State of Science in Canada

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This talk grew out of an invitation to address my Rotary Club on the research developments underway at our Research Station. At the same time as I was drafting this talk, I was also struggling with sourcing funds to bring some of these innovations and ideas to fruition. This led me to reflect, as you do when you get older, on where we had come from and how we had arrived at the somewhat unhealthy state that Canadian science finds itself in today.

I began to list the policies and trends that concerned me. It was clear that even though today's scientist has a much expanded and easily accessible information base and the means to do efficient and effective science, it is doubtful that the present level and quality of science can be sustained in today's political and economic climate. It was also clear that the policies that are constraining and misdirecting our science efforts are based on misconceptions and attitudes that should be set right, or at least challenged.

I felt it important to voice these concerns to my colleagues and the public since our success as a nation and our general living standard are certainly at risk.

The four concerns I wish to touch on today are:

- The policy decision that nearly all science should be market-driven.
- That it is more important to control science than to do science.

- The perception that Canada's population is too small to support research and development—that we can buy technology when we need it.
- The apparent low level of science knowledge and understanding within the Canadian population and the perception that science is dangerous.

The concept that all innovation must be market-driven is a policy that has been put forward and applied by conservative governments, particularly in the U.K. and more recently in Canada and the United States. The theory is that industry is close to the market and therefore knows what innovations are required. These views are put forward by businessmen, market lobbyists, and graduates from business schools, not by scientists. Scientists know that most innovations are idea-driven, not the result of market pressure. Sir Francis Bacon once said: "Basic research increases our understanding of nature. Technology increases our power over nature, but the power comes from the understanding." Unfortunately, more and more, Canadian scientists are being asked—compelled—to do technology rather than science.

I shared some of my thoughts a few weeks ago with my deputy minister, Mr. Noreau. His reply noted that the rapeseed/canola program is a prime example of a successful market-driven research program. How could I say that market-driven research is not effective? The fact is that the process was science-driven. The industry and the market did not know what was possible. It was the scientists who saw the need and the opportunity. Industry was not the driving force, but it has been very useful to have them a part of the team.

I am not so concerned with orienting major research efforts toward a market or broad objective. My concern with the present policy is that it directs research to a much narrower industry target and requires the delivery of short-term technological improvements.

Why do we have such a policy? One of the base reasons is the miserably low proportion of Canada's GNP that is invested in R & D, still about 0.4 percent even though the federal Conservative government promised to double that if elected. Indeed, the latest announcement is that the federal expenditure on R & D will be held to increases of 3 percent per year, at least until 1995/96, which is, in effect, a means of reducing the availability of effective R & D dollars.

The policy is designed to have industry pick up the slack, but unlike most other countries, only 20 percent of Canada's industry does any research, and those that do focus on short-term payoffs and obtaining matching federal and provincial research funding. Thus, the policy objective is to marry the public and private research efforts through directed short-term funding. To my mind, a high proportion of our research directed to such narrow objectives will result in "long-term pain for short-term gain."

I guess you could ask, why play their game? The facts are that my institution could not survive today without a major infusion of outside funding, in addition to the federal support that used to be sufficient to run an excellent but independent research program. The universities are facing a similar plight, with frozen or reduced A-Base budgets and galloping inflation in scientific equipment and supply costs. The only option is to compete for short-term contracts. Most are of a one-year nature; many for three years, with five years the maximum. Western Diversification funds are only available if there is a payback, and within five years. The same is true for NABI and most other federal and provincial funding.

Even the NRC, in their recently released research plan, indicates that the vast majority of the research conducted in their labs will be applied to short-term research and that additional funding will only be available if a company or industry partner is involved and supports the research thrust. This policy will surely damage and inhibit the scope and depth of science at one of our most important centers of innovation. Unfortunately, NRC doesn't have much choice. Politics is now running science, and markets and immediate profits are the main concern.

What's so bad about market-driven and short-term research? History tells us that many of the most successful innovations had no markets at the time they were developed. Take, for example, the steam engine, or the invention of electricity: Faraday's contemporaries stated that "Electricity is universally allowed to be a very entertaining and surprising phenomenon, but it has frequently been lamented that it has never yet, with much certainty, been applied to any useful purpose." Indeed, Gladstone, prime minister of England, said to Faraday following a demonstration of his generator-dynamo, "This is all very amusing, but is there any use for it?" Faraday's reply was very astute: "Sir, someday you may tax it." And how right he was.

Similarly, the first flight of airplanes was considered "unmarketable" and the flight machines "impractical and insignificant, if not utterly impossible."

The invention of the laser was largely the result of an intellectual obsession of C. H. Townes and others. The discovery of penicillin, the development of transistors, and the basic information necessary for biotechnology and computers were all curiosity—not market—driven.

Bureaucrats today appear to view science as a near luxury and see the opportunity to transfer the moral and monetary responsibility for science from a publicly supported endