THE ECONOMIC IMPACT OF THE BRITISH COLUMBIA INSTITUTE OF TECHNOLOGY ON THE PROVINCE OF BRITISH COLUMBIA

2007 Report

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EXECUTIVE SUMMARY

The British Columbia Institute of Technology is a significant contributor to the British Columbia economy. The impact that BCIT has on both the gross domestic product (GDP) and government tax revenues comes from a variety of sources, all of which have a multiplier – or spillover – effect that far exceeds its annual operating budget. The purpose of this report is to summarize and quantify the economic value of BCIT to the provincial economy.

In any economic impact study, the results are sensitive to the choice of multiplier. An impact multiplier can reasonably range from 1 to 4. A relatively conservative multiplier of 1.49 was selected for this study. A value in this range is supported by independent studies of provincial and regional multipliers. The multiplier value also allows for comparisons to the University of British Columbia, Simon Fraser University and the University of Victoria as the multipliers used for their economic impact studies are within this range.

SOURCES OF ECONOMIC VALUE

BCIT's economic value added to the GDP is derived from three sources:

1) Direct purchases by BCIT within the local economy and the income of its employees.
2) The economic value added by its graduates.
3) The economic contribution of its applied research programs.

BCIT OPERATIONS

In 2006, $152 million was spent on salaries and compensation. Direct spending on goods and services by BCIT was $78 million which resulted in $39 million being considered as local value added. In addition, approximately $92 million was spent by full-time students and BCIT's visitors.

The direct spending by BCIT, its staff, students and visitors generated a short-term impact of $350 million. As a result, 9,210 jobs were supported, directly or indirectly, by BCIT.

BCIT EDUCATION

Graduates of BCIT – in 2006 – will earn $176 million annually. When compared to the income of high school graduates, this adds an additional $56 million in income and $19 million in tax revenues for the province**.** A BCIT graduate will earn $4,164 more annually than system graduates. In comparison, the 5,371 graduates of BCIT will earn a premium of $22 million, or 49%, more than the system average income.

BCIT APPLIED RESEARCH

While more difficult to accurately quantify, BCIT's applied research is reasonably estimated to have a $77 million impact on the economy.

RETURNS ON GOVERNMENT INVESTMENT

In terms of a return on government investment, there was $3.15 million in regional economic activity per $1 million tax dollars invested at BCIT. In addition, there were 84 jobs created per $1 million tax dollars invested.

The additional taxes paid by graduates translate into a 17% return on the government's education funding to BCIT. When compared to the post-secondary system equivalent return of 10%, the "BCIT Premium" is 7%.

THE OVERALL ECONOMIC IMPACT OF BCIT

The overall impact of BCIT on the economy is close to half a billion dollars ($603 million gross, and $483 million net impact). The totals are summarized as follows:

Summary of Value Added	Gross Income	Net Income	Tax Revenue
		($ Millions)	
VALUE GENERATED FROM BCIT OPERATIONS	$350	$350	$74
VALUE ADDED BY BCIT GRADUATES	$176	$56	$18
VALUE ADDED BY APPLIED RESEARCH	$77	$77	$25
TOTAL IMPACT	**$603**	**$483**	**$117**

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INTRODUCTION

The British Columbia Institute of Technology is an engine of economic growth in the province of British Columbia. As the province's premier polytechnic, the magnitude of the institute's operations, combined with the contribution to industry from its applied programs and applied research, is a major contributor to the provincial economy. The impact can be measured through additions to the gross domestic product, government tax revenue, and increases in both human and physical capital stock.

BCIT's contribution can be measured in three broad categories:

1) The addition to GDP arising from the purchases of goods and services, employment income of faculty and staff, and the local spending contributions of students and visitors.
2) The value of a BCIT education as measured by the increased income and taxes of graduates.
3) The economic value to government and industry of BCIT's applied research initiatives.

The purpose of this report is to calculate the net impact of each category for 2006. This includes any multiplier effects that arise from indirect job creation and secondary rounds of spending in the local economy. Determination of the spending impact of BCIT on the economy is based on the guidelines established by the American Council on Education (ACE) in 1971.[i] The methodology used is identical to that employed by Simon Fraser University, University of British Columbia, University of Victoria and other post-secondary institutions to determine the economic impact of their operations.

In any economic impact study, the results are inherently sensitive to the choice of multiplier. An impact multiplier can reasonably range from 1 to 4, depending upon the structural characteristics of the regional and local economy at the time of the study[ii]. A relatively conservative multiplier of 1.49 was selected for this report. A multiplier in this range has strong empirical support by independent studies of regional multipliers for the province of B.C., thus giving greater validity to the final results. Further, the multiplier value employed allows for meaningful comparisons to institutes such as the University of British Columbia, Simon Fraser University and the University of Victoria in any discussion of relative impact.

All of the data used in this report is publicly available. The primary sources were the BCIT *Fact and Figures* report, the Ministry of Advanced Education website, and *Statistics Canada* census reports.

Considerations Beyond the Scope of the Report

This type of study is limited by the both the availability of the data and the complexity of the linkages with the data. As such, certain aspects of BCIT are not included in the actual calculation of BCIT's economic impact, but are worthy of mention since their omission places a downward bias on the overall results.

Apprenticeship Programs

Significant portions of BCIT's student population are part of trades training and are included in the economic impact study. However, apprenticeship programs were not included in this study. While it is recognised that apprenticeship programs make up an important component of the benefits to the Trades Industry, difficulties in aggregating apprentices prevented their inclusion. Specifically, apprenticeship students are not surveyed under the BC Student Outcomes Reporting System (SORS); therefore not enough key variables on apprentices were available at the time this report was written.

The Qualitative Aspects of Part-Time Studies

BCIT supplies a significant amount of part-time studies courses and industry training to people currently in the workforce. These people are integrating the additional skills they acquire into their current professions. This implies an ongoing increase in labour productivity which further enhances the gross domestic product. Gains in labour productivity are typically measured by differentials in wages. The current available data only captures wage differentials by educational credential. Therefore the ongoing nature of productivity gain due to part-time studies – or life long learning – is not measured in the calculations done for this report.

BRITISH COLUMBIA ECONOMIC IMPACT ASSESSMENT

This section employs a standard economic expenditure model that determines the economic impact of BCIT on the entire British Columbia economy resulting from cash flows which are directly and indirectly attributable to the operations of BCIT. Cash flows originate through faculty and staff income, Institute direct purchasing, and expenditures by students and by visitors to campus. A regional "multiplier factor" is used to account for spin-off effects on business volume in other sectors of the economy as a direct result of Institute-related expenditures.

