THE ENGINEERING INSTITUTE OF CANADA
and its member societies

L'Institut canadien des ingénieurs
et ses sociétés membres

EIC's Historical Notes and Papers Collection

(Compilation of historical articles, notes and papers previously published as Articles, Reports, Working Papers or Journals)

ENGINEERING HISTORY PAPER #106

"Some Thoughts on Innovation"

by Andrew H. Wilson

(previously produced as Cedargrove Series #60/2022 – Apr 2022)

****

EIC HISTORY AND ARCHIVES

****

THE CEDARGROVE SERIES OF

DISCOURSES, MEMOIRS AND ESSAYS

#60/2022

SOME THOUGHTS ON INNOVATION

…AND ENGINEERING

by Andrew H. Wilson

April 2022

Abstract

Innovation as a part of the production process has been discussed for many years in Canada, but at no time more seriously in relation to the nation's economic health than in the last 10 years, Engineering has seldom been part of these discussions, explicitly. I would suggest that in contemporary times it should be, simply because innovation and engineering are closely connected as activities. The factual material in this paper generally stops pre-COVID.

This paper summarizes these discussions historically and suggests where we might go from here.

About this Series

Principally, the Cedargrove Series is intended to preserve some of the research, writings and oral presentations that the author has completed over the past half-century or so, but has not yet published.

About the Author

He is a graduate in mechanical engineering (1949) and the liberal arts (1954) and has held technical and administrative positions in industry in the United Kingdom and technical, administrative, management and research positions in the Public Service of Canada, from which he retired more than 30 years ago. He became actively interested in the history of engineering on being invited (in 1975) to chair the first History Committee of the Canadian Society for Mechanical Engineering (CSME). He was later president of CSME and of the Engineering Institute of Canada (EIC), and chaired the Canadian Engineering Manpower Council (CEMC) and the Canadian Association for the Club of Rome (CACOR).

The research for this paper was originally intended to be part of a large Sesquicentennial one commemorating *150 Years of Engineering in Canada.* But as the material for it accumulated, there had to be some rearrangement of the subject matter into smaller parts, one of which (this one) is about the innovation process. All the other parts of the original paper have been included somewhere in the Cedargrove Series.

To set the scene…

What is innovation? The word has been in use for a very long time, and especially during the last twenty years it has become a 'buzzword.' But, its definition has been changing, growing more academic, complex and confusing, acquiring more and more 'experts' in it internationally, and conclusions about it have been integrated with national economic performance and with R&D statistics, prompting one distinguished Canadian engineer to comment:

> Innovation is one of those words that is dropped everywhere by everyone to the point where it has really lost its true meaning. (Gilles Patry during a speech at Western University, in 2017)

My own first foray into innovation territory was a background study for the Economic Council of Canada, *Science, Technology and Innovation,* published in May 1968. In it, I maintained that the innovation stage of the production process came after the invention one, if there had been one, since few inventions were market-ready. In practice, therefore, engineering activities have always been closely associated with innovation. I go on to say:

> The innovation process as a whole needs the talents and resourcefulness of at least five different kinds of people: the scientists, engineers and other technical people who look after the R&D, the design and engineering aspects of a project; the project manager who becomes identified with the project and who carries it forward; the marketing and sales specialists who find the customers; the entrepreneur who recognizes the need or opportunity for innovation…and who accepts the risk of failure; and the venture capitalist who, after appraising the risks and resources involved, is willing to back the project financially. (p 83/84)

In its fourth report, *Towards a National Science Policy For Canada* in 1968, the Science Council defined *Innovation* to include "the practical implementation of the results of research and development to provide new, improved or less expensive goods or services." This 'R&D connection' was a commonly held view at the time. It failed to recognize that, while particular innovations might require some R&D to reach the marketplace, only a few of them could be traced all the way back to basic research.

