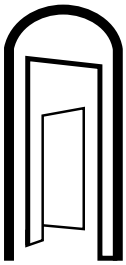

THE KILLAM TRUSTS

2004 KILLAM ANNUAL LECTURE

Commercializing University Scientific Discoveries: Issues and Challenges

W. A. Cochrane, OC, MD, LLD, FRCP(C), FACP

Former Paediatician-in-Chief,
Izaak Walton Killam Hospital for Children in Halifax;
Founding Dean, Faculty of Medicine, University of Calgary;
Former President, University of Calgary;
Former Chairman and CEO, Connaught Laboratories Ltd.
President, W.A. Cochrane & Associates, Inc.

Published by the Trustees of the Killam Trusts

Izaak Walton Killam

Born in 1885 at Yarmouth, Nova Scotia

Died in 1955 at his Quebec fishing lodge

Dorothy Brooks Killam, née Johnston

Born in St. Louis, Missouri in 1899

Died in 1965 at La Leopolda, her villa in France

Foreword

> Psst! Want a quick and easy guide on How to Make Yourself/Your University/Your Country Rich Through Commercializing R&D? Six easy steps! Totally Painless!!

If the academic world had truly turned commercial, an ad like this for the 2004 Killam Annual Lecture would fit the bill perfectly. For Dr. William H. Cochrane, O.C. has indeed given us a succinct yet comprehensive blueprint for commercializing research and development from Canadian universities, showing its importance to our future and comparing us both to our American cousins and to what we might become. We have a long way to go.

Bill delivered his Lecture, "Commercializing University Scientific Discoveries: Issues & Challenges", on November 4 in St. John's, Newfoundland and Labrador, to a full audience of over 250 academics, business leaders and government officials. The occasion was the annual conference of the Canadian Association for Graduate Studies (CAGS), which brings together the Deans of all Canadian faculties of graduate studies and their assistants. The Killam Annual Lecture has become a regular feature of the CAGS' yearly meeting. Bill is, however, unique among the ten Killam Lecturers to date: he is the only one who knew Dorothy Johnston Killam, the benefactor who, together with her husband, businessman-financier Izaak Walton Killam, gave birth to the Killam Trusts. It was Bill who, as Paediatrician-in-Chief at the Halifax Children's Hospital in the mid-1960s, played such a large part in persuading Mrs. Killam to fund the construction of a new hospital to be known as The Izaak Walton Killam Hospital for Children, the leading tertiary care hospital for the children of Atlantic Canada.

Dr. Cochrane is, perhaps, better placed than any other Canadian to give a paper on the theme of commercializing R&D. After his bril-

liant academic career, he became head of Connaught Laboratories Ltd., then Canada's leading researcher and developer of vaccines, insulin and pharmaceuticals. His business interests continue unabated; as President of his own consulting company and a valued member of many boards in the public and private sectors, he continues at the forefront of commercialization of R&D in Canada.

Bill's central message is clear. If we in Canada want to maintain our standard of living, let alone improve it, we must be smarter in how we go about reaping the commercial rewards that should go along with new discoveries.

The Killam Trustees are convinced that Dr. Cochrane's Lecture will be invaluable to future generations of university administrators, government officials and business leaders, as they seek to take hold of the best R&D our country has to offer and convert it for use by all humanity. Our purpose in sponsoring these Killam Annual Lectures would then have been well served.

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For copies of this lecture and others in this series (listed at the end of this booklet), go to our website: www.killamtrusts.ca or write our Administrative Officer at the address on the back.

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The Killam Trusts

The Killam Trusts were established through the generosity of one of Canada's leading business figures, Izaak Walton Killam, who died in 1955, and his wife, Dorothy Johnston Killam, who died in 1965. The gifts were made by Mrs. Killam both during her lifetime and by Will, according to a general plan conceived by the Killams during their joint lifetimes. They are held by five Canadian universities and The Canada Council for the Arts. The universities are The University of British Columbia, University of Alberta, The

University of Calgary, Montreal Neurological Institute of McGill University, and Dalhousie University.

The Killam Trusts support Killam Chairs, professors' salaries, and general university purposes; but the most important part of the Killam program is support for graduate and post-graduate work at Canadian universities through the Killam Scholarships. In each of the Killam universities and at the Canada Council, they are the most prestigious awards of their kind.

The Canada Council also awards five Killam Prizes annually, in Health Sciences, Natural Sciences, Engineering, Social Sciences and Humanities. Worth $100,000 each, thay are as a group Canada's premier awards in these fields.

To date, over 5,000 Killam Scholarships have been awarded and 73 Killam Prize winners chosen. The current market value of the Killam endowments approaches $400 million.