In summary, the following economic impacts may be attributed to the British Columbia Institute of Technology:

TABLE 1
SUMMARY OF BCIT EXPENDITURES AND ECONOMIC IMPACT

	Cash Injection	First Round Income Generated	Regional Economic Impact
		(Thousands of Dollars)	
SALARIES AND WAGES	129,103	129,103	192,363
BENEFITS	23,575	18,860	28,101
DIRECT LOCAL SPENDING	78,109	39,055	58,191
SUBTOTAL	**$230,787**	**$187,018**	**$278,655**
INDUCED EXPENDITURES			
TOTAL STUDENT	90,873	46,978	69,997
TOTAL VISITOR	2,000	1,000	1,490
SUBTOTAL	**$92,873**	**$47,978**	**$71,487**
TOTALS	**$323,660**	**$234,996**	**$350,142**

$152 million spent on salaries and compensation.

Compensation of BCIT Personnel

The BCIT payroll reflects the total compensation associated with full-time and part-time faculty and staff who were actively employed. According to BCIT Facts and Figures 2006, the Institute's financial statements reflect a total salaries, wages and benefits outlay of approximately $152 million [iii] for the fiscal period ended on March 31, 2006.

Direct spending of $78 million resulted in $39 million being considered as local value added.

Direct Local Spending by BCIT

BCIT's financial statements indicate that approximately $78 million was dispersed for the purchase of capital and operating goods and services. Of this amount, one-half, or $39 million is considered to fall into the category of "local value added". [iv]

Approximately $90 million was spent by full-time students.

Student Expenditures

The expenditures of students, excluding tuition, books and residence fees, were estimated on the basis of government-recognized costs and information provided by BCIT's Office of Student Financial Aid Services. In order to present a conservative estimate, non-BCIT expenditures of students are calculated on the assumption that only full-time students have an impact on the local economy. Based on available data, BCIT's 15,633 full-time students spent approximately $90 million annually.[v]

$2 million in local spending generated by BCIT's visitors.

Visitors-to-BCIT Expenditures

The Institute attracts an estimated 50,000 visitors annually to the campuses. [vi] Based on Tourism Vancouver's estimate that each visitor spends an average daily total of $40 off campus, BCIT is credited with generating an additional $2 million in local spending.

$234 million realized as a result of BCIT's direct local spending.

Total Direct Local Spending by BCIT

Local value-added ratios were applied to account for the value of imported inputs. It is estimated that 73 percent of the initial cash injections, or equivalently approximately $235 million was realized as a result of direct local spending by BCIT[vii].

1.49 multiplier was used to estimate re-spending into B.C. economy.

Provincial Multiplier Effect

The economic ripple-effect associated with direct spending by BCIT, its students and visitors is captured by a multiplier. Several independent economic studies have provided a multiplier ranging from 1.39 to 2.0 for the BC economy. For purposes of this study, a conservative multiplier value of 1.49[viii] was used to estimate the re-spending of dollars injected into the B.C. economy by BCIT, its students and visitors.

IMPACT OF BCIT ON THE BRITISH COLUMBIA ECONOMY

BCIT is a major contributor to the BC economy, specifically the local economies within the Metro Vancouver Region, both in terms of dollars injected and circulated within the economy, and job creation.

BCIT generated a short-term impact of $348 million.

Total B.C. Economic Impact

The short-term economic impact resulting from BCIT operations is approximately $350 million.

9,180 jobs were supported, directly or indirectly, by BCIT.

Jobs Created (Directly or Indirectly)

The Institute supported, directly or indirectly, 9,210 jobs during the year. This figure is calculated by dividing the Institute's total direct and spin-off expenditures by $38,000, the average annual income of British Columbians. [ix]

Total taxes returned to government as a result of BCIT operations were $74 million.

Taxes Returned to Government

Assuming an average annual income of $38,000, and the Federal and Provincial tax rates applicable to this income, the total taxes returned to government in the form of personal income taxes as a result of BCIT operations was $74 million. Of this total, the British Columbia government realized $22 million in tax revenues.

$3.15 million in regional economic activity per $1 million tax dollars invested.

Income Generated (per $1M tax dollars invested)

In fiscal year 2006, BCIT received $110,672,000 [x] in Provincial grants. Based on this figure, for every $1 million taxpayer dollars spent at BCIT, the Province benefits through $3.15 million in regional economic activity.

84 jobs created per $1 million tax dollars invested.

Jobs Created (per $1M tax dollars invested)

For every million dollars spent by the Province, the British Columbia economy benefits from the creation of 84 jobs.

VALUING A BCIT EDUCATION

This section of the report calculates the additional income and tax revenues resulting from a BCIT education relative to a high school diploma (or equivalent). Further, the increase in value associated with a BCIT education is directly compared to the additional income and tax revenues resulting from an Applied Program education received from other such B.C. certification-granting institutions. The difference between a BCIT education and the system equivalent is referred to as the "*BCIT Premium*". This section also calculates the return on investment, specifically the payback period, associated with the Provincial Grants currently received by the Institute.

GRADUATE OUTCOMES SURVEY

The following table (Table 2) was taken from the Ministry of Labour and Citizens' Services (B.C. Stats) Graduate Outcomes Survey (2006)[xi] in the category of ***applied programs***. When reporting "All B.C. Institutes", this includes all colleges, university colleges, institutions and agencies within BC, and is referred to as "system-wide" below.

TABLE 2
EMPLOYMENT OUTCOMES INDICATORS

		INDICATOR		BCIT Former Students Value	BCIT Former Students N	All BC Institutions Former Students Value	All BC Institutions Former Students N	All BC Institutions Provincial Range Min-Max	All BC Institutions Standard Deviation Value
Respondents – Applied Programs									
Employment	Of Resp.	In the Labour Force	%	**91%**	**2893**	90%	10785	84% - 97%	3%
		Employed	%	**86%**	**2738**	84%	10164	71% - 96%	5%
	Of Employed	Employed in a Training-Related Job	%	**81%**	**2223**	79%	7988	67% - 89%	6%
		Employed Full-Time, Training-Related	%	**75%**	**2063**	67%	6833	47% - 75%	8%
		Employed Full-Time, Non Training-Related	%	**15%**	**405**	15%	1554	8% - 27%	4%
		Employed Full-Time (30 hrs or more a week)	%	**90%**	**2471**	83%	8393	66% - 92%	6%
		Employed Part-Time	%	**8%**	**210**	15%	1475	7% - 31%	6%
		Unemployed (of those in labour force)	%	**5%**	**155**	6%	621	1% - 15%	3%
		Gross Hourly Wage (main job)	Median	**$17**	**2421**	$17	9009	$15 - $25	$2
		Weekly Hours Worked (main job)	Median	**40**	**2674**	40	9828	32 - 40	2

[xii] See Endnote below for explanation of categories.

In addition, the data presented in Table 2 was also collected for the years 2004 and 2005. From these tables a three year average was calculated. For the purposes of the calculations in this section, the variables extracted for use in the estimation of the economic value added from education are summarized in Table 3.