On this particular matter, an interesting comment may be culled from the (2006) autobiography of Alexander King, for many years a leading and influential member of OECD, with an interest in science policy….and innovation:

> When it came to technical rather than scientific information, I came to appreciate the depth of my own ignorance. I had shared the naïve assumption of many basic science researchers that technological advances arise from an entrepreneur becoming aware of the potentiality of a discovery in pure research and transforming it into a commercial product through rather pedestrian applied research. I was quite unaware of the thousands of small technical advances that contribute to ever advancing technologies. I had given little heed to the importance of know-how and still less as to how it was disseminated. I also found, during an Internet search, reference to a study titled *What is Innovation: Fifteen experts share their innovation definition.* Indeed they did, with 15 different answers! The simplest was attributed to Paul Sloane: *Innovation is the implementation of something new;* who added that it is usually, but not always, distinguished from *invention*, which may precede it time-wise.

King was not the only one to hold such views; the Science Council's fourth report identified above is an example; and they have persisted. For example, the 1986 report of the (Canadian) National Technology Policy Roundtable noted:

> The innovation process involves a continuum of activities that are interlinked: no link in the chain can exist for long in isolation.
>
> The process begins with the conduct of basic science. Market research then filters out the products or ideas that might be transferred into commercially viable products at the applied research stage. Success at this point may lead to commercial production and sales in either consumer or industrial market.

The next report to which I would draw attention is the Science Council of Canada's Report #15 of October 1971, *Innovation in a Cold Climate: The Dilemma of Canadian Manufacturing*. The Council's definition of *innovation* appears to include invention:

> Though widely used, the term "innovation" has many different meanings. Applied to industrial activities, it usually means a conscious sequence of events, covering the whole process of creating and offering goods and services that are either new or better or cheaper than those previously available. In this report "innovation" means this whole process, from original conception to acceptance in use…
>
> Most innovations, of course, are not revolutionary (or disruptive) in scope. In fact, most innovation in recent times has been evolutionary and has occurred

> through a series of extensions (to) existing technology….(And it) has become clear that a large high-quality, national scientific research and development effort…does not necessarily lead to a high rate of innovation, nor does a large population of technologically-skilled people.

This particular report went on to list what it called *major impediments to innovation* in manufacturing in Canada in the 1970s. Among these were: an inadequate technology base, influenced by the proximity of the highly-developed industrial base in the United States; limited (domestic) market size and market access (abroad); a poor climate for investment; inadequate management skills; tariff and non-tariff barriers; and the sub-critical size and stability of the industry. Among the non-tariff barriers cited in the report were: import quotas; licensing; concessional financing; anti-dumping regulations; government purchasing policies; international trading policies; export subsidies; and outright prohibitions.

Consistently, in contemporary analyses of Canadian innovation policies, government purchasing has been identified as a way to improve the situation, one that seldom seems to have been taken.

It is important to remember that inventions and innovations can be successful or not, risky as inventions in the laboratory and as innovations in the marketplace. It is also important to recognize that, while inventions can be serendipitous, innovations are deliberate.

Inventions may also be patented, and this draws attention to similarities between patented inventions and their eventual innovations. In practice, an innovation will be put through tests somewhat similar to the ones for a patent application - novelty, applicability and un-obviousness. It is therefore not surprising that the output of Canada's Patent Office is of interest to examiners of the country's innovative activities. But in Canada's case, this comparison must take into account the heavy participation and motives of American applicants with regard to their Canadian patents.

In 1970, the Science Council of Canada published (as its *Background Study No. 11*) my study of patent practices, or the lack of them, in 80 Canadian companies of various sizes and in a variety of industries, plus 36 private and public companies and agencies with patent protection activities. The 80 companies were all R&D performers. Incidentally, these were the days before the Canadian and American systems (two of only three in the world) adopted the 'first-to-file' application requirement and still used the more complex 'first-to-invent' one. Need for protection among the 80 could be summarized this way: potential market protection; competitiveness within their markets; growing technical sophistication of these markets; defence for significant up-front R&D expenditures; reduction and possible avoidance of the risks of litigation; and helping police potential infringers.

