The Way Ahead

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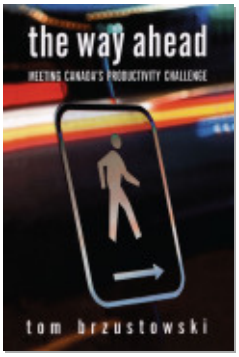

Published by University of Ottawa Press

Brzustowski, Tom.
The Way Ahead: Meeting Canada's Productivity Challenge.
University of Ottawa Press, 2008.
Project MUSE.muse.jhu.edu/book/4435.

CHAPTER 3

Getting Started

It's not rocket science.

How do we start meeting our productivity challenge? In the first two chapters, we saw that Canada must shift from a commodity economy to a knowledge-based, value-added economy. Now we begin to look at how that might be done.

This chapter provides guidance of two kinds. The first is high-level, long-term advice on harnessing a nation's scientific capacity for wealth creation. This advice has been influencing US science and technology policy since the end of World War II, and it is considered by many to have been its recipe for success as an extraordinarily innovative and prosperous economy. Much of this advice is applicable to Canada today.

The second part of the chapter deals with something much more immediate and practical. It demystifies the process of increasing productivity. It's not rocket science. It requires a consistent system of simple, practical measures that everyone can understand. The example chosen to make this point is the Hong Kong Productivity Council, and the list of its activities describes what needs to be done.

The high-level vision: "Science The Endless Frontier"

What has made American industry such an innovative powerhouse? There are a great many contributing factors, but one document published sixty years ago is widely acknowledged to have been extraordinarily influential.

In late 1944, with the end of World War II in sight, President Franklin D. Roosevelt wrote to his Director of the Office of Scientific Research and Development (OSRD) for advice on how to use science to create a better peacetime. He put the challenge in these words: "The information, the techniques, and the research experience developed by the Office of Scientific Research and Development and by the thousands of scientists in the universities and in private industry, should be used in the days of peace ahead for the improvement of the national health, the creation of new enterprises bringing new jobs, and the betterment of the national standard of living."

The Director to whom the letter was addressed was Vannevar[1] Bush (1890–1974), a distinguished and successful American engineer, inventor, professor, entrepreneur, businessman, and public servant. He had been a professor of electrical engineering and dean at MIT, the co-founder of the Raytheon company in 1922, had developed an analog computer, and proposed some of the concepts of the Internet. As well, he had helped to organize the Manhattan Project, and as Director of OSRD he had coordinated and guided a very large and complex wartime research effort that Roosevelt described as "a unique experiment of team-work and cooperation in coordinating scientific research and in applying existing scientific knowledge to the solution of the technical problems paramount in war."

The response from Vannevar Bush came eight months later. It was addressed to President Harry Truman because Roosevelt had died in the interim. Bush gave it the title "Science The Endless Frontier."[2] The title was very important because it positioned science right in the American tradition of pioneers opening up new frontiers, something the public could immediately grasp. Bush put it this way: "The pioneer spirit is still vigorous within this nation. Science offers a largely unexplored hinterland for the pioneer who has the tools for his task. The rewards of such exploration both for the Nation and for the individual are great. Scientific progress is one essential key to our security as a nation, to our better health, to more jobs, to a higher standard of living, and to our cultural progress."

"Science The Endless Frontier" (STEF, for short) has had an enduring impact. It led to the creation of institutions such as the National Science Foundation (NSF), and of programs that have promoted research excellence and given the US world leadership in research and in technological innovation based on the results of that research. It is the reason why US defence agencies have been supporting an enormous amount of unclassified basic research that has produced major scientific advances in many fields. Its themes have seeped into the nation's scientific, academic, industrial, political, and public consciousness and continue to influence decisions to this day. STEF may be thought of as a statement of the social contract between science and society in the United States.

In Canada we have no such document and no such contract, nor does there seem to be widespread public understanding of the role of science and research in our society. Nevertheless, much has been done by the federal government and the provinces to strengthen Canadian research since 1997, and the quality and

scope of Canadian university research in science and engineering are now at an all-time high.

Canada now needs that capacity to meet our productivity challenge. To make our prosperity sustainable in a knowledge-based global economy, we must trade extensively and successfully, facing increasingly demanding customers and increasingly sophisticated competitors. Manufacturing has been very important in Canada and must continue to be very competitive in world markets in terms of both functionality and price, using the most advanced science, the newest technologies, and the best of international business practice to succeed. It is also true that much of our nation's wealth has been derived from natural resources, and we are lucky to have much more in store. But much of the low-hanging fruit in the resource sectors has already been picked, and the ongoing, sustainable exploitation of our natural resources will require sophisticated new engineering and further advances in science. In addition, in the markets for raw materials we also face increasingly capable competitors from countries with much lower labour costs. There are limits to the reductions in production costs that raw material producers can make to stay competitive, as shown by the number of mills and plants that have closed. This means that Canada's quest for competitive advantage has to be shifted from extracting raw materials to producing value-added intermediate goods or finished products. Thus, all the signs indicate that in the future Canada's prosperity will depend much more on our capabilities in science and engineering, and our international business acumen, than it has in the past. To smooth the way for the required efforts in a time of rapid global change, Canada will need appropriate and responsive public policies and government practices.