TABLE 3
3 YEAR AVERAGE OF EMPLOYMENT OUTCOMES

	Eligible Cohort	Respondents	Employed in Permanent Job	Average Hourly Wage (Main Job)
BCIT	15,081	9,585	90%	$19
SYSTEM	53,056	29,389	81%	$17

BCIT's employment rate was 90%, with an average hourly wage of $19.

[xiii] See Endnote below for data source

ECONOMIC VALUE OF A BCIT EDUCATION

To determine the economic value of education at BCIT, the following calculations were carried out, using both the BCIT and system-wide average salary and the percentage of graduates who gained full-time employment (column one, Table 4).

TABLE 4
VALUE ADDED INCOME AND TAX REVENUE FROM 2006 BCIT GRADUATES

Applied Programs	Total Income	Additional Income Added	Additional Taxes
BCIT (2006)	$176,340,672	$56,586,686	$18,673,606
SYSTEM EQUIVILANT	$142,000,646	$34,222,059	$11,293,279
DIFFERENCE	**$34,340,026**	**$22,364,627**	**$7,380,327**
BCIT PREMIUM (%)	22%	49%	49%
PER BCIT GRADUATE	**$6,393**	**$4,164**	**$1,374**

2006 BCIT graduates will earn $176 million annually.

This is $34 million more than that earned by the system.

[xiv] See Endnote below for explanation of column headings.

A BCIT graduate will earn $6,393 more annually than system graduates.

In 2006, BCIT graduated 5,371 students from its full-time and part-time programs[xv]. These graduates will earn $176 million annually. This amount is $34 million, or 22%, more than that earned by students elsewhere in the system. On a per graduate basis, a BCIT applied program graduate holder will earn $6,393 more annually than a graduate from elsewhere.

The additional income added as a result of high-school graduates obtaining an applied program credential (column two, Table 4) was calculated taking the difference between the average income of a high-school graduate (or equivalent) from the Statistics Canada (2000 Census, adjusted) and the BCIT and "System" rates (Table 3) and applying this differential to the BCIT graduate population.

When compared to high-school graduates, BCIT graduates will earn $56 million more annually.

When compared to the earnings of 5,371 high-school graduates, BCIT graduates will earn $56 million more annually as a result of having earned an applied program credential from BCIT. If these high-school graduates had received their post-secondary education elsewhere, the additional income would have been $34 million. The employment income advantage is $22 million. This equates to $4,164 per BCIT student annually relative to earnings of graduates from other institutions offering applied program credentials.

The Tax Revenue Advantage Associated with a BCIT Education

Using both the 2005 federal and provincial income tax rates, the increase in tax revenues due to the applied education received by BCIT and system graduates is calculated on the additional income earned by graduates (Table 4).

BCIT graduates paid an additional $7 million in taxes than system graduates.

The 5,371 BCIT graduates paid an additional $7 million, or 49%, more in personal income taxes than an equivalent number of applied program graduates from other credential-granting educational institutions. On a per graduate basis, the differential is $1,374 annually.

Rate of Return Associated with a BCIT Education

The tables which follow calculate the rate of return which the two levels of government realize, in the form of tax revenues, on BCIT credential graduates. For comparison purposes, equivalent tax revenues have been provided for other credential granting institutions.

TABLE 5
ANNUAL TAX REVENUE FROM BCIT AND SYSTEM EQUIVALENT EDUCATION (2006 GRADUATES)

BCIT provides the Governments with a tax premium of $7 million annually.

	BCIT Additional Tax Revenue/Year	System Equivalent Additional Tax Revenue/Year	BCIT Premium
PROVINCIAL TAX	$6,224,535	$3,764,426	**$2,460,109**
FEDERAL TAX	$12,449,071	$7,528,853	**$4,920,218**
TOTAL GOVERNMENT RETURN	**$18,673,606**	**$11,293,279**	**$7,380,327**

The Provincial Government's share of tax premium is $2.4 million.

[xvi] See Footnote below for explanation of return on investment.

Table 5 indicates that BCIT provides the Provincial and Federal government with a tax premium of $7 million annually, relative to other institutions which grant applied credentials, with the Province share of this total being $2.4 million.

TABLE 6
RATES OF RETURN ON BLOCK FUNDING (TAX REVENUES)

The BCIT rate of return to government is 17%.

	BCIT Rate of Return per Graduate	System Equivalent Rate of Return per Graduate	BCIT Premium
PROVINCIAL TAX	6%	3%	**3%**
FEDERAL TAX	11%	7%	**4%**
TOTAL GOVERNMENT RETURN	**17%**	**10%**	**7%**

A system graduate provides a rate of return of 10%.

BCIT provides a premium of 7%.

[xvii] See Footnote below for explanation of return on investment.

The return on investment by government, in terms of tax revenues, is 17% for a BCIT credential graduate, and 10% for a non-BCIT post secondary graduate. The BCIT premium earned by the British Columbia taxpayers, by investing public dollars in BCIT, is 7% higher than that realized from an investment in alternate educational institutions.

Present Value Calculation of Educational Benefits of BCIT

Present value calculations were undertaken to determine the additional income earned attributed to a BCIT applied program five, ten, and twenty years following graduation. From this earnings profile, the additional Provincial and Federal tax revenues generated by BCIT graduates were determined.

For comparative purposes, the additional income and tax revenues attributed to graduates from all post-secondary sector institutions were determined, and the BCIT Premium calculated.

This analysis yielded the following results.

Over a five year period, BCIT graduates will earn an additional $272 million over that earned by individuals with only grade 12 and some post-secondary education.

TABLE 7
BCIT PRESENT VALUE CALCULATIONS

Years in Work Force	Years since Admission	Additional Income	Federal Tax	Provincial Tax	Total Tax
5	7	$272,332,951	$59,913,249	$29,956,625	**$89,869,874**
10	12	$531,942,338	$117,027,314	$58,513,657	**$175,540,972**
20	22	$1,015,340,462	$223,374,902	$111,687,451	**$335,062,353**

TABLE 8
SYSTEM EQUIVALENT PRESENT VALUE CALCULATIONS

Years in Work Force	Years since Admission	Additional Income	Federal Tax	Provincial Tax	Total Tax
5	7	$164,699,418	$36,233,872	$18,116,936	**$54,350,808**
10	12	$321,703,979	$70,774,875	$35,387,438	**$106,162,313**
20	22	$61,404,762	$135,090,948	$67,545,474	**$202,636,422**

The present value differential – BCIT versus the "System" – is as follows:

TABLE 9
BCIT PREMIUM: PRESENT VALUE DIFFERENTIAL FOR BCIT AND SYSTEM

BCIT graduates will earn, over the first five year period, an additional $107 million in income, and contribute $24 million more in Federal and $12 million more in Provincial taxes.

Years in Work Force	Years since Admission	Additional Income	Federal Tax	Provincial Tax	Total Tax
5	7	$107,633,533	$23,679,377	$11,839,689	**$35,519,066**
10	12	$210,238,359	$46,252,439	$23,126,219	**$69,378,659**
20	22	$953,935,700	$88,283,954	$44,141,977	**$132,425,931**

Highlights

- Over a five year period, BCIT graduates will earn an additional $272 million over that earned by individuals with only grade 12 and some post-secondary education. **This will result in an additional $60 million in Federal tax and $29 million in Provincial tax revenues.**
- In comparison, the equivalent number of "System" graduates will earn an additional $164 million over the five year period, and contribute an additional $36 million in Federal and $18 million in Provincial tax revenues.
- In comparing the BCIT and "System" graduates, **the BCIT graduates will earn, over the first five year period, an additional $107 million in income, and contribute $24 million more in Federal and $12 million more in Provincial taxes.**

RESEARCH AND DEVELOPMENT ACTIVITY IMPACT ANALYSIS[xviii]

As B.C.'s premier technical institute, BCIT and its faculty are engaged in a wide range of research and development activities on behalf of, and with, industry clients, including applied research, technology transfer, commercialization, technical and business consulting, and associated training.

The local economy is a direct beneficiary of BCIT's applied research services, expertise and graduate labour pool, in that hi-technology firms are induced, in part, to locate within proximity of the Burnaby campus.

For example, Technology Place, built on the BCIT Burnaby campus by Discovery Parks Inc., makes available office and laboratory space to hi-tech firms. A number of high-profile employers, such as eBay, Electronic Arts and Creo Inc., who regularly employ BCIT graduates are also located nearby.

When evaluating the economic impact of applied research, it is important to recognize that the benefits tend to diffuse throughout the economy over a longer time horizon. Unlike the impact calculated in the previous two sections, the economic benefits of applied research will not necessarily be realized in the same year that the investments were made.

BCIT TECHNOLOGY CENTRE

Whereas considerable research and development activity occurs across the various technology programs at BCIT, and independently by faculty, the Institute's principal research and development facility is its Technology Centre.

The Technology Centre's mission[xix] is to support economic development in British Columbia through *applied* research, technology transfer and enterprise development. It achieves its mission by:

- Providing solutions to technical and business problems
- Developing prototypes and systems
- Organizing industry-specific conferences and workshops
- Providing advice and training for people who want to start new business ventures

BCIT Technology Centre research focuses on activities with short-term/immediate industrial and commercial relevance.

The key differentiator between university and BCIT research is that the research conducted at the BCIT Technology Centre focuses on activities with short-term/immediate industrial and commercial relevance, whereas university research is undertaken principally to develop new knowledge.

BCIT achieves its research mission through a number of unique research facilities that have been established in the Technology Centre and Schools, as a result of partnerships with industry and with the help of federal and provincial programs:

Advanced Prototyping Hub

The Advanced Prototyping Hub is a new facility that serves a broad range of research disciplines, and is equipped to allow researchers to develop prototypes not only at the lab mock-up level, but at an advanced level equivalent to that of commercial products that are released into the marketplace. It comprises two key platforms: (1) an integrated design/machining platform and (2) a performance evaluation platform for life-sciences products, with emphasis on safety, efficacy and environmental impact.

Integrated Molecular Biology Laboratory (IMBL)

This new facility focuses on the study of the biological activity and safety of natural health products (NHPs), with the overall objective of providing molecular and biological evidence-based data on a NHP's mechanism of action and safety profile. IMBL's research strategy is to apply molecular biology and drug-discovery based techniques to the study of NHPs. Its core facilities include infrastructure for cell culture and imaging, assay development and activity screening, as well as for genetic manipulation and analysis of expression changes.

Centre for the Advancement of Green Roof Technologies (CAGRT)

Green roofs are specialized roofing systems that support vegetation growth on rooftops. Green roof technology offers multiple benefits to urban areas – they can reduce site level stormwater runoff, lower a building's cooling/heating energy demand and when widely adopted, they can reduce impact on the regional watershed, mitigate urban heat island effects, and improve air and water quality of the local community. The Centre's principal functions are to develop the regional infrastructure network; to inventory performance of green roofs; develop a system performance evaluation module; provide a testing and verification facility for the local green roof industry; and improve public awareness of the technology through education and demonstration.

Building Science Centre of Excellence

This Centre has been developed through national and international partnerships and it focuses on themes related to building envelopes and rain control. Research facilities have been established in three areas: (1) a Building Science Materials Laboratory for instrumentation and testing of construction materials, (2) a Water Penetration Test Chamber for special purpose testing of window and wall assemblies, and (3) a Building Envelope Test Hut, which is a real time, real weather exposure facility for field tests on wall panels.

BCIT Centre for Biomechanics Research

To improve police dog performance as partners in the law enforcement field, BCIT has launched the world class BCIT Centre for Biomechanics Research. This unique research centre will develop best practices in health screening, fitness training and rehabilitation care for police dogs.

Centre for Rehabilitation Engineering And Technology that Enables (CREATE)

CREATE, developed in partnership with the Neil Squire Foundation, is a research facility devoted to development of devices, technologies and products for people with disabilities. Equipped with a state-of-the-art Rapid Prototyping Machine, CREATE is the first research facility of its kind in B.C.

Herbal Analysis and Evaluation Lab (HEAL)

The Herbal Analysis and Evaluation Lab is fully equipped for research-oriented investigations into a variety of areas concerning herbal medicines including the determination of toxic components and contaminants, the quantification of active and marker compounds, and the identification of constituents in medicinal preparations to assist in clinical studies.

Industrial Instrumentation Process Lab

The BCIT Industrial Instrumentation Process Laboratory is capable of simulating a wide variety of complex control process for research testing of industrial control systems. The lab houses a fully operational distillation column, evaporator and power boiler and extensive process control equipment.

Internet Engineering Lab (IEL)

One of only four research centers of its kind in North America, BCIT's Internet Engineering Lab (IEL) is capable of emulating and testing any network configuration, from small plant floor networks to complex sets of interconnected backbone nodes of the Internet. Research conducted within the IEL focuses on the design and management of advanced networks involving layer 3/4 (TCP/IP) issues including: network security and critical infrastructure protection, conformance to standards, and network performance testing and evaluation.

Dr. Tong Louie Living Laboratory

The Living Lab is a joint venture between BCIT and Simon Fraser University. Designed for research and development of age and disability sensitive environments and products, the lab occupies 1500 square feet on the 7th floor of the BCIT Downtown Education Centre and contains an experimental studio, a viewing theatre and a data acquisition and analysis centre.