In the words of Mrs. Killam's Will:

> "My purpose in establishing the Killam Trusts is to help in the building of Canada's future by encouraging advanced study. Thereby I hope, in some measure, to increase the scientific and scholastic attainments of Canadians, to develop and expand the work of Canadian universities, and to promote sympathetic understanding between Canadians and the peoples of other countries."

John H. Matthews
W. Robert Wyman, CM, LLD, Chancellor Emeritus, UBC
M. Ann McCaig, AOE, LLD, Chancellor Emeritus, U of C
George T.H. Cooper, CM, QC, Managing Trustee
Trustees of the Killam Trusts
November 2004

Dr. William Cochrane

**Former Paediatician-in-chief,
Izaak Walton Killam Hospital For Children In Halifax;
Founding Dean, Faculty Of Medicine,
University Of Calgary;
Former President, University Of Calgary;
Former Chairman And CEO,
Connaught Laboratories Ltd.
President, W. A. Cochrane & Associates Inc.**

Dr. Cochrane was born in Toronto and graduated in Medicine from the University of Toronto. He did postgraduate work in pediatrics and research in diseases of children in various centres including the Hospital for Sick Children, Toronto; Cincinnati Children's Research Foundation; Peter Bent Brigham Hospital, Boston; Great Ormond Street Hospital, London, England and the Radcliffe Infirmary in Oxford, England. He participated in the Executive training program at the Business Faculty, Stanford University.

He was in pediatric practice for three years in Toronto and moved to Halifax in 1958, becoming Professor and Head of Department of Pediatrics, Dalhousie Medical School in 1963, where he remained

until 1967. He was intimately involved with the planning, development and financing of the I.W. Killam Hospital for Children in Halifax. He moved to Calgary, Alberta in July 1967, as founding Dean of Medicine of the new Faculty of Medicine of the University of Calgary. He was heavily involved with the curriculum planning, recruiting Faculty and designing and building a Health Sciences Centre in Calgary. He resigned this position in July 1973, at which time he was seconded by the Government of Alberta to serve as Deputy Minister of Health Services for a period of two years. In fact, he served only one year as Deputy Minister due to his appointment in August 1974 as President and Vice-Chancellor of the University of Calgary. In late 1978, he assumed a business career as Chairman, President and Chief Executive Officer of Connaught Laboratories Ltd., subsequently acquired by Institute Merieux, Lyon, France in 1989.

Dr. Cochrane is a Fellow of the Royal College of Physicians and Surgeons of Canada, a Fellow of the American College of Physicians, a Diplomat of the American Board of Pediatrics and Fellow, American Board of Nutrition. He has been a member of numerous medical and research societies in Canada and the United States, and was President of the Canadian Society for Clinical Investigation in 1964 and President of the Canadian Pediatric Society in 1965. He was awarded the Borden Award of the Nutrition Society of Canada for his scientific research into metabolic diseases of children. He was made Honorary Medicine Chief of the Stoney Indians of Alberta for his contribution to the health care of the Indian people.

He has received honorary degrees (LL.D.) from the University of Calgary and Dalhousie University in Halifax and a Doctorate of Science (D.Sc.) from Acadia University. In 1977, he received the Queen's Jubilee Medal and in December 1989 he was made an Officer of the Order of Canada. In 1992, he received the 125th Commemorative Medal from the Government of Canada. In 1999 the Ottawa Life Sciences Council awarded him the National Merit

Award for his contribution to Biotechnology in Canada. In 2001, the Alberta Science and Technology Leadership Awards Foundation awarded him the Outstanding Contribution to the Alberta Science and Technology Community. In 2002 he received the Queen's Golden Jubilee Medal for his many contributions to Canada as well as a BioAlberta Association Award for his contribution to biotechnology in Alberta.

He is a Director of several Canadian and American companies including: Immune Vaccine Technologies Inc., Halifax; Selective Genetics, San Diego; Pheromone Science Corp., Toronto; Medicure Inc., Winnipeg; University Technologies International Inc., Calgary; Oncolytics Biotech Inc., Calgary, Resverlogix Inc., Calgary and QSV Biologics, Edmonton.

He has also served on the Boards of Monsanto Canada, Connaught Laboratories Ltd., Vasogen Inc., Fluor/Daniel, MDS Capital Corp., the Banff Centre and Andrés Wines.

He has served on several Government Boards, including the Alberta Science and Research Authority (Government of Alberta), Past Chairman of the National Biotechnology Advisory Committee, as well as the National Advisory Board on Science and Technology (Government of Canada) and Co-Chairman, Calgary Economic Department Committee, Calgary. He is President of W.A. Cochrane & Associates Inc., a health products investment consulting company.

Dr. Cochrane is married and has four children.