STEF was written sixty years ago for the US, but there is much in it to guide us today as we acknowledge the need to mobilize our science for a better future. Here are several paragraphs taken from Bush's chapter "Science and the public welfare" that Canadians would do well to take very seriously as we build for the long term.

> ...We will not get ahead in international trade unless we offer new and more attractive and cheaper products.
>
> Where will these new products come from? How will we find ways to make better products at lower cost? The answer is clear. There must be a stream of new scientific knowledge to turn the wheels of private and public enterprise. There must be plenty of men and women trained in science and technology for upon them depend both the creation of new knowledge and its application to practical purposes.
>
> More and better scientific research is essential to the achievement of our goal of full employment.

The importance of Basic Research

Basic research is performed without thought of practical ends. It results in general knowledge and an understanding of nature and its laws. This general knowledge provides the means of answering a large number of important practical problems, though it may not give a complete specific answer to any one of them. The function of applied research is to provide such complete answers. The scientist doing basic research may not be at all interested in the practical applications of his work, yet the further progress of industrial development would eventually stagnate if basic scientific research were long neglected.

One of the peculiarities of basic science is the variety of paths which lead to productive advance. Many of the most

important discoveries have come as a result of experiments undertaken with very different purposes in mind. Statistically it is certain that important and highly useful discoveries will result from some fraction of the undertakings in basic science; but the results of any one particular investigation cannot be predicted with accuracy.

Basic research leads to new knowledge. It provides scientific capital. It creates the fund from which the practical applications of knowledge must be drawn. New products and new processes do not appear full-grown. They are founded on new principles and new conceptions, which in turn are painstakingly developed by research in the purest realms of science.

Today, it is truer than ever that basic research is the pacemaker of technological progress. In the nineteenth century, Yankee mechanical ingenuity, building largely upon the basic discoveries of European scientists, was able to greatly advance the technical arts. Now the situation is different. A nation which depends upon others for its new basic scientific knowledge will be slow in its industrial progress and weak in its position in world trade, regardless of its mechanical skill.

Centres of Basic Research

Publicly and privately supported colleges and universities[3] and endowed research institutes must furnish both new scientific knowledge and trained research workers. These institutions are uniquely qualified by tradition and by their special characteristics to carry on basic research. They are charged with the responsibility of conserving knowledge accumulated in the past, imparting that knowledge to students, and contributing to new knowledge of all kinds. It is chiefly in these institutions that scientists may work in an atmosphere which is relatively free from the adverse pressure of convention, prejudice, or commercial necessity. At their best they provide the scientific worker

with a strong sense of solidarity and security, as well as a substantial degree of personal intellectual freedom. All of these factors are of great importance in the development of new knowledge, since much of new knowledge is certain to arouse opposition because of its tendency to challenge current beliefs or practice.

Industry is generally inhibited by preconceived goals, by its own clearly defined standards, and by the constant pressure of commercial necessity. Satisfactory progress in basic science seldom occurs under conditions prevailing in the normal industrial laboratory. There are some notable exceptions, it is true, but even in such cases it is rarely possible to match the universities in respect to the freedom which is so important to scientific discovery.

To serve effectively as the centers of basic research these institutions must be strong and healthy. They must attract our best scientists as teachers and investigators. They must offer research opportunities and sufficient compensation to enable them to compete with industry for the cream of the scientific talent.

And what can be done to strengthen industrial research? Bush's answer is short and sweet:

The simplest and most effective way in which Government can strengthen industrial research is to support basic research and to develop scientific talent. [But] the benefits of basic research do not reach all industries equally or at the same speed. Some small enterprises never receive any of the benefits.

Bush realized that this state of affairs had to be improved with some sort of outreach mechanism. Though he did not develop that idea, the observation was noted and later became the basis of the very successful SBIR[4] program of the NSF.

These statements are as true in the US today as they were in 1946, and they apply to Canada in 2007 as well. They are wise words, and the policies and practices derived from them have worked well in the United States. Canadian governments, universities, and industry should take them very seriously as we develop our own agenda to guide us to increased and sustainable prosperity in the twenty-first century.

The practical approach: Hong Kong Productivity Council

Visions and policies are important, but what do people actually do to raise their productivity? There are many examples around the world of nations taking systematic action to improve their productivity. Hong Kong is a beehive of manufacturing within an intensely competitive business environment. The information provided on the Hong Kong Productivity Council (HKPC) website is very practical, and it takes the mystery out of raising productivity. To begin with, their definition of productivity is very suggestive:

> Productivity is the effective use of innovation and resources to increase the value-added content of products and services. It is the true source of competitive advantage that creates long term economic viability and a better standard of living for all.

The key phrase is "value added." How do we raise our productivity? By increasing the amount of value that Canadians add in what they do. Since productivity is a statistical measure over the whole economy, this will happen even if only a portion of the workforce moves into higher value-added activities. Of course, the bigger the portion the better, and the higher the value added of the new activities the better.