Photovoltaic Energy Applied Research Lab (PEARL)

A novel facility for applied research and development in alternative energy. This lab is equipped with state-of-the-art instruments for flash testing and custom prototyping of solar modules. Currently, we intend to fold the PEARL facility into a new BCIT Centre for Advancement of the Adoption of Renewable Energy Technologies, which will focus on applied research on a range of alternative energy technologies, including wind power, solar thermal as well as solar electric, biodiesel, mini-hydro and so on, and on strategies for improving the integration of such technologies into the grid, as well as increasing the efficient use of energy in the built environment.

Food Analysis Lab & Pilot Plant

This food pilot plant and food analysis laboratory has a broad range of equipment for use in food processing simulation, drying, packaging, chemical, physical and microbiological analysis, texture and colour measurement, and shelf life studies.

Forensic Science Centre

The Forensic Science Centre conducts investigative research in the analysis of forensic, physical and biological samples.

110 active projects.

57% growth in applied research projects over a 6 year period.

91% of work performed for external (non-BCIT) clients.

The BCIT Technology's partner/client base includes the following organizations: BC Hydro; BC Cancer Research Centre; BP International; Canadian Police Research Centre; Cisco Systems; Environment Canada; National Research Council; Institute for Fuel Cell Research; Omnex Control Systems; National Infrastructure Security Coordination Centre (UK).

The following data indicates the scope of the BCIT Technology Centre's activities:[xx]

- $4 million plus annual budget during fiscal year 2004/05
- 110 active projects (93% applied research projects)
- 57% growth in applied research projects over a six year period
- 91% of work performed for external (non-BCIT) clients.

RESEARCH & DEVELOPMENT ECONOMIC IMPACT ANALYLSIS

Economic theory predicts that one dollar of expenditure made in the economy will create more than one dollar of total economic activity. This is commonly referred to as the multiplier effect and the size of the multiplier effect varies depending on the type of expenditures made.

Of the more than 20 studies surveyed, only two organizations reported multipliers specifically for applied R&D. Most expressed their impacts in terms of anecdotal evidence of the relationship between their research institution and industry. This is likely due to the need for confidentiality concerning client firms' production costs and profits, and the labour resources required to collect relevant information for purposes of determining the multiplier effect.

Ultra-Conservative multiplier is 4.04.

Realistic multiplier is 18.

Optimistic multiplier is 23+.

A Michigan State University study estimated their R&D multiplier effect to be 4.04. Alternatively, a 2001 report by the Science Council of B.C. estimated the multiplier effect associated with the Technology B.C. Program to be 18. NASA's officially stated multiplier is 23. In other words, depending upon the multiplier factor used, one dollar of applied research and development expenditure will return $4.04 or $18.00 to the economy. Selection of an appropriate multiplier factor is therefore critical in estimating the economic "ripple-effect" associated with applied research and development.

As anecdotal evidence about various R&D activities undertaken across the various schools/ departments and by faculty is difficult to quantify, for purposes of this study only BCIT Technology Centre data has been used to estimate the economic impact of research and development by BCIT. *It should be noted, however, that the estimates arrived at as a result of this narrower focus are a significant understatement of the real impact of R&D activities by BCIT and its faculty.*
Using a five-year average expenditure (public and private sources of funds) of $4,327,000[xxi] by BCIT's Technology Centre, and the aforementioned multiplier factors, the economic impact of this

Ultra-Conservative estimate of economic impact of the Tech Centre is $17million per year.

Realistic estimate of economic impact of the Tech Centre is $78 million per year.

Optimistic estimate of economic impact of the Tech Centre is $100 million per year.

facility on the Province can be estimated as follows:

Ultra-Conservative Estimate (using multiplier 4.04x)	$17,481,000
Reasonable Estimate (using multiplier 18.0x)	$77,886,000
Optimistic Estimate (using multiplier 23x)	$99,521,000

Applied R&D at BCIT likely has a larger economic multiplier than that associated with university research since a large percentage of research undertaken at universities is for the sake of knowledge only and usually does not translate into efficiency enhancing or commercially valuable applications – at least not in the short term, or with any direct localized effects. For example, research in philosophy, pure mathematics and the like are funded but not expected to have any real short-term economic impact.

This differs markedly from applied R&D where the sole objective is efficiency enhancement and the development of commercially viable applications. Given the commercial nature of applied R&D, the tax revenues received by the provincial government from spin-off economic activity are likely much higher for a dollar spent on applied research, compared to the same expenditure made in a traditional R&D environment where the funding is allocated to both pure and applied research.

Furthermore, applied R&D develops not only new products and processes offered for sale, but often also results in operating cost reductions, which are reflected on financial statements in the form of higher profitability. Such productivity gains benefit the Province through increased corporate tax revenues.

A conservative approach to measuring the tax revenues generated by applied research is to determine the additional income tax which results from the economic impact, indicated above. The following assumptions are used in calculating tax revenues:

- 65% of economic activity reported above is labour income.
- Per CCRA's 2005 tax table, 22% federal tax (on income up to $71,190), and 7.45% (6.05% on first $33,061 of income, and 9.15% on balance).

Based on these assumptions, the following Federal and Provincial tax revenues are generated as a result of BCIT's Technology Centre related research activities.

	Impact	Federal Tax	Provincial Tax
Ultra-Conservative Estimate	$17,481,000	$ 2,500,000	$ 847,000
Realistic Estimate	$77,886,000	$ 11,138,000	$ 3,772,000
Optimistic Estimate	$99,521,000	$ 14,231,000	$ 1,082,000

NON-QUANTIFIED RESEARCH & DEVELOPMENT ECONOMIC IMPACTS

As mentioned earlier, the various schools of BCIT, and faculty independently of BCIT, also undertake research and development activities which generate positive economic impacts for the Province and in some cases, internationally.

The following examples are intended to illustrate the broad range of applied research activities in which the various BCIT Schools and faculty have been engaged:

> *Several School of Business faculty members have authored technical and business textbooks. These texts are being marketed nationally, and in at least one instance the distribution is international in scope.*

One School of Business faculty member has been instrumental in facilitating negotiations for overseas oil & gas leases, and chairing several meetings with a foreign Deputy Oil Minister and his staff to discuss/ negotiate the construction of a 300,000 bpd refinery.

A faculty member on professional development leave led a collaborative National Research Council, UBC and BCIT project that developed techniques for manufacturing a new generational of platinum nanostructured catalysts which accelerate the chemical reaction and thus boosts the current generated.

A Mechanical Engineering Technology faculty member developed a new numerical technique for predicting the flow of incompressible fluids, such as water. The findings were presented to scientists at a conference at the Massachusetts Institute of Technology (MIT) and at the National Aeronautical Space Agency (NASA).