The 2004 Killam Lecture

Commercializing University Scientific Discoveries: Issues And Challenges

November 4, 2004

Dr. W. A. Cochrane

I would like to thank the Killam Foundation Trustees for their invitation to present the Annual Killam Lecture in St. John's, Newfoundland at this time. I am particularly honoured as it brings back many memories of my visits to Newfoundland during the sixties while serving as the Professor of Paediatrics and involved with the continuing medical education programme of Dalhousie University.

I also recall meeting Dorothy Killam on several occasions to seek her financial support for a new Children's Hospital in Halifax. She was a most intelligent, generous and gracious lady who was interested in supporting young scientists engaged in engineering, science and medical research.

The contribution that Izaak Walton Killam and Mrs. Dorothy Killam made for the continuing support for scientists and scholars in Canada is well recognized and well remembered.

I have been directly and indirectly involved with the commercialization of scientific discoveries for 20 years and have chosen the title of this presentation to reinforce the present emphasis on looking to commercialize government and private investments in research at our Canadian universities. My remarks will be related to the following headings – Overview; Progress to Date; Issues Relating

to Research, Personnel, Organization and Finance; Comments and Conclusion.

While the emphasis by most organizations has been on the importance of providing more financial support for university research, only recently has there been an appreciation of the highly significant economic benefits of commercializing the resulting discoveries.

Without the involvement of industry and business, the benefits of academic scientific discoveries to individual citizens and society on the whole would likely not occur.

Overview

Fifteen years ago, an editorial described the economic future well:

> "For most of history, Canadians have prospered by relying upon resources beneath our feet – in the information age we will all need to rely on the resources between our ears."
>
> *Charlottetown Evening Patriot, Editorial, 1989*

The standard of living we have come to know in Canada is not sustainable if we continue on our present path. Economic success as a nation is dependent on our ability to develop and deploy our knowledge. It is evident that the major increase in the world's trade of goods and services will be related to knowledge intensive and scientifically dependent products and services. The development, manufacturing and subsequent importance of knowledge-based products is, in many cases, dependent on the availability of scientific discoveries and new technologies that are identified and discovered by highly skilled individuals. In most countries such individuals are engaged in basic and applied research, generally within university and government laboratories. To this end, governments have increased their support to universities for scientific

research and have developed a number of agencies and organizations to provide such support. In Canada, these include such organizations as the Canada Foundation for Innovation, Genomics Canada, the Networks of Centres of Excellence, Canadian Institutes for Health Research, the Natural Sciences and Engineering Research Council and various other research councils of the federal government. Various acronyms have been used to describe these organizations, including CFI, NSERC, NCE, CIHR and NRC to name a few. One meaningful new acronym to be considered is ROI, or the Return on Investment, of the various grants made for research to our institutions.

Since the mid 1980s, Canadian universities have gradually developed more offices and methods of looking to commercialize research discoveries with the intent of benefiting the institutions, but also to having some impact on the economic growth of the country. In the academic milieu there exists a large and vast resource composed of thousands of talented scientists involved with frontier research efforts in areas of product, process and services. This resource, however, has been generally untapped until recently. A significant degree of individual and institutional attitudinal blocks to the transfer of discoveries from the educational institutions to industry has been apparent. Prior to the early 1980s there was suspicion and discomfort on the part of academic scientists to associate with industry; however, this has now changed to where many academic scientists have seen the benefits, both personally and for the institution, and indeed for the country, of more fully cooperating in commercializing their discoveries.

The failure of greater collaboration between the academic scientist and industry has been related to the following:

- For the academic, concerns of: limiting publication; distribution of royalties and revenue; too much emphasis on market-driven

research; potential conflict of interest and ethics; faculty distraction from teaching and risk of litigation.

- For industry, certain concerns impeding greater collaboration with faculty include: the need for exclusivity and patent protection; confidentiality; need for targeted objectives and scientific milestones; inflated financial expectations by faculty and the requirement of continued involvement by the scientist, particularly related to scale-up.

The large number of start-up companies and licensing agreements with universities suggests that the issues identified by faculty and industry can be satisfactorily addressed given continued understanding and cooperation. As an example, MIT, with a Tech Transfer Office since 1940, has generated significant return to the institution with no apparent negative effect on the quality of research by the faculty.

The report of the Expert Panel on Commercialization of University Research published in April 1999 outlines extremely well some of the reasons, issues and problems associated with enhancing the innovation process and building an appropriate commercialization infrastructure for the effective transfer of discoveries from universities to industry. To emphasize the importance of universities in advancing scientific knowledge, it was noted that universities perform 21% of all Canadian R&D, represent 31% of Canada's R&D personnel, generated 65% of Canadian scientific publications and have trained many highly skilled individuals. The 'intellectual capital' present in our universities represents the principal resource for the future economic growth of the country. Several recommendations were made that focussed on the importance of increased funding by government for scientific research to our institutions, but also various proposals were put forward to ensure the appropriate commercialization of scientific discoveries.