Over the years, the idea that an innovation represented something new in the marketplace or the processing plant, has not really changed. What has changed, apparently, is the categorical imperative that, to be of any value in the marketplace, a product or process *has to be* innovative technologically, possibly based on someone's research.

Since the 1960s, science policy academics and government people around the world have been examining technology-based and other forms of innovation. The leading contributor was perhaps the American economics academic, Joseph Schumpeter. His successors have included R.R. Nelson, Derek de Solla Price, Robert Solow, Harvey Brooks, and Zvi Griliches in the U.S., plus Christopher Freeman in the U.K., and others at OECD. This was before the study of innovation really took off, which happened 10-15 years later.

The last 20 years or so have seen the publication of a number of books/reports about Canadian innovation, some supportive, some critical. The following comments refer to a few of them:

Two of the books are by Kristian Palda, a business academic. One was published in 1984, the other in 1993, by the Fraser Institute. The first was called *Industrial Innovation: Its Place in the Public Policy Agenda.* Its message is summed up in its last paragraph:

> It will be noted that throughout this volume no position is advocated that would lead toward an overall increase in the taxpayer's contribution to the support of innovation. It will also be noted that less interventionist policies, baptized as 'indirect,' are preferred to more direct ones. As till such times as we have clear-cut evidence about the extent of the social returns relative to private returns to innovation, we consider existing mechanisms for its support more than ample. Any suggestion at this stage of knowledge for a further increase in spending or intervention should be received in the manner of the eighteenth century French economist Turgot. When consulted by Louis XV as to what he would do if appointed Minister of Finance, he replied, "Rien, Sire!"

Palda's second book was called *Innovation Policy and Canada's Competitiveness,* and was published nine years after the first. Again, its message is best summed up in its concluding paragraphs:

> Canadian governments spend more than adequate funds supporting activities designed to bring forth new knowledge, new products, and new processes as well as on activities which facilitate the diffusion of innovations.
>
> Innovativeness, in both its facets of research and diffusion, is reasonably alive and well in this country. In large part, this is due to the much-maligned presence of multi-nationals, domestic and foreign, who 'invisibly' import research or diffuse its results.
>
> The contribution of government subsidies to our innovative successes is not clear, but the evidence suggests it to be small in certain areas. Subsidies to enterprises are often simply substitutes for activities that business would have

> carried out anyway. Subsidies to basic research (usually carried out in universities) seem to be of more lasting value.
>
> Perhaps what we have not stressed sufficiently is the most fundamental dimension of the competitive performance of a country's economy. This is the level of access of the final user, industrial buyer or consumer, to innovative products and processes in the market. The Canadian consumer is, in this respect, more favoured than most others. The country is one of the most trade-intensive in the world, with increasing openness to the world's most open economy.
>
> (In parentheses: This was written before the trade policies of former U.S. President Trump dampened down on 'openness.')
>
> Thus, if only for these three reasons, there is no call to intensify direct policies supporting innovation. There is plenty of advice about how to improve the existing policies, some of which are mentioned in this book.
>
> What is needed is a major effort to enhance the quality of the business climate for innovation and competitiveness. This can be achieved by a return to sound fiscal policies and adequate infrastructure investment, at the federal and especially at the provincial levels. On how to do this, more than enough sound advice is available, but not nearly enough readiness to accept at least some of it.

Thomas Carpenter's *Inventors: Profiles in Canadian Genius* appeared in 1990. Among those whose biographies are included are: Abraham Gesner, the geologist and inventor of kerosene; (Sir) Sandford Fleming, of multiple accomplishments; Mabel Bell and the Aerial Experimental Association; Thomas 'Carbide' Willson, who was the first to make acetylene; radio's Reginald Fessenden; (Sir) William Stephenson, who first sent photographs by wire; the snowmobile's Armand Bombardier; and G-E Desbarats and William Leggo, who published the ground-breaking *Canadian Illustrated News.*

In 1994, Roger Voyer and Patti Ryan published *The New Innovators: How Canadians are shaping the knowledge-based economy.* Right at the beginning, they say that the purpose of their book is to 'demystify' the process of technological innovation. They write:

> While many people believe that innovation is synonymous with a flash of genius, there are underlying principles that may be set out…
>
> What is technological innovation? Basically, it is the ability to transform an idea into a marketable product, process or service. Traditionally, Canadians have been very good inventors or generators of ideas…

> But many Canadian ideas, possibly too many, have been commercialized by others, meaning that the major benefits did not accrue to Canada.