BCIT's Centre for Wood Science and Applied Technology conducts activities that enhance the development of forest-based communities. The focus is on the development of practical solutions, innovative technologies and products to keep B.C.'s economic sector competitive and sustainable. A particular research emphasis is the production of value-added products from local forest resources, the use of underutilized species, beetle-killed timber and woody residues.

School of Construction and Environment faculty members have been engaged in investigating the feasibility of constructing specialized roofing systems that support vegetation growth on rooftops. Such a vegetative roof system provides numerous environmental and economic benefits, including the decrease of the urban "heat island" effect.

BCIT's Building Science Centre of Excellence is undertaking research in the area of building performance, notably rain penetration damage and mitigation.

The Fish, Wildlife and Recreation Program of BCIT is involved in supporting environmental initiatives concerned with the management, protection and/or restoration of rivers and streams. Current research encompasses the monitoring of rivers, streams to determine how the ecosystem is responding to the return of natural flow regimes.

The BCIT Canadian Housing & Construction Centre has been working with government and industry partners to assist in the development of new technologies and/or the adaptation of existing technologies to create more sustainable, energy efficient, functional, and environmentally friendly housing. As an example, Home 2000, located on the Burnaby campus, is a demonstration project which showcases some of the most innovative, yet practical, housing ideas.

Considerable work is being carried out by BCIT faculty in the area of Geographic Information System Technology (GIS) notably the development of Open GIS solutions, Indoor GIS location and routing, GIS data updates via the internet and the development of a prototype wireless GIS service which delivers location-based information to cell-phone or PDA mobile users.

The Civil Engineering Technology department is conducting structural and earthquake engineering research, with particular focus on the seismic performance of woodframe, concrete and masonry structures, performance-based sismic design and passive seismic control devices.

The School of Computing and Academic Studies faculty members are engaged in a variety of research projects, including: applications of science-based attributes in enterprise information systems, pattern discover of computer systems for intrusion detection, modeling genome sequences using Markov models, firewall and perimeter designs, covert channels and steganography, and ultra-wideband antenna design.

For additional examples of research updated for 2007, see Appendix B

Applied research by various schools and departments at BCIT is estimated to have an additional impact of $17-$77 million

Because of a lack of data associated with R&D activities carried out by individual Schools and Departments, these additional applied research initiatives have not been quantified in terms of their economic impact. A reasonable, conservative estimate is likely to be in the range of $17 to $77 million, similar to returns realized by the BCIT Technology Centre.

SUMMARY OF RESULTS

BCIT, as an economic entity with 2,224 employees operating in the province of British Columbia, generated a short-term impact of $350 million and 9,210 jobs were supported, directly or indirectly, by BCIT.

In 2006, the 5,371 graduates of BCIT earned $176 million annually in gross income, which is $56 million more than they would have earned if they had not pursued higher education. Further, because they chose BCIT, they will earn a premium of $22 million, or 49%, more than the system average income.

Applied research conservatively adds $77 million to the provincial economy. Calculations only include projects associated with the BCIT Technology Centre. They do not include the applied research being carried out directly by the different schools within BCIT or any research initiatives of the individual faculty members.

The overall impact of BCIT on the economy is close to half a billion dollars ($603 million gross income and $483 million in net income). The totals are summarized as follows:

TABLE 10
SUMMARY OF BCIT'S VALUE ADDED TO ECONOMY

Summary of Value Added	Gross Income	Net Income	Tax Revenue
		($ Millions)	
VALUE GENERATED FROM BCIT OPERATIONS	$350	$350	$74
VALUE ADDED BY BCIT GRADUATES	$176	$56	$18
VALUE ADDED BY APPLIED RESEARCH	$77	$77	$25
TOTAL IMPACT	**$603**	**$483**	**$117**

The investment in education, as measured by the increased tax revenues associated with a BCIT education is 17% and the payback period is six years after graduation (see Appendix A). The overall annual tax contribution related to BCIT various activities is $117 million, which exceeds the annual funding of $110 million supplied by the government to the institute.

END NOTES

[i] See Caffrey, J., Isaacs, H.H. "Estimating the Impact of a College or University on the Local Economy". American Council on Education, Washington, 1971.
[ii] Impact multipliers are highly sensitive to such variables as: current unemployment rates, capacity utilization ratios, and the adaptability of industries to sudden economic change. All such variable tend to fluctuate over the normal business cycle, thereby changing the magnitude of the impact multiplier.
[iii] The information is based on page 5-5, BCIT Facts and Figures 2006, prepared by the Institute of Research and Planning, BCIT, October 2006. The number has been rounded to million.
[iv] The information is based on page 5-5, BCIT Facts and Figures 2006, and information provided by the Finance Office, BCIT.
[v] The information is based on page 2-6, BCIT Facts and Figures 2004 (Revised), the B.C. government's 2004 Student Living Allowance, and information provided by the International Student Centre, BCIT International, BCIT.
[vi] It is not possible to accurately estimate the number of visitors to the campuses as BCIT does not track this information. The estimated number is similar to that reported in other economic impact studies.
[vii] The percentage of initial expenditures attributed to the local economy is referred to as the "Export Factor". If BCIT ceased to exist, the export factor accounts for the portion of the economic activity attributed to BCIT that would disappear from the province.
[viii] This value is based on the income multiplier derived by Davis, C.H. "Income and Employment Multipliers for Seven British Columbia Regions", Canadian Journal of Regional Science, vol. 9:1, 1986, p. 103-115.
[ix] The income figures are based on the data from the Provincial Comparison – Average Weekly Wage Rate, http://www.bcstats.gov.bc.ca/data/lss/empern/eet21.pdf
[x] The information is based on page 5- 4, BCIT Facts and Figures 2006.
[xi] The information was taken from BC Stats. http://outcomes.bcstats.gov.bc.ca/Publications/collegereports/keyout/2006keyoutcomes.pdf
[xii] For survey purposes, the government divides education into various categories. The data used in this report corresponds to the "Applied Programs" category.
[xiii] The information was taken from BC Stats Student Outcomes Reporting (SORS) database.
[xiv] Applied Programs: Values in each case (BCIT and "System") were calculated by using 5,371 grads multiplied by the appropriate average wage and weighted by the percentage of grads that found full-time employment.
Additional Income Added: Earnings per credential were compared to the average income of British Columbians with a high-school diploma and some post-secondary education, as reported by Statistics Canada 2000 (and adjusted to current dollars).
[xv] The information is based on the Quick Facts page, BCIT Facts and Figures 2006.
[xvi] Calculations are based on 2 years' FTE (full-time equivalent) funding being provided for 5,371 students.
[xvii] Calculations are based on 2 years' FTE (full-time equivalent) funding being provided for 5,371 students.
[xviii] Accurate data was only available up to 2005. Results in this section are based on extrapolations from that year.
[xix] Source: BCIT Technology Centre Annual Review 2000-2001, p.4.
[xx] Source: BCIT Technology Centre, Technology Centre Activities 1999-2005.
[xxi] Source: BCIT Technology Centre.