Commercialization, by definition, is the identification of a discovery for possible transfer to industry, the recording of intellectual property protection and subsequent marketing to industry providing a return to the institution and faculty through licensing or equity in a start-up company.

The Association of University and Canadian Colleges published a report in January 2004 entitled 'Bridging the Innovation Gap: An AUCC Commercialization Proposal'. The report emphasizes the contribution universities make to growth for a strong and vibrant society. Many recommendations were proposed to increase the transfer of scientific discoveries to industry.

It was also suggested commercialization should be tripled over the next decade.

The importance of capitalizing on university intellectual capacity is increasingly recognized by the international community. Countries of Europe and Asia are expanding their efforts to commercialize university scientific discoveries with, as an example, Great Britain, becoming much more aggressive in encouraging such commercialization efforts in their universities. A recent report in Scrip World Pharmaceutical News addressed the issue of public research and commercialization and the need for greater efforts for the Danish/ Swedish biotech region.

The United States is the most advanced nation promoting the commercialization of university scientific discoveries. The presence of academic entrepreneurs is well recognized and supported. Technology Transfer Offices in their universities have been well developed for more than two and a half decades.

It is important to recognize the 'virtuous circle' which is the formula of research discovery ➔ commercialization ➔ revenue generation ➔ research support.

Progress to Date

Factual and accurate data available to assess the performance and success of commercializing university research discoveries is somewhat difficult to obtain and interpret. However, reports by Statistics Canada and the Association of University Technology Managers, or AUTM, do permit some observations. Comparison of the AUTM Survey Reports for 1995-96 to 2003 reveals the following: The number of Canadian institutions reporting increased from 16 in 1995-96 to 36 in 2003. Similarly, sponsored research in Canada increased from $1.08 billion to $3.50 billion with disclosures increasing from 509 to 1282. Gross licensing income and equity income increased from $14.88 million to $55.5 million. Of interest was the recording of 46 start-up companies in 1995-96 compared to 58 in 2003 (Figure 1).

Figure 1

Technology Commercialization - Canada (AUTM Surveys)
(Fiscal Year)

AUTM Categories	1995-1996	2001-2002	2002-2003
# of Institutions	16	31	36
Total Sponsored Research	1.08B	$2.42B	$3.50B
# Disclosures	509	1175	1282
Gross Licensing Income	14.88	$37.87M	$55.5M
Startup Companies Formed	46	49	58

*Canadian Dollars

Examining data from Statistics Canada and AUTM up to and including 2003 there were 715 spin-off companies and approximately 20,000 employees as a result of technology transfer from Canadian universities.

Such spin-off companies covered a wide range of industries, for example, computer systems, design engineering, medical therapeutics and diagnostics, and medical devices.

It would appear that approximately 50% of disclosures were from the Life Sciences, 25-30% from Engineering and the remainder from Science. However, the distribution of disclosures by faculty may vary from one university to another; for example, at the University of British Columbia 50% of the disclosures are from the Faculty of Science.

Comparison ratios of technology commercialization between Canadian and US institutions is of interest and is provided by the AUTM Survey for 2003. The United States institutions in the AUTM statistics are divided into US universities and US research hospitals and expressed in US dollars. For comparable purposes these are presented separately and expressed as ratios US vs. Canada. It is noted that of the 36 Canadian institutions reported to AUTM, 33 were universities and 3 research hospitals. There were 163 US universities and 31 US research hospitals to a total of 194. There were some 5.4 times as many US institutions compared to Canada. In the sponsored research area the total Canadian contribution was (in USD) $2.54 billion compared to $38.53 billion, some 15.17 times as much invested in the US as Canada. The revenue from commercialization, including licensing revenue and cashed in equity in start-ups, was $41.17 million in Canada while $1.34 billion in the US, some 32.62 times as much. There were 58 start-up companies in Canada and 274 in the United States. The US, therefore, started only 5.4 times as many as Canada in spite of the large research investment. In recalculation the number of start-up companies per institution in Canada was 1.6 versus the US 1.2. The disclosures in Canada were 1,282 versus 15,355 in the US. The US received 11.98 times the number of disclosures as Canada but with 15.17 times as much research funding. Revenue dollars per one million dollar of research indicates that Canada generated 1.6

cents of revenue for each one million dollar spent in research. The United States generated 3.5 cents; therefore, were twice as efficient in generating revenue from research funding (Figure 2).