At the level of the enterprise, one can consider increasing productivity by increasing the output per worker with better technology and training, and therefore decreasing the number of jobs required. This is a scary approach, and probably the reason why the word "productivity" does not resonate well with the public. Increasing unemployment is too expensive in many ways and can be very damaging at the local level. At the other extreme, one can try to maintain the number of jobs and increase production, but market conditions, and the increased emission of greenhouse gases (GHG) may make that approach unrealistic. And there are probably strategies in between that combine aspects of the two extremes.

Or one can do something very different—use innovation to increase the value added per worker, and maintain or even increase the number of jobs. At the national level this third strategy must surely be the compelling option. We must strive to increase the value-added content of jobs in every sector of the Canadian economy, and to do that we must have entrepreneurial managers who are constantly on the prowl for opportunities to find ways of adding more value in their businesses.

But if we know how to increase Canadian productivity, why don't we do it? All sorts of business and industry groups, and think-tanks of all persuasions, keep pointing to low productivity growth as a Canadian problem that must be fixed. The Government of Canada announced an Innovation Strategy in 2002; there were lots of discussions across the country, and a national summit at the end of that year... and nothing much since. We seem to be looking for a silver bullet: "if only government lowered taxes and got out of the way," "if only business started investing its profits more in machinery and equipment," "if only our education system were better," etc. But that approach is

bound to fruitless. There is no silver bullet. Instead there must be a patient process of organizing ourselves to enable advances on many fronts and for a long time.

Once again, the Hong Kong Productivity Council provides a useful example of how to proceed. Their website states that

> HKPC's mission is to promote productivity excellence through the provision of integrated support across the value chain of Hong Kong firms, in order to achieve a more effective utilization of resources, to enhance the value-added content of products and services, and to increase international competitiveness.

But the question remains: How do they do this? Here is what they say on their website:

> The Hong Kong Productivity Council (HKPC) is a multi-disciplinary organization established by statute in 1967 to promote increased productivity and the use of more efficient methods throughout Hong Kong's business sectors.
>
> HKPC is governed by a Council comprising a Chairman and 22 members. This Council represents managerial, labour, academic and professional interests, as well as a number of government departments concerned with productivity issues.
>
> HKPC and its subsidiary companies provide a multitude of services to around 3,000 clients each year. The operation of HKPC is supported by fee income from its services and a government subvention in balance.
>
> With 25 Centres of Excellence, 10 testing laboratories, as well as exhibition and training facilities at its headquarters at the HKPC Building in Kowloon Tong, HKPC provides a diverse range of services in manufacturing technologies,

management system, information technologies, and environmental technologies to clients from different industrial and commercial sectors.

As the Hong Kong economy continues to move to higher value-added production, a constant flow of creatively applied technology is essential if the territory is to stay ahead in competitive global markets. To fulfil its role, HKPC is focused on both new technologies and continuous competence development in order to upgrade the performance of its workforce.

Those 25 Centres of Excellence are not research organizations. They are narrowly-focused service organizations where companies find the knowledge they need to meet the detailed needs of their sector. Here are some names indicative of both the focus and the nature of the knowledge provided: Advanced Electronic Processing Technology Centre, Clothing Technology Demonstration Centre, Electromagnetic Compatibility Centre, Intellectual Property Service Centre, Productivity Training Institute, Reliability Testing/Calibration Centre, The Hong Kong Plastic Machinery Performance Testing Centre, etc.

The centres help their clients with what HKPC calls "Eight Pillars of Industry and Support Services." They are as follows:

1. Business Development and Strategic Planning;
2. Technology Transfer and Commercialization;
3. Product Design and Engineering;
4. Business Management Processes and Logistics;
5. Production Technology and Processes;
6. Standards and Quality;

7. Human Resources Management and Development;
8. Other Industry Support Services.

These services are all familiar to Canadian companies, they all make sense, and they're all needed. So working to increase our productivity is not so much about exploring unknown territory as it is about getting our act together and then working to make it a very good act.

It's time for Canadians to stop moaning about our low productivity and do something about it. We need an urgent national effort, and all sectors must play their role in it. Productivity is mainly a private-sector issue, and it's time Canadian industry took the lead in getting the national effort going. The public sector should be a partner, but government shouldn't be expected to pay for the whole thing. Government and education should be ready to join in and help out in playing their appropriate supporting roles, and respond fast enough to make a difference.

It really isn't rocket science!

NOTES:

1 pronounced Van-ee-var.
2 The full text of the report by Vannevar Bush can easily be found on the Internet by searching for "Science The Endless Frontier."
3 It should be noted that American and Canadian terminologies in this area are different. The institutions referred to as colleges and universities by Bush would all be called universities in Canada, as distinct from our community colleges, whose activities are important for the economy but do not include

basic research and education for advanced degrees in the context of research.

4 Small Business Innovation Research program of the US National Science Foundation that helps small businesses participate in US federal R&D and in the commercialization of inventions arising out of federally funded research.

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