Irving Oil refinery in Saint John, New Brunswick.

The Cahill Group's locally-developed capabilities and resources have also allowed it to expand into non-oil industry activity, including work on the Voisey's Bay mine and Long Harbour minerals processing projects (through alliances with such companies as ABB, P. Kiewit and Black Macdonald), the Newfoundland Refinery, and Iron Ore Company of Canada's iron ore mine in western Labrador. Strategic partnerships have also assisted in capturing further oil industry work; for example, with Aker and SNC-Lavalin in undertaking Husky Energy maintenance and modifications work. Outside of Newfoundland and Labrador, the Cahill Group has assisted in the construction of waste and water treatment plants across Atlantic Canada, and it is responsible for the electrical and instrumentation, mechanical and piping work on the Wuskwatim hydro project in Manitoba.

In 2010, the Cahill Group moved its corporate office to the redeveloped St. Bride's College, now renamed as The Tower Corporate Campus at Waterford Valley in St. John's. The company has come full circle with the purchase of the property; in the late 1960s, GJ Cahill was selected as the sole contractor for the installation of the electrical systems for the construction of The Sisters of Mercy's St. Bride's College, one of the largest institutional projects of the time. The 12,000 m^2 Tower Corporate Campus is now the home to many of the companies involved in the Hebron project.

A number of other companies are engaged in petroleum industry-related construction and fabrication activity. For example, **C&W Offshore** provides custom or client design steel and aluminum fabrication, and undertakes some piping work. It was incorporated in 2004 on the basis of opportunities that the company president identified while he was working in Texas. It was soon fabricating subsea components for the White Rose project for Technip, as well as undertaking specialist work for drilling company GlobalSantaFe. In order to achieve this success, the company had initially to introduce quality and safety standards much more rigorous than were common in metal fabrication in the Province at the time.

Subsequent oil industry work has included the fabrication of lifeboat decks for a drilling rig (for TransOcean), subsea assemblies for Husky Energy's North Amethyst satellite development (for Technip), custom ROV components (for Oceaneering) and components for the Hibernia gas lift (for Wood Group/PSN). C&W Offshore has also undertaken work for projects outside Newfoundland and Labrador, both for the oil industry, in the form of ROV and launch recovery system components for a company in Morgan City, Louisiana, and for the mining industry, fabricating steel tanks for a mine in the Northwest Territories. Overall, the oil industry accounts for over 95 percent of C&W's business. It now occupies a custom-built 1,500 m^2 building, including a 1,100 m^2 fabrication space with a 50 tonne crane, in Mount Pearl.

In support of offshore petroleum construction and fabrication activity, **Pennecon Energy** has developed and operates a Marine Base in Bay Bulls, approximately 30 km south of St. John's. It provides a service facility for a wide range of marine operations, which have included such oil industry activity as drilling rig servicing, rock dumping, chain inspection, pipe inspection and other support for a range of offshore construction and maintenance projects. The clients for this work have included Husky Energy, Technip, Tideway, Transocean, Rowan and GlobalSantaFe. This work has seen a progressive expansion and improvement in the Marine Base, with increased ocean frontage, water depth, bollards and crane pads, and the construction of an office/warehouse, an encapsulated sewer system and a garage. These have helped attract work on both oil and non-oil industry activity, with the latter including work on fishing vessels and the transshipment of wind turbines. However, the oil industry still provides approximately 90 percent of the base's business.

Marine activity is also the focus of oil industry work by **A. Harvey Group**. Founded in the 1860s, it first became involved in offshore petroleum activity in the 1960s, acting as ships agents and customs brokers, and providing crewing, for drillships engaged in exploration off Labrador. While St. John's Harbour was once the home of a number of single-operator supply bases, increased asset sharing has led to A. Harvey becoming the main provider to the oil companies operating in the Newfoundland and Labrador offshore sites. Its Offshore Marine Base encompasses almost five hectares of waterfront property. It can accommodate five offshore supply vessels, providing fuel and water via pipeline, drilling bulks, 24 hour-security, and a heavy lift crane capable of 44-tonne lift. A. Harvey has been active in offshore logistics since the start of exploration, with experience in vessel operations, cargo planning, safe rigging and slinging practices, container repairs and certification, heavy lift management, freight forwarding, oil spill response, and crane and equipment maintenance.