FIGURE 2

Comparison Ratios - Technology Commercialization - Canadian to US Institutions
Fiscal Year 2002-2003 AUTM Statistics (Interim) - in $USD

AUTM Categories	Canadian Institutions	US University	US Research Hospitals	Total all US Institutions	Ratio US-CA
# of Institutions	36	163	31	194	5.4:1
Sponsored Research	2.54B	34.83B	3.70B	38.53B	15.17:1
Revenue	41.17M	1,029.16M	313.89M	1,343.05M	32.62:1
Startup Companies	58	348	26	274	5.4:1
Disclosures	1,282	13,718	1,637	15,355	11.98:1
Revenue $ per $1M research	.016	.030	.084	.035	2.2:1
Research $ per one disclosure	1.98M	2.54M	2.41M	2.51M	1.27:1

The findings suggest that in Canada, for every $2.5 million (CAD) of research, a new invention disclosure might be expected versus $3.1 million (CAD) in the United States. Data suggests that for every 22 disclosures one might expect one spin-off company.

Recognizing that the data can be interpreted in many ways, possible explanations for some of the differences between Canada and the United States might include: the greater number of disclosures in the United States could be the result of a larger number of institutions and the longer term activity of commercial offices in universities in the US beginning with MIT in 1940; the attitude of academic scientists could be more positive to industry in the United States than those in Canada; the revenue received by Canada in comparison to the United States is much less and is perhaps related to the more experienced commercialization by offices in the US

with more potential partners and investment funds to support the development of spin-off companies and royalty revenue. Creator sponsored research funds in the United States could be partly related to increased government funds as well as the military/industrial complex that provides significant support to the universities. There exists also a critical mass and cluster of research activities in such places as Silicon Valley, the Boston New England complex and bio-technology centres around San Diego and San Francisco. It is also possible that industry in the United States has a greater positive respect for value out of universities than perhaps in Canada.

In many cases it would appear that the US has greater vision for new technologies emerging from universities as evidenced by such organizations as Hewlett Packard, Google and Gatorade just to mention a few. In comparison to our southern neighbour, Canada would appear to have much less in the way of research support as well as fewer disclosures and much less revenue generated from commercializing discoveries. However, Canada maybe more efficient in turning research money into disclosures than our colleagues in the United States, while requiring fewer research dollars per disclosure.

Issues Related to Commercialization

Research

The recent significant increase in funding for research by the Government of Canada and some Provincial Governments has obviously recognized the importance of supporting good research at Canadian universities. It is essential that adequate support be provided for so-called basic or curiosity driven research as such activity is essential if subsequent applied research is to be pursued. Failure to provide such support will make it difficult for universities to retain highly qualified scientists. Funds to support specific individuals of high quality must be available to allow them to proceed with curiosity

driven research or a 'skunk works' approach. Identifying such individuals and giving them major financial support for a period of time, with only limited requirements for reporting, would contribute greatly to recruiting and retaining highly skilled scientists. The recent Canada Research Chairs Program by the Government of Canada, and the scientist support programme of the Alberta Heritage Fund for Medical Research Foundation (AHFMR) by the Government of Alberta, are examples of giving significant support to outstanding scientists.

One of the important outcomes of a scientific discovery is the identification of intellectual property and the appropriate protection of such. One of the major weaknesses to commercialization is the unclear policy for intellectual property ownership and patenting by many Canadian institutions. In some institutions the creator owns the intellectual property and can commercialize as he or she sees fit. In other situations, the creator owns the intellectual property but must assign the discovery to the university for subsequent commercialization. The fundamental responsibility rests with the inventor who decides whether or not the invention is to be treated as intellectual property and patents obtained. If the individual has published then he or she has decided the discovery cannot be commercially developed. Therefore there is a challenge for the universities and the scientists to come to some agreement on policy in which the institution would be responsible for patenting the discovery, with the scientists accepting there might be a delay for a short time in publication while there is assessment of the value of the discovery and whether it indeed should be patented.

It is important to recognize that the university has some 'ownership' and that they are entitled to a return if they see fit.

Personnel

The academic scientist is key in terms of the reporting of the discovery and therefore disclosure to the respective university organiza-

tion. The concerns of the academic scientist have been previously outlined. It is necessary for the scientist to recognize the importance of considering that their discovery might be commercialized to provide not only personal benefit but also benefit to the university and to the country as a whole. Up to the early 1980s the attitude of most academic scientists was not to get involved with the industrial sector. Many of the concerns of both parties resulted in the lack of communication and understanding the mutual benefits that could occur as a result of collaboration between the scientist and industry. Fortunately, there has been a significant change in the attitude of many of the academic scientists, so that today the increased disclosures that have been identified are significant in at least exploring the possibility of patenting and commercially transferring the discovery.

The recruitment over the next decade of new faculty will be crucial in terms of a continuation of the expansion of the number of disclosures. Senior university administration must play an important role in encouraging new faculty members to seriously consider reporting and potentially commercializing their discovery and to continue to have a positive attitude to such opportunities. The challenge for senior administration is to develop ways and means of encouraging new faculty to seriously address this issue without jeopardizing their research efforts and careers.