This book set out to describe contemporary (1990s) Canadian companies that *had* contributed to *Canadian* innovation (although not all of them were still in business in 2019). They included: Vortek Industries Ltd.; Quadra Logic Technologies Ltd., Xillix Technologies Corporation; DY4 Systems Inc.; the Corel Corporation; Newbridge Networks Corporation; Dynapro Systems Inc.; Cognos Inc.; Mitel Corporation; Gandalf Technologies Inc.; and International Submarine Engineering.

These statements appeared at the end of the book:

> By the late 1980s, Canadian technology-intensive exports were about 15 per cent of total exports, up from 11 per cent in 1971. The paradigm is shifting slowly. However, the proportion of technology-based exports are about 40 per cent (of exports) in the United States, 30 per cent in Japan and 25 per cent in the newly industrializing countries of Asia. Canada is in a catch-up mode relative to its competitors…
>
> Apologists for this situation argue that Canada's resource-based economy does not require as much R&D and related investment as do the economies of countries more involved in manufacturing.

Another 'double' author was Roy Meyer. His *Inventing Canada:100 Years of Innovation,* appeared in 1997, and *Scientific Canadian: Invention and Innovation from Canada's National Research Council,* appeared in 1999.

Meyer explains that the first book is "about truly inspired Canadians from various walks of life who committed themselves to originating something new and necessary, whatever the consequences." The examples also show that some of these important innovations were not patentable, but were nonetheless significant. He gathered the information through interviews, news media reports, books, biographies and scrapbooks, as well as published patents.

Innovation: Essays by leading Canadian Researchers appeared in 2002 and was edited by James Downey and Lois Claxton and its publication was closely linked to the Canadian Foundation for Innovation. The two-dozen authors of the essays are articulate and have been drawn from a variety of academic/research disciplines, including engineering. Neither of the editors have technical backgrounds, and some of the essays are social, cultural or historical. This book is not really about 'innovation' in the end-use sense. It is about research activities, skills and energies that have been going into recent scientific discoveries and into the results of these activities - information that could potentially wind up as marketplace innovations. It paints a rosy picture of the, then current, potential of academic research in Canada to contribute to innovation in its 'usually-accepted' meaning.

To borrow from the Downey/Claxton introduction:

> Today's curiosity-driven research is tomorrow's technology, and we can never be sure where the next revolution in knowledge will come from…
>
> This collection reveals that Canada's research community is ready to do its part. It is brimming with intelligence, energy, and commitment, in touch with the vital issues of our time, and probing the deeper meanings on 'innovation.'
>
> Learning more about what futures are possible is the beginning of the wisdom. We will need to choose well.

I have included this book to express concern about the 'wisdom' of accepting relatively-recent, doubtfully digested 'research' results. As well, the application of some piece of basic research may be so many years into the future that the original connection may be missed. Also, around this time, the turn of the 21st century, one question was being asked: Is the (federal) government's solution to problems involving innovation, simply, 'to throw money at them?' Another was, "Do we have the technical/engineering competence within the country to do all the innovating we see to be needed (for economic recovery, competitiveness, productivity and GNP growth etc.).