As demonstrated above, a number of Newfoundland and Labrador companies are working directly for the industry developing and delivering the results of R&D activity. For example, **C-CORE** was founded in 1975 under a five-year Devonian Foundation grant to address challenges facing oil and gas development offshore Newfoundland and Labrador and other ice-prone regions. It was incorporated as a federal non-profit in 1992, and has become a major international player in the fields of remote sensing, ice engineering and geotechnical engineering.

As a key contributor to Memorial University's research capacity, C-CORE undertakes more than 100 R&D projects annually, as single client or multi-participant joint industry projects, and works with the oil and gas industry to define R&D priorities to meet the requirements of

this sector. It is committed to building Newfoundland and Labrador's knowledge base for offshore engineering, particularly ice and geotechnical engineering aspects, and to further acceptance of new engineering concepts for oil and gas development. This knowledge base includes unique familiarity with Atlantic Canada and a growing understanding of engineering considerations for such other harsh cold-ocean environments as the Barents, Beaufort and Caspian Seas. C-CORE successfully worked with industry to secure funding and other support for long-term R&D addressing barriers to development of hydrocarbon resources in Arctic and other ice and iceberg prone regions.

C-CORE has branch offices in Ottawa, Halifax and Calgary and is active on every continent, providing research-based advisory services and technology solutions to clients in the natural resource, energy, security and transportation sectors. In 2010, oil industry work accounted for 60 to 70 percent of its turnover, with 20 percent directly concerned with the Newfoundland and Labrador offshore sites.

Since 1993, **Oceanic**'s researchers, engineers, and technical personnel, working with one of the world's most comprehensive collections of hydrodynamic research facilities, have made the company a world leader in commercial R&D. Developing out of Marineering in an alliance with the NRC, based around the IOT, Oceanic emerged as an independent entity in 1998. Marineering had undertaken a range of work in the oil industry, including evaluation studies for Global Marine, Noble Drilling and for the Terra Nova FPSO in the late 1990s. There was then a lull in Oceanic's local oil industry work until it undertook studies for the White Rose project (examining green water impacts, combined wind, current and wave loads, and the effectiveness of disconnectable moorings for the SeaRose FPSO) and subsequent work on the Hebron GBS and Hibernia offshore loading system. Based on its early local FPSO work, Oceanic has gone on to work on more than 60 FPSO-related projects worldwide for clients such as ExxonMobil, Husky Energy, Single Buoy Moorings, Suncor, Technip and Woodside Energy. The company's work has reached as far as the Tatar Strait, the South China Sea, the Sea of Okhotsk, Australia, Brazil, Italy and West Africa.

Oceanic's range of physical modeling and numerical simulation research has included: sea-keeping studies (with one or more floating or fixed structures); free running and captive ship manoeuvering tests; evaluations of current loads on moored structures; hull resistance in level and pack ice as well as in open water; ship performance in ridged ice; and ice abrasion studies. In recent years the oil industry has been responsible for approximately 70 percent of Oceanic's business, of which approximately 70 percent is in export markets. In 2011, Oceanic became part of the J. D. Irving Limited Group of Companies, providing new opportunities for growth in the oil and gas industry, in Newfoundland and Labrador, nationally, and internationally.

The aviation sector is also important to, and a beneficiary of, the oil industry. **Provincial Aerospace Ltd.** (PAL) started life in 1974 as a St. John's flying school with less than 10 employees but, primarily thanks to opportunities presented by the oil industry, it has developed into a global leader in aerospace and defence. It now provides highly tailored airborne and maritime surveillance solutions, including custom aircraft design and modification, mission system design and integration, and mission operations, training and support. It has more than 900 employees, approximately 750 of them in Newfoundland and Labrador, with domestic operating bases in Newfoundland and Labrador, Nova Scotia and

Photo courtesy of Provincial Aerospace Ltd.