There would be considerable value in providing opportunities for professors to have some training and understanding of an entrepreneurial approach to their discoveries and to appreciate the problems of the transfer of their discoveries to industry. They must also have appreciation of the great costs that are involved in commercializing their discoveries both in time and in money. While the invention is key, it is only part of the value, as management, product manufacture, and sales and distribution are essential for success.

Management continues to be the key in the successful operation of any organization, but particularly at Tech Transfer Offices. In the past, the senior management of various Tech Transfer Offices was composed of individuals who were retiring or were recently retired senior academics who had strong scientific backgrounds but little knowledge regarding the complexities of commercialization. They had few skill sets related to negotiation and limited industrial contacts. As a consequence, the leadership of such Tech Transfer Offices must be headed by individuals who have some scientific appreciation and technical background, but more particularly have some experience in investment and venture funds and the ability and desire to negotiate business arrangements. The challenge then is for the university to recruit highly skilled professional managers who have experience in both the technical and financial aspects of industry as well as a background in marketing analysis, and who are comfortable in negotiating with industrial management personnel. Such individuals are scarce in Canada and a training and education programme for such skilled managers would seem essential.

The WestLink Innovation Network Ltd. in Calgary provides a two-year training programme for graduate students from the four western provinces. Some 20 students receive skills training through rotation in companies, Tech Transfer Offices and financial institutions. The organization is a not-for-profit consortium of 25 Western Canadian colleges, technical and research institutes. The model could be applied across Canada and provide badly needed skilled managers.

Organization

There has been a wide range of organization models for operating commercialization offices in various universities. In some cases the Industrial Liaison Office, or Tech Transfer Office, is an integral part of the university and administered by academic personnel. In other situations there exists a Board of a non-profit organization

composed of both business and academic members with the sharing of responsibilities by outside consultants and internal experts. There also exists a model in which a profit organization operates at arms-length from the university, but with the university owning 100% of the equity of the organization and consisting of a Board of experienced business and industrial people as well as academics. There appears to be no ideal model identified as yet at Canadian universities and it is important to have some means of bringing to the attention of the university administration the advantages and disadvantages of respective models through, possibly, an independent committee of the university providing recommendations. Regardless of the model, experienced personnel are key for the success of any organization. Such senior managers must communicate and collaborate with the faculty, obtain adequate financial support for administration of the office and seed funding. There is a need to avoid extensive time spent in assessing the potential value of disclosures and come to some decision as to the potential industrial value. On occasion, the result may be a negative decision to commercialize the discovery due to little market interest which may be disappointing to the scientist. The technology may not be ready at the time for industrial transfer and therefore could be put on hold while further development takes place. It often requires time to find a vehicle or recipient for the respective technology and this information must be carefully explained to the scientist to avoid disappointment.

Universities with a Faculty of Business should encourage close collaboration between this Faculty and the Tech Transfer Office to identify potential candidates and possibly second them for a short period to gain knowledge and experience in commercialization.

One of the major activities of a Tech Transfer Office is to decide to license the technology or to initiate a start-up company. For a start-up company, valuation assessment and negotiation of equity participation for the university require considerable negotiation

skills. It must be recognized that it is most difficult for the members of a Tech Transfer Office to pick winners and this can be done only with experienced personnel.

To increase the number of disclosures, the Tech Transfer Office could be more proactive by reviewing research grant submissions by faculty members, to be aware of possible commercial opportunities should the grant proposal be successful.

Finance

The Report of the Expert Panel on Commercialization of University Research emphasizes the need to provide adequate financial support to the Tech Transfer Office. In some provinces the provincial governments have provided basic funding for the office as well as the federal government providing support through a number of its scientific councils. The infrastructure support programme of the Government of Canada permits use of some funds for commercialization. However, there continues to be a significant need to financially support and sustain the operation of whatever model is developed and to allow the recruitment of appropriate and experienced personnel. The Panel has suggested that the federal government should invest new and additional resources to strengthen the commercialization capacity of the university equal to 5% of its investment in university research. The new funding would be invested in the commercialization function and must be additional to the university's current spending.

The other aspect of financial support is related to the availability of seed funds for start-up companies. Venture fund support is limited in comparison to the United States, and it continues to be difficult to obtain such support for early discoveries at universities. Canadian industry has been slow in identifying ways and means of taking advantage of the opportunities by transferring discoveries from universities to respective corporations. In general, it would appear that many Canadian companies are somewhat risk adverse

and this is understandable when the economy is not doing well. However, visionary corporate management might recognize and seek new opportunities on a world scale by exploiting linkages with university scientists and their discoveries and with a focus on long-term benefits.