We should also note a rather startling statistic in regard to innovation publications internationally. Mark Zachary Taylor wrote in his book, *The Politics of Innovation,* in 2006 that…"a cursory search of the research literature over the past 13 years reveals the publication of just under 20,000 research articles on technological innovation in over one hundred categories of social science research." He then added, "Yet despite all of this study and debate, there still remains no consensus on the precise definition of *innovation* or *technology,"* or what to do to encourage them! Also, it is pertinent to ask how many of these authors were writing after having taken part in actual innovative situations. Or have they simply researched someone else's experience and written around it? But it is also pertinent to ask how many engineers (or their marketers) have published material on their actual, successful innovative achievements? After all, a great deal of what engineers do for a living is, technically, innovative, whether it involves research or design or production…and whether the writers really looked into what engineers did?

Before it was disbanded in 1992, the Economic Council of Canada was seriously concerned about Canada's economic and industrial competitiveness, especially in manufacturing. One of its last reports, *Pulling Together: Productivity, Innovation and Trade,* had this to say, (for example, to the authors of the 20,000 articles):

> There is no single set of reliable indicators of a country's relative capacity to innovate. In part that is because the process of technical innovation is so complicated that, even if ideal data were available, it might be difficult to

> select one or two key factors that could adequately capture the ranking of different countries. But the data available are far from ideal and are very uneven across countries. All inter-country comparisons necessarily have limitations as a result, but comparisons are frequently attempted nonetheless. They involve such diverse criteria as R&D expenditures, the numbers of patents granted, the proportion of the labour force that is made up of scientists and engineers, the adoption rate of new technologies, the level of on-the-job-training, and so on…
>
> By virtually any of these criteria, Canada ranks poorly among the industrialized countries…

This report does, however, include a breakdown of the innovation costs of sample manufactured products in 1991:

Activity	Percentage
Applied research	17
Preparation of product specification and design	9
Prototype or pilot plant	36
Tooling and manufacturing equipment and facilities	19
Manufacturing start-up	11
Marketing start-up	8
	—
	100

This is a somewhat similar breakdown to the one published in 1967 by the U.S. Secretary of Commerce's 'rule-of-thumb' figures from the report of a Panel on Invention and Innovation, (which I used in my 1968 report on *Science, Technology and Innovation)*:

Activity	Percentage
Research/advanced development/basic invention	5-10
Engineering and designing the product	10-20
Tooling/manufacturing engineering	40-60

Manufacturing start-up	5-15
Marketing start-up	10-15

While the two sets of figures do not correspond, one message is clear: the engineering, manufacturing and start-up costs (of an innovation?) may significantly exceed those associated with research… as well as establishing a connection between engineering and the innovation stage of the manufacturing process. In other words, engineering and innovation have a lot in common!

Roger Miller and Marcel Cote's book *Innovation Reinvented: Six Games that drive Growth* appeared in 2012. It dealt with innovation in a way that the previously-discussed books did not: the authors say that innovation is based on the simple idea that market conditions shape innovations and drive innovators' strategies. The points I want to make in regard to it can be captured in the following quotation from the preface:

> Over the years…consulting with business on innovation led us to change our views significantly. Our grandiose first conception we discovered was wrong: we found innovation to be much more mundane and ubiquitous throughout the economy, a basic mode of competition aiming at product differentiation through improvements and at a lowering of costs.
>
> We also found the classic paradigm on innovation, structured around a linear path from the laboratory to the marketplace, to be of little use in understanding the actual innovations. What matters most are customer interactions and marketing. It is not that technology is not important in many innovations, but that its availability is not the main drive of most innovations, nor a determining factor of whether innovation occurs or not. Even in the sectors that embed the most effervescent technologies, innovation is mostly driven by competitive considerations. Moreover, most of the technological progress over long periods after the inventors' initial breakthrough. How quickly innovation happens and why it happens, and who benefits from it, are questions that concerned us when we set out to write this book.

…shades of Alexander King!

By the way, the six games in the title have been described in the book as: Eureka! - the development of a new market for a stand-alone product; battles of architecture - as applied to telephone companies, fought over emerging open systems built around platforms; systems breakthroughs; new and improved - the continuous development of an edge in the marketplace through product differentiation; cost reduction; mass customization - battles of brands; and pushing the envelope - redefining the state of the art.