"Provincial Aerospace Limited, in St. John's, Newfoundland and Labrador, has grown from its origins as a small flight school to being a world leader in maritime and airport surveillance. The company now employs 900 people, sells to 30 countries and has operating bases in the Caribbean and Middle East.

Again, success is rooted in local strengths and global demand. In this case, Provincial Aerospace built upon its hard-won expertise in flying and navigating in difficult Maritime weather conditions to develop leading-edge aerospace engineering. The local know-how was the basis for a global service, with the value added by innovation."

David Johnston
Governor General of Canada
November 18, 2011

British Columbia, and international bases in Barbados, Trinidad and Tobago, Netherlands Antilles, and the United Arab Emirates (UAE).

The company's involvements with the oil industry started with ice surveillance flights in the early 1980s. The requirement for this service grew as the industry's activity increased and in the wake of the sinking of the Ocean Ranger drilling rig with 84 fatalities in February 1982, which resulted in greater safety-related requirements, including in the area of ice response. This provided a challenge to which PAL responded by adapting military anti-submarine technology to ice surveillance in a harsh environment. This also saw PAL moving away from simple ice data collection to ice management and coordinating appropriate responses.

With the lull in oil industry exploration activity in the late 1980s, PAL used its oil-related expertise to diversify into fisheries monitoring, which provided greater business stability. PAL has subsequently further extended its operations into products and services related to sovereignty protection, search and rescue, maritime security, environmental management, pollution detection and monitoring, drug interdiction and smuggling, customs and immigration patrol, disaster relief and general law enforcement. This has included, for example, a 2009 $370-million contract with the UAE for the design, modification, and integration of two Dash-8 Q300 aircraft as well as training and integrated logistics support. A feature of the UAE program is the incorporation of design innovations that PAL developed over its 25 year history modifying and operating maritime patrol aircraft. The company continues to explore the use of new technologies and innovations, and is currently moving forward with commercial applications of military drone technology

Notwithstanding this diversification, the oil industry is still directly or indirectly responsible for approximately 70 percent of PAL's aerospace and defence work. This includes work in Newfoundland and Labrador, the Maritimes, and internationally, with the last including supporting Cairn Energy, Husky Energy and Shell exploration programs in Greenland.

Virtual Marine Technology (VMT) is a more recent Newfoundland and Labrador-based technology company, a simulation specialist that grew out of Memorial University and the IOT. It was founded in 2004 as a result of offshore petroleum industry interest in having a lifeboat simulator developed. It is engaged in lifeboat, fast response craft and electronic navigation simulation for the oil, defence and commercial shipping industries. This includes the development and sales of hardware, software and teaching curriculum. VMT is also investigating links to the gaming industry, and pursuing business opportunities in foreign markets, including Mexico, and building on relationships that it has established with major international corporations working in aviation (e.g., CAE, a Canadian world leader in providing simulation and modelling technologies and integrated training solutions for the civil aviation industry) and defence (e.g., Lockheed Martin).

The wide range of other oil industry services provided locally includes those of **PF Collins**, a St. John's-based family business. Newfoundland was still a colony of Great Britain when PF Collins was appointed the Customs Broker for Newfoundland in 1921. St. John's was the key port of entry for Newfoundland at the time, and PF Collins participated in the development of Newfoundland's first industries and helped arrange the movement of imported goods to points around the island. After Confederation in 1949, Newfoundland's trading patterns and transportation systems changed significantly, providing new opportunities. The company

participated in early industrial developments such as the pulp and paper mills, the U.S. military bases built during the Second World War, refineries at Holyrood and Come-By-Chance, and the Churchill Falls hydro project.

In the 1970s, the company initiated its involvement in offshore petroleum exploration. During the 1970s, working with operators and government legislators, the company implemented many operational procedures to accommodate the then "customs free zone" on the Continental Shelf. As the company continued to grow, it expanded its services and capabilities and its international network of agents and affiliates. At the same time, the company initiated an extensive program to incorporate the latest advances in technology and automation, and it expanded into Nova Scotia and Alberta. PF Collins now provides custom brokerage, freight services, warehouse and distribution services, project logistics, project administration, marine agency services, immigration consulting, and compliance consulting services. Company managers are proud of the fact that more than half of its personnel, including many in senior positions, are women.