The challenge for a university will be to initiate new approaches to obtaining seed capital and venture funds to assist in both the licensing of disclosures and the start-up of new companies. Some universities in Canada have received significant seed funds from their provincial governments for this purpose of initiating new start-ups from scientific disclosures that have major potential, e.g. Ontario and Quebec.

It must be recognized that the 'intellectual capital' of the country and the transfer of their discoveries will serve as the engine for economic growth, not only in the province where the university is located but for the country as a whole.

Comment and Conclusion

David Crane of the Toronto Daily Star stated on April 4, 1999 the following, and I quote:

> "Universities have always played a key role in discovering the new ideas that lead to social and economic progress. But, in a knowledge-based economy we now live in universities are now literally the idea factory that will shape our future prosperity."

The most essential resource for successful development of science and technology and its diffusion and application to industry is the human resource and the availability of innovative, energetic and skilled individuals in the area of commercialization. They become "the pistons in the engine of economic growth" (A. Berkeley) with the faculty providing the fuel.

For continued economic progress both academe and business must recognize their interdependence and develop strategies and organizational structures that will enhance the working relationship between the two constituents. Government should play a promotion and supporting role for this working relationship. It is not necessary that university faculty consider themselves entrepreneurs, but that they recognize the contribution they can make to the continued growth and expansion of the country and the benefit to tax payers who provide the support for the research that they carry out. Universities will need to continue to have a positive attitude to the application of scientific discoveries for commercial development for the purpose of not only a potential return to the university but for the opportunity to employ graduates coming from those same institutions. For industry and corporations, there is a need for a much more vigorous and aggressive approach to universities in seeking not only research that supports their existing products, but also to look to the academic scientist to provide them with disclosures and new opportunities for new products and business expansion.

In summary, certain basic principles for the successful commercialization of scientific discoveries may be identified:

1. The encouragement and promotion of faculty members, and particularly new faculty, to recognize the importance of commercializing their research discovery. For faculty members the reward and upward career movement is dependent on his/her teaching abilities, their research production and their community service. Consideration should be given to recognizing the successful commercialization of their discovery into industry.

2. A policy on intellectual property ownership and assignment should be clearly established, recognizing the contribution of faculty as well as post-graduate students involved with the research. Preference perhaps should be given to have such

intellectual property awarded to the inventor but with assignment to the university for its subsequent disposal and commercialization.

3. The organizational structure should be such that it is clear to faculty members and the business community who is responsible for commercializing the discoveries and the appropriate contact points. To assure a critical mass in certain regional areas, close cooperation and collaboration between adjacent universities and their tech transfer personnel would seem valuable.

   Regardless of the model selected, Tech Transfer Offices must recognize that the academic scientist is a customer and client who will utilize the Office if there is a quality service.

4. The staffing of the appropriate office must include individuals with some technology background, but with skill sets in the areas of negotiation, valuation, marketing and experience with investment and financial institutions.

5. There should be a clear policy as to how the funds returned to the university from the Tech Transfer Office would be distributed, including faculty, the respective Faculty to which the faculty member is attached, and subsequently the university institution as a whole. A dividend or repayment policy should be clear so that all parties are aware of the distribution of funds that are generated by the Tech Transfer Offices.

6. Adequate funding for the operation of the respective Tech Transfer organization is required. A suggestion would be that a minimum of $750,000 per annum, or 1% of sponsored research dollars, for a period of five years be available for successful initiation and ongoing activity of the Tech Transfer Office. It is expected that certain goals and objectives would be identified and reviewed in a five year time frame to observe the progress made and whether it meets the goals that were initially established.

7. A seed fund or capital available to the Tech Transfer Office is required to assist in start-up and ongoing activities for newly established companies. The funds would be provided by the university as well as government, private individuals and venture organizations with a target of $10-15 million per institution.

8. Encouraging local industry representatives to participate in the university organization for commercialization would aid greatly its success.

It is of interest that little information or data is available to assess the economic impact of technology transfer on a local or regional area where the university is located. A recent paper by Robert Lowe and Suzanne Quick, University of California, emphasizes the importance of attempting to identify data and methods to asses this important aspect. Having reviewed the AUTM Licensing Survey in 2003, the authors indicate that more than 75% of start-ups are founded in the same state or province as the licensing university. Combined data from the United States and Canada does not permit examination of this interesting observation for Canada alone. The University of British Columbia has recently reported that 94% of 115 spin-off companies are located in British Columbia.

Some assessments have been made using raw data and information such as the number of firms founded, patents licensed by start-ups, employees hired by new firms, and investment capital attracted to the regions by new firms. While some results are available, there needs to be considerable caution in interpreting the present data until a proper assessment and economic analysis might be carried out. The authors conclude that while universities do have a significant role to play in providing information for policy makers and assistance to understand the economic impact of higher education in general by technology transfer, there is much to be done with regard to clarifying the impact of both direct and indirect benefits that such transfer activity imparts.