The next book has a special Canadian context; it also is the most profusely illustrated one, published in 2017, and called *Ingenious: How Canadian Innovators Made the World.* Its co-authors were Rt. Hon David Johnston, then the Governor-General, and Tom Jenkin, chair of the firm *Open Text,* who also chaired a report preparation committee included in Cedargrove Series #59/2022 on Canadian S&T, R&D Programs. (They were once colleagues in the innovation hub at Waterloo, Ontario.)

Grouped under headings like 'smarter, smaller, kinder, safer, healthier, wealthier, and happier', the origins of several hundred Canadian 'innovations' are pictured and described. I have put innovations in inverted commas because, in my view, some are 'scientific discoveries', and some are not 'technical' at all but are about individuals or institutions - although this does not interfere with the authors' message, which they say is that "invention is never the whole story!" Their motive for doing what they did can be seen in these excerpts from the text:

> Ours is an era of uncommon opportunity. New ways of meeting, problem solving, designing and delivering what people need and want have blown the doors off our old ways of thinking and collaborating…
>
> There has never been a better time to have an idea, share it, improve it, and turn it into something else for the better…
>
> Canada has a long tradition of welcoming new ideas and, at this stage of our national development, we urgently need better ideas in every arena. We want to help…

The book begins with a chapter on "What makes Canadians so innovative?" - going back to the innovations engineered by generations of First Nations that were later taught to, and used by, the newcomers from Europe. It defines 'innovation' as the creative combination of anything that, once done, makes something better. Scattered throughout the book are panels with practical advice for the budding innovator.

Among the innovations described are Rogers' battery-less radio, the Woodward/Evans light bulb, the patents for which were reputedly sold to Edison, C.D. Howe's rotary car dumper, the telephone, the Blackberry phone, standard time, 'bush' aircraft, the ski-doo, the paint roller, the steam foghorn, kerosene, the rotary snowplow and canola oil.

One further message to help illuminate the 'innovation' definition and other questions: I recently read a historical novel, *The Last Days of Night,* by Graham Moore, (published in 2016 by Random House, New York) about the 'current war' (a/c, d/c) of the late 19th century between Thomas Alva Edison and George Westinghouse, with the participation of Nicola Tesla. Each chapter of this book was prefaced by

quotations from two people well-known in the 'innovation business,' one of whom was the late Steve Jobs of *Apple* fame. Here are some words by this 'master' of innovation, quoted in Moore's book:

> Innovation comes from people meeting up in hallways or calling each other at ten-thirty at night with a new idea, or because they've realized something that shoots a hole in how (they've) been thinking about a problem. (p 167)
>
> We're not going to be the first to this party, but we're going to be the best (in contrast with Edison's 'first-to-invent' priority view.) (p 75)
>
> People don't know what they want until you show it to them. (p 3)
>
> Deciding what not to do is as important as deciding what to do. (p 154)
>
> If you look closely, most overnight successes took a long time. (p 198)
>
> Sometimes when you innovate, you make mistakes. It is best to admit them quickly and get on with Improving your other innovations. (p 240)
>
> I'm convinced that about half of what separates the successful entrepreneurs from the unsuccessful is pure perseverance. (p 256)
>
> Great things in business are never done by one person. They're done by a team of people. (p 353)

And now, if you will permit, two examples from the same source by Edison…

> I have not failed. I've just found ten thousand ways that don't work. (p 30)
>
> No experiments are wasted. (p 111)

Finally, I want to include mention of a recent federal publication, which is more relevant to Cedargrove #59/2022, but has some relevance for this paper too. As we know, the Liberal Cabinet that took office in late 2015 did not include a 'conventional' Minister of Industry, Trade and Commerce. No, his title was Minister of Innovation, Science and Economic Development (MISED), with much the same basic mandate, but with emphasis on innovation. Also appointed, as a subordinate of MISED, was a Minister for Science, a 'real' scientist, not just a politician, who very shortly afterwards appointed a chief science adviser, and was followed in this by some of her Cabinet colleagues. This structure gave rise to the question: If you have a *science or innovation* problem, who do you call? No help with technology or people or market problems, unless they could be linked to innovation!