The founder of St. John's-based **Atlantic Offshore Medical Services** (AOMS) began working with a commercial diving company in the late 1970s, leading to his establishing AOMS in 1978 and success in capturing work on the Hibernia project. AOMS offers harsh environment occupational health and emergency medical services, both onshore and offshore. They include the assessment of occupational health and safety practices, pre-employment examinations, health surveillance programs, periodic medical examinations, independent medical examinations, disability management programs, workplace drug testing, occupational therapy, vaccinations and immunizations. AOMS also provides response teams for medical emergencies at remote sites, and it has extensive experience in setting up medical services for offshore drilling rigs.

The company has provided its services to all the oil companies operating in the Newfoundland and Labrador offshore, and to the Come-by-Chance oil refinery. It also has a Halifax-based Nova Scotia affiliate which has supported the Sable Gas and Deep Panuke offshore gas projects. Drawing on its Newfoundland and Labrador-developed expertise, AOMS has also provided medical support for the Sunrise (Husky Energy), Kearl (ExxonMobil) and Albian Sands oil sands projects in Alberta. The company has used its oil industry-based expertise to expand into other sectors, working for such organizations as workers compensation commissions in both Newfoundland and Labrador and Nova Scotia, and the cities of St. John's and Mount Pearl. However, the oil industry is still responsible for about two-thirds of company revenues.

East Coast Catering (ECC) was established in St. John's in 1984, largely on the basis of perceived opportunities related to offshore oil exploration. The company now operates in seven Canadian provinces and in Ireland, and it is the dominant workforce catering service provider to the offshore petroleum industry in Atlantic Canada, supporting three of the region's four producing projects and many of the drilling rigs operating in the region. ECC's oil industry clients include or have included ExxonMobil, Suncor, Husky Energy, Canship Ugland, Transocean, GlobalSantaFe, Petrodrill, Sedco and Rigco. It has also provided camp facilities for drilling rig refit work at Bull Arm in Eastern Newfoundland.

The company has long recognized that the oil industry is very demanding in the areas of safety and training. However, the adoption of such standards for the oil industry has been beneficial in bidding work in both that industry and historically less-demanding sectors, helping the company to expand into other jurisdictions and to get work on mining, hydro and other projects. In the former case, ECC operates four camps associated with onshore oil activity in Alberta and British Columbia.

In an early example of work in other industries, ECC provided accommodations, catering and housekeeping services at the Hope Brook gold mine in southwestern Newfoundland in the 1990s. The company has subsequently provided similar services for the construction and/or operation of Vale's Voisey's Bay mine and Long Harbour minerals processing project, mining projects in Western Labrador, Ontario, Manitoba, British Columbia and Northwest Territories, and a number of hydro projects in Newfoundland and Labrador. ECC also provided workforce accommodations for the Confederation Bridge construction project in PEI, and East Coast (Ireland) Limited has operated accommodations for asylum seekers for the Irish Department of Justice since 2002.

Smaller Newfoundland and Labrador companies provide a range of specialist services to the industry. For example, **Strategic Concepts** was originally established in 1990 to assist small businesses with business planning and marketing. However, the company principals soon recognized that there were opportunities associated with forecasting and demonstrating the economic impacts of major resource development projects. Strategic Concepts has subsequently expanded its offerings to include: cash flow and economic impacts analysis; strategic advice re advancing projects; the provision of software to monitor project benefits and commitments; specialist studies, such as project labour requirements and supply; and the negotiation and implementation of Impact and Benefits Agreements.

The local oil industry clients for Strategic Concepts services have included ExxonMobil, Chevron and Husky Energy, and local success has led to its benefits monitoring software being adopted for projects elsewhere in Canada, including the Mackenzie Valley Gas Pipeline and Kearl oil sands projects for ExxonMobil and the Surmont oil sands and Parson's Lake gas projects for ConocoPhillips. However, non-oil projects, such as the Vale's Voisey's Bay mine in Labrador, have become increasingly important to the extent that, at times, work for the oil industry has only been responsible for 20 to 25 percent of the company's turnover.