APPENDICES

APPENDIX A

PRESENT VALUE OF EDUCATIONAL BENEFITS OF BCIT

Year in school	PV of 2 year Block funding for Graduates	
1	$ (55,332,042.00)	
2	$ (52,697,182.86)	**$ (108,029,225)**

Years in Workforce	Year since admission	Discounted Values of Income & Taxes (assume work after 2 yrs)				Cumulative PV of Income and Taxes				NET RETURN on BLOCK Funding	
		Additional Income	Fed Tax	Prov Tax	Total Tax	Additional Income	Fed Tax	Prov Tax	Total Tax	Net PV (income)	Net PV (Taxes)
1	3	$55,513,977	$12,213,075	$6,106,537	$18,319,612	$55,513,977	$12,213,075	$6,106,537	$18,319,612	-$52,515,248	-$89,709,613
2	4	$54,985,272	$12,096,760	$6,048,380	$18,145,140	$110,499,249	$24,309,835	$12,154,917	$36,464,752	$2,470,024	-$71,564,473
3	5	$54,461,603	$11,981,553	$5,990,776	$17,972,329	$164,960,851	$36,291,387	$18,145,694	$54,437,081	$56,931,626	-$53,592,144
4	6	$53,942,921	$11,867,443	$5,933,721	$17,801,164	$218,903,772	$48,158,830	$24,079,415	$72,238,245	$110,874,547	-$35,790,980
5	7	$53,429,179	$11,754,419	$5,877,210	$17,631,629	$272,332,951	$59,913,249	$29,956,625	$89,869,874	$164,303,726	-$18,159,351
6	8	$52,920,329	$11,642,472	$5,821,236	$17,463,709	$325,253,280	$71,555,722	$35,777,861	$107,333,582	$217,224,055	-$695,642
7	9	$52,416,326	$11,531,592	$5,765,796	$17,297,388	$377,669,606	$83,087,313	$41,543,657	$124,630,970	$269,640,382	$16,601,745
8	10	$51,917,123	$11,421,767	$5,710,884	$17,132,651	$429,586,730	$94,509,080	$47,254,540	$141,763,621	$321,557,505	$33,734,396
9	11	$51,422,674	$11,312,988	$5,656,494	$16,969,483	$481,009,404	$105,822,069	$52,911,034	$158,733,103	$372,980,179	$50,703,878
10	12	$50,932,935	$11,205,246	$5,602,623	$16,807,868	$531,942,338	$117,027,314	$58,513,657	$175,540,972	$423,913,114	$67,511,747
11	13	$50,447,859	$11,098,529	$5,549,264	$16,647,793	$582,390,197	$128,125,843	$64,062,922	$192,188,765	$474,360,973	$84,159,540
12	14	$49,967,403	$10,992,829	$5,496,414	$16,489,243	$632,357,601	$139,118,672	$69,559,336	$208,678,008	$524,328,376	$100,648,783
13	15	$49,491,523	$10,888,135	$5,444,068	$16,332,203	$681,849,124	$150,006,807	$75,003,404	$225,010,211	$573,819,899	$116,980,986
14	16	$49,020,175	$10,784,439	$5,392,219	$16,176,658	$730,869,299	$160,791,246	$80,395,623	$241,186,869	$622,840,074	$133,157,644
15	17	$48,553,317	$10,681,730	$5,340,865	$16,022,594	$779,422,616	$171,472,975	$85,736,488	$257,209,463	$671,393,391	$149,180,238
16	18	$48,090,904	$10,579,999	$5,289,999	$15,869,998	$827,513,520	$182,052,974	$91,026,487	$273,079,462	$719,484,295	$165,050,237
17	19	$47,632,895	$10,479,237	$5,239,618	$15,718,855	$875,146,415	$192,532,211	$96,266,106	$288,798,317	$767,117,190	$180,769,092
18	20	$47,179,249	$10,379,435	$5,189,717	$15,569,152	$922,325,664	$202,911,646	$101,455,823	$304,367,469	$814,296,439	$196,338,244
19	21	$46,729,923	$10,280,583	$5,140,291	$15,420,874	$969,055,587	$213,192,229	$106,596,115	$319,788,344	$861,026,362	$211,759,119
20	22	$46,284,876	$10,182,673	$5,091,336	$15,274,009	$1,015,340,462	$223,374,902	$111,687,451	$335,062,353	$907,311,237	$227,033,128

Assumptions		**2006**
Hourly		19
BCIT Grad Income/month	$	3,040.00
BCIT Grad Annual Income	$	36,480.00
BCIT Grad FT empl. Rate		90%
System Hourly		17
Syst Grad Income/month	$	2,720.00
Syst Grad Annual Income	$	32,640.00
System Empl. Rate		81%
Grade 12 Annual income (yr 2000 census)	$	22,259.00
Inflation Rate		1.8%
Number of years since Base (yr 2000)		6
Grade 12 Annual income adjusted	$	24,773.78
Block funding per Graduate (2yr average stay	$	10,302.00
Growth Rate for Wages		4%
Discount Factor		5%
Fed Tax Rate		22%
Prov Tax Rate		11%
BCIT Graduates		5,371
Base Income for BCIT Graduates (GR 12)	$	133,059,984.91
Government Investment	$	55,332,042.00

APPENDIX B

APPLIED RESEARCH SINCE JANUARY 2007

Health Technology Research Group at BCIT certified to ISO 13485 and ISO 9001
The Health Technology Research Group at BCIT conducts applied research focused on medical and assistive device development. Projects range from design and fabrication of clinical-ready prototypes to testing and evaluation of commercial products. Small medical device start-up companies, world-class research hospitals, industry associations, and government organizations from across Canada have benefited from this group's extensive expertise and unique research facilities. Thus, the Health Technology Group has become certified to ISO 1S0 13485 and 9001 Standards.

A Map With Wheels: Designing, Implementing and Evaluating a Collaborative Technology To Encourage Sustainable Transportation and Build Community
BCIT researcher Ari Goelman proposes to develop and test a collaborative mapping technology, accessible via the Internet and mobile telephone, which utilizes user-generated content to provide real time cycling and commuting information. The central idea is a collaborative map through which users can exchange real time information on buses, cycling routes and attendant hazards. This project will be funded by IRAP.

Human Lift Technology
BCIT was awarded a US National Patent for the Human Lift Technology.
Work-related injuries among homecare workers are abundant. Chronic injuries of the back, neck, shoulder, and arm are related to the considerable lifting and transferring of patients they are required to perform. BCIT received funding from the Worker's Compensation Board (WCB) to develop and an innovative manual lift device focused on reducing musculo-skeletal injuries in home support workers.