Related to the issue of adequate economic information, as well as the need for more skilled personnel operating the Tech Transfer Offices, consideration should be given to establishing a National Centre for the Study of Commercialization of University Scientific Discoveries.

The objectives of such an organization might include:

- to identify, study and promote the education of technology transfer managers;
- to obtain factual data and information on technology transfer of university scientific discoveries;
- to study the impact on local, regional and national economies of technology transfer;
- to serve as a repository of information on financial organizations providing investment capital for company formation from Tech Transfer Offices;
- to advise governments, education institutions and investors on policies related to the transfer of scientific discoveries to industry;
- to record information on international activities of university technology transfer programmes.

Such an organization would collaborate with individual institutions and regional organizations with mutual interests. Funding would be provided by government, industry and foundations. No such organization exists in North America.

We live in a country of unique opportunity. The future growth of the country will depend on the search for innovative ideas and proposals. Our universities can be the focus of inventions and innovation but the organizational structure, skilled human resources,

and financial support must be available if we are to be successful in transferring these discoveries into commercial ventures.

We need to look to new ventures and new approaches for the future. In the words of William Wadsworth Longfellow:

> Look not mournfully to the past - it comes not back again;
> wisely improve the present - it is thine;
> go forth to meet the shadowy future without fear,
> and with a joyful heart

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The Killam Annual Lectures*

1995 **Dr. David L. Johnston**
Chair, Canadian Institute for Advanced Research;
Former Principal, McGill University
"Research at Canadian Universities and the Knowledge Based Society"
Hart House, University of Toronto

1996 **Dr. Richard A. Murphy, Ph.D.**
Director, Montreal Neurological Institute, McGill University
"Government Policy and University Science: Starving the Golden Goose"
The University of Calgary

1997 **Hon. Peter Lougheed, P.C., C.C., Q.C.**
Partner, Bennett Jones Verchere; Corporate Director;
Former Premier of Alberta; Chancellor, Queen's University
"The Economic and Employment Impact of Research in Canada"
Reading Room, Houses Of Parliament, Ottawa

1998 **Dr. Michael Smith, C.C., O.B.C., Ph.D., D.U., D.SC., LL.D., D.C.L., F.R.S., F.R.S.C.**
University Killam Professor, and Peter Wall Distinguished Professor of Biotechnology, University of British Columbia;
Nobel Prize Laureate in Chemistry, 1993
"Science and Society in the Forthcoming Millennium"
Hyatt Regency Hotel,Vancouver

1999 **Dr. Björn Svedberg**
Chairman, the Royal Swedish Academy of Engineering Sciences;
Chairman, Chalmers University of Technology, Gothenberg;
Former President and CEO, L.M.. Ericsson AB
"University Research as the Driving Force for the Development of a Modern Nation in the Next Millennium"
Pier 21, Halifax

2000 **Prof. J. Robert S. Prichard**
Prichard-Wilson Professor of Law and Public Policy and President Emeritus, University of Toronto;
Visiting Professor, Harvard Law School
"Federal Support for Higher Education and Research in Canada: The New Paradigm"
St. Boniface Genera search Centre, Winnipeg

2001 **Dr. John R. Evans, C.C.**
President Emeritus, University of Toronto;
Chair, the Canada Foundation for Innovation;
Chair, Torstar Corporation and Alcan Aluminum Ltd.
"Higher Education in the Higher Education Economy: Towards A Public Research Contract"
Montreal Neurological Institute, Montreal

2002 **Dr. Martha C. Piper, D.Sc., LLD**
President and Vice-Chancellor, The University of British Columbia;
Director, Canadian Genetic Diseases Network
"Building a Civil Society: A New Role for the Human Sciences"
National Library of Canada, Ottawa

2003 **Shirley M. Tilghman, Ph.D.**
President, Princeton University
Professor of Molecular Biology, Princeton University
"The Challenges of Educating the Next Generation of the Professoriate"
The University of British Columbia, Vancouver

2004 **W. A. Cochrane, OC, MD, LLD, FRCP(C), FACP**
Former Paediatician-in-Chief,
Izaak Walton Killam Hospital for Children in Halifax;
Founding Dean of Medicine and former President,
University of Calgary;
Former Chairman and CEO, Connaught Laboratories Ltd.
President, W.A. Cochrane & Associates, Inc.
"Commercializing University Scientific Discoveries: Issues and Challenges"
The Fairmont Newfoundland, St. John's

*NOTE: The positions held by the Lecturer are stated as at the date the Lecture was given.