In another example of a small specialist company working in the oil and other industries, **Canning & Pitt** was established in 1991, primarily to support the Hibernia development project in its relations with fisheries interests. Since that time it has worked for such companies as Husky Energy, Suncor, ConocoPhillips, Hebron, WesternGeco, PGS and GXT, developing and supporting operational management plans and compensation programs, providing consultation services, and assisting in the development of environmental assessments. This has included seismic-related work in Nova Scotia, the Beaufort Sea, and Greenland. While the oil industry accounts for approximately 80 to 85 percent of the company's business, it has diversified into work on minerals processing and subsea transmission line projects.

The oil industry supply and service sector is not just comprised of companies engaged in industry-specific activity. For example, **Greg Locke** was originally a freelance photographer and reporter, working for the Globe and Mail, Maclean's and other newspapers and magazines.

He increasingly became involved in corporate photography for such companies as Ford, Toyota and Imperial Oil, while based in Ottawa. Greg moved back to Newfoundland in 1988 and in the 1990s he became involved in local photography for the oil industry, including documenting the Hibernia construction site preparation for HMDC. This led to work for Chevron, Petro-Canada, GJ Cahill, Texas Instruments, Schlumberger, Baker Hughes, and other companies engaged in oil activity. Greg's recent work has included what he calls "engineering telemedicine," photographing damaged offshore equipment for evaluation by experts onshore.

Working in such a demanding industry has driven Greg's professional development, further expanding his business. For example, he has had to acquire suitable equipment for working offshore (where, for example, flash cannot be used because it might set off sensors) and to maintain current safety training certification for working offshore. These have helped Greg get work at other types of industrial sites, within and outside the province, including work for such companies as Teck-Cominco, Sandwell Engineering, and Schneider Electric. The importance of the oil industry to Greg Locke has been quite variable, representing between 10 and 60 percent of his total business income.

While St. John's is the Province's largest city, the centre of oil industry management, regulation and R&D, and the location of the main marine supply base and helibase for offshore activity, not all oil industry business occurs there. For example, the construction of the Hibernia, Terra Nova, White Rose, North Amethyst and Hebron projects, and rig mobilization and refurbishment work, has mostly been concentrated around the Isthmus of Avalon and in Marystown; work on the White Rose Extension Project is primarily occurring near Placentia, and the transshipment of Grand Banks' oil occurs at a terminal near Arnold's Cove on Placentia Bay.

Some supply and service companies are also located outside of the St. John's region. For example, **Dynamic Air Shelters** is based in Grand Bank on the Burin Peninsula, approximately 360 km by road west of St. John's. It evolved from Calgary-based Aero Dynamics Inflatable Shelters Inc., which originally focused on designing and manufacturing inflatable shelters for promotional events. Involvement with the oil and gas industry had an important influence on product development, and it was through the industry that it first began working in Newfoundland and Labrador in 2002, leading to it moving its manufacturing operations to Grand Bank in 2004.

The company began engineering and testing its shelters for explosion resistance in response to petroleum industry demand. A turning point came when the company demonstrated that its structures could withstand pressures from an explosion of up to four pounds per square inch (psi), with later tests concluding that they would likely withstand a blast of nine or ten psi. The product is now being used on work sites for offices, warehouses and lunchrooms, with the company becoming heavily involved with the oil industry internationally, producing structures for refineries and other sites across North America, the Caribbean and Australia.

Contracts with oil and gas companies represent about half of its sales; however, engineering and manufacturing capabilities developed to meet oil industry requirements have helped Dynamic sell its products to the construction and fabrication industries. The company has also worked with the Canadian Armed Forces to provide protective structures for use in military operations. About a quarter of its business comes from construction and fabrication