In February 2019, MISED issued a 200-page 'brochure' (*Building a Nation of Innovators)* describing all of

the federal financial and other programs in support of innovation and innovators, which included some with increased funding. Suitable endorsements for the package from potential users and user organizations were included in the brochure. Again, you begin to wonder who to call, and how much to ask for? No solutions to marketing, structure and size problems, or regarding non-tariff barriers, or any missing, but needed, technical competence. (Throwing money….?)

Changing the subject…

My preferred 2019 definition of *engineering* (and there are several in use) would be: It is an informed activity, performed by purpose-trained practitioners, in regard to the design, production and maintenance of machinery, constructions, processes and devices; it is being augmented constantly by experience, research and other information that extends beyond science and technology and requires some understanding of economics and business, the law, the social sciences, and politics, as well as an appreciation of the past and the future. Incidentally, also, I would define science to be associated with 'know-why' and technology with 'know-how.'

In my view, the book by Miller and Cote is the most useful.

Where we may go from here…

It may be that the 'environment' for innovation in Canada has improved just a little, recently. For example, national newspapers have begun carrying advertisements by universities such as Waterloo, Toronto, McMaster, Concordia , UBC and Simon Fraser extolling their innovation 'connections' and the courses they can now offer on the subject. Newspapers are also publishing articles about new technologies such as artificial intelligence (AI) and quantum computing. Articles on the importance of protecting intellectual property/patents have appeared, written for example by Jim Balsillie, the former joint head of RIM and Blackberry. He has also been involved with the activities of the Council of Canadian Innovators, founded in 2015. The supply of venture capital also appears to have increased, along with the possibility that we will 'grow' more 'unicorns' with funds from, for example, pension funds.

Canada has lost Nortel, and Blackberry, but has brought back the Canadarm- and Radarsat-builder, MDA Associates, from the U.S.. (Balsillie, again!) We have held on to Shopify, and the number of general analyses of 'innovation in Canada' articles in business and other magazines and in newspapers has increased. Perhaps some of this wisdom and experience will find its way into government policy.

!t seems possible, also, to conclude that to 'innovate' is also to 'engineer' changes/steps/processes that will improve what industries and companies can offer to their customers, *successfully*. That the engineering may be 'evolutionary' and represent the next step in the design process for the product or process in question, or may be 'revolutionary' (or 'disruptive') is also important from the

market/economics points of view. Incidentally, the question of protecting intellectual property must also be addressed, because the protection of potentially profitable technical advances is also important. And if 'engineering' is not an appropriate word to apply to non-technical innovations, the appropriate other word should be used. So there is an important role to be played by engineering societies in providing more details of the 'business' of innovation. (Trade secrets, hopefully, will remain so!)

It seems possible, also, to conclude that an innovation will not be commercially successful unless it is appropriately marketed, meaning that marketing research activities on its behalf are essential. In other words, as Steve Jobs has said (above), potential customers *DO* have to be convinced they need it. But measures that have worked in the past, may not work now, or a few years from now.

It may also be appropriate to ask: if economists don't like monopolies (limited or not), and hence are unsympathetic to patents which confer limited ones, why count patents as parts of the innovation process? After all, it depends on *what* is being patented. Yet patents *do* play parts in this process, and different parts for different innovations. How, then, to analyse these differences?

What about doing something about the non-tariff barriers to innovation? And what about more government purchasing of innovative products?

Today, in 2022, I would amend the title of my 1968 ECC report to *Science, Engineering and Innovation!*

*****

Sources…

The various Economic and Science Council and other reports and the books referred to in the text have already been identified in the text, above.

Alexander King, *Let the Cat Turn Round: A Man's Traverse of the 20th Century,* CPTM, London, 2006

…and, of course, the Internet.