First NSERC Undergraduate Student Research Award (USRA) received by BCIT
The proposed research project is to investigate the influence of cavity designs on the drying performance of rainscreen walls in the costal climate of BC..

The undergraduate student will assist with the development of instrumentation including sensor calibration, installation, and troubleshooting. The student will perform standard and customized tests, perform data analysis, and write up reports

CFI funded Building Envelope Test Hut almost complete.
A test hut is a real time, real weather exposure facility for field tests on wall panels. We are developing a two-storey test hut with the capacity for insertion of wall panels of varying configuration and rain-deflection details. The second floor will allow the insertion of balconies and floor/wall junctions. In this respect the two-storey test hut is unique and will represent, more closely than single-storey test huts, the 3- or 4-storey condominiums typical of low-rise residential construction in the lower mainland of BC.

Public Health Agency of Canada: "Overcoming Assistive Device Stigma: A Campaign to Improve the Daily Lives of Non-Metropolitan Canadian Seniors"
The Health Technology Research Group has received funding from PHAC to conduct a three year research project on aging rural seniors. The project has engaged three selected rural communities: Oliver, BC; Nipawin, Sask; and Middleton, NS. Key objectives are to create and deliver a program that educates seniors and their families on the positive benefits of

Assistive Device usage and addresses associated stigmas to such usage. As part of the program, each community held 4 workshops that: a) focused on 5 assistive devices; b) were facilitated by seniors, for seniors, c) included original comedy by Canadian icon Don Harron (otherwise known as Charlie Farquarson of Hee Haw). The workshops were deemed a great success and attracted many participants and much media attention. We are now entering the final phase of the project which will focus on sustainability.

School of Computing and Academic Studies

Here are some highlights of the many research projects being undertaken at the School of Computing and Academic Studies.

Physics

Dave Kenyon studies how humans walk and adapt to amputation in his specially designed prosthetics and orthotics lab.

Barry Pointon is a renowned expert in state-of-the-art medical imaging, PET and SPECT, and is part of the PET (Positron Emission Tomography) group at UBC – TRIUMF.

James Brewer is studying the evolution of stars by comparing imagery data from the Hubble Space Telescope with previous observations using leading edge software that he developed.

Jim Booth's strong interest in the growing field of optics has led him to construct a magneto-optical atom trap lab at BCIT for manipulating atoms using lasers. Atomic computer chips are his next challenge.

Chemistry

Djamel Khelifi is in food science and is working on extracting carotenoids and other biologically active ingredients from sources such as plants and fish oils.

Bob Bower has been doing research in the areas of photodynamic therapy – using light for medical diagnostics – and in kinetics.

Forensics

Edwin Chan's research orientation is chemical analyses methodologies for forensic investigations - for drug analyses and for arson investigations. He is also working on Chinese herb profiling to identify active ingredients.

Dean Hildebrand is expanding the field of human DNA profiling for forensic identification.

Mathematics

David Holloway uses mathematical modeling to understand how plants and animals achieve their body plans and shapes through embryonic spatial chemical patterns. He is also looking at what embryonic mechanisms reduce errors in embryos' growth and development.

Eric Hiob has been working on computer simulations of laser-plasma and laser-matter interactions, and is currently mining data for a Green Roof project. He is also developing a computer program called The Algebra Coach.

Computer Science

Benjamin Yu has been exploring distributed network architecture patterns in computer systems to prevent new forms of attacks on computers.

Aman Abdulla has been developing adaptive filtering techniques for digital signal processing. He has also been looking at network security issues, in particular, at covert channels and steganography and at firewall and perimeter designs.

Tejinder Randhawa is involved in investigating various wireless networks, including doing research on security systems for MANETs. He has also been modeling genome sequences using Markov Models.

Kim Dotto has recently patented a novel ultra-wideband antenna and is working on instrumentation and on embedded and real-time systems.

School Dean **Ken Takagaki** is examining research methodologies used in information technology. He is also researching the applications of science-based attributes in enterprise information systems.

School of Construction and the Environment

Green Roof Technology

Green roofs" refer to specialized roofing systems that support vegetation growth on rooftops. This vegetative roof system provides many environmental and economic benefits characteristic of sustainable building principles. Green roofs help decrease the urban "heat island" effect, decrease energy use, and detain stormwater. With growing awareness of environmental preservation in the design and construction sector, and the Federal government's commitment to the Kyoto Accord and addressing climate change (2004 Throne Speech), a green roof industry is emerging in Canada. The interest in green roof technology is particularly strong in British Columbia due to its favourable climate and regional government environmental commitments.

Building Science

In the 1990's, thousands of British Columbians awoke to the reality of a billion dollars in damage to their newly constructed homes. Damage was caused by rainwater that had penetrated the building envelope, leading to increased health risks, energy use, and a waste of unrecyclable building materials. The Building Science Centre of Excellence (BSCE) at BCIT has been established to build a regional research facility in the area of building performance. A regional interest in rain penetration has combined with national and international partnerships to focus the initial infrastructure development and research activities on themes related to building envelopes and rain control. For information, contact Dr. Hua Ge.

Housing and Construction

The BCIT Canadian Housing & Construction Centre works in cooperation with government and industry partners to assist in the development and demonstration of new technologies and/or the adaptation of existing technologies, and to provide support for the transfer of these technologies, expertise and capability both locally and internationally. As an example, AFRESH Home is a housing demonstration project located on BCIT's Burnaby Campus that showcases some of the most innovative yet practical ideas in sustainable

housing, including energy conservation, environmental impact management, occupant health, comfort and productivity, functionality, longevity and ability, quality assurance and commissioning, and life cycle analysis.

Energy Systems Applications

Renewable and alternative energy technologies have been emerging worldwide as viable alternatives to conventional fossil fuel derived energy. To meet the needs of this growing industry, the Centre for Energy Systems Applications (CESA) has recently been established at BCIT. CESA is mandated to develop, coordinate and support polytechnic training and education, conduct applied research, and transfer emerging technology in an integrated system approach. CESA will consider renewable (photovoltaics, micro-hydro, biomass, etc.), alternative and emerging energy systems (hydrogen, geoexchange, etc.) as they relate to waste management, climate change, and overall global energy sustainability. Applied research at CESA will focus on applications to the built and natural environments, standards and best practices, efficiencies and conservation, and commercialization. For information, contact Barbara Dabrowski.

GIS/Geomatics

Applied research in the area of Geographic Information System Technology (GIS) is focused on the development of Open GIS solutions. Current work concentrates on Indoor GIS location and routing problems. Another initiative will examine a GIS 'wiki-web' concept that allows GIS data updates by the general internet community. One of the ongoing projects is developing a prototype wireless GIS service named GeoRanger that delivers location-based information to cell-phone or PDA mobile users whose exact indoor location is obtained using RFID.