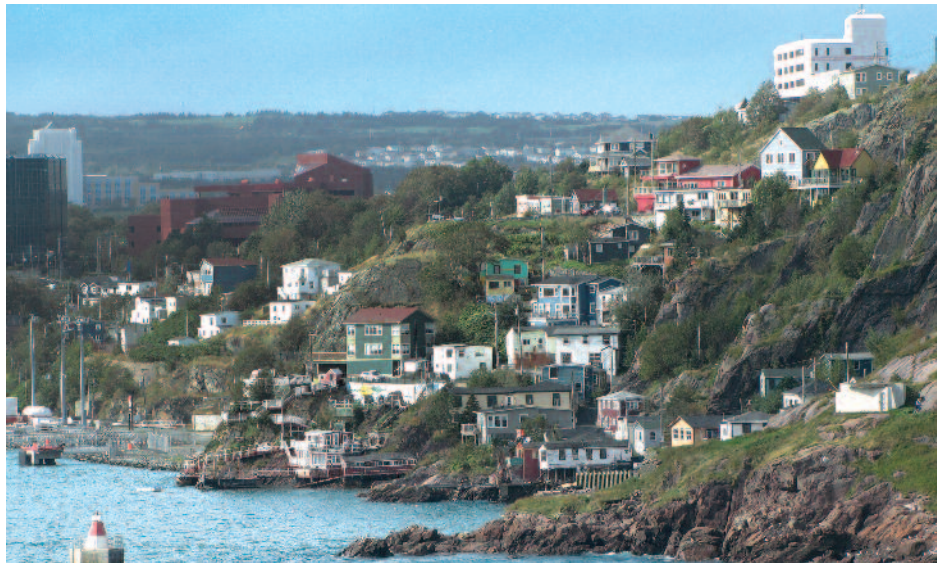
projects, many of which are linked to the oil and gas industry, while the remaining quarter is split between military applications, promotional structures, and emergency response shelters.

Conclusion

Thanks to a combination of natural resource potential and private-sector enterprise and investment, the past twenty years have seen a dramatic increase in Newfoundland and Labrador offshore petroleum industry activity and expenditures. Although total oil production volumes have recently decreased as the three main existing fields mature, additional investments in satellite fields and enhanced recovery have begun to offset these declines. With continued exploration and with the development of the Hebron field and the White Rose Extension project underway, the industry is making investments that will extend production into the second half of this century, and is contributing to a thriving and expanding innovation ecosystem.

As of 2010, this still relatively new industry was responsible for approximately 33 percent of provincial Real GDP and resulted in the average personal income being 6.5 percent higher, the unemployment rate being 1.8 percent lower, and the province's population being 16,400 larger, than they would have been without the industry. Thanks in part to strategic government support for, and leveraging of the economic benefits from, the offshore oil industry, Newfoundland and Labrador has also been transformed into a "have" province, as Atlantic Canada's only contributor to, rather than recipient of, equalization payments. The industry has also driven the growth of the St. John's region as a cosmopolitan centre of business, educational, recreational and cultural activity. Future oil industry activity, and associated additional investments in infrastructure, education, training, R&D and business growth in Newfoundland and Labrador seems certain to deliver further economic growth and diversification.

St. John's, Newfoundland and Labrador



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Biography

Mark Shrimpton (Principal, Stantec Consulting Ltd.) has over 30 years' experience assessing, planning and managing the socio-economic impacts of large natural resource and infrastructure projects. He has played a lead role in preparing requirements studies, impact assessments and benefits plans for petroleum, mining, hydro and transportation projects in Canada, and assisted project proponents, governments, regulators, industry groups and non-governmental organizations in the US, Greenland, Iceland, the Faroe Islands, the UK, France, Argentina, the Falkland Islands and Australia. He has also undertaken policy-related studies of resource development activity, including for the US Minerals Management Service and UN International Labour Office, and he is a member of the Pool of Experts for the UN Regular Process for Global Reporting and Assessment of the State of the Marine Environment, including Socioeconomic aspects, focusing on offshore petroleum activity.

Mark has published and presented widely on his research, including conference presentations in Canada, the US, Norway, Denmark, Greenland, Iceland, the Faroe Islands, the UK, France, Lithuania, Russia, Malaysia and Australia. In addition to his consulting work, Mark holds Professional Associate positions with the Leslie Harris Centre for Policy and Regional Development and the Faculty of Business Administration, at Memorial University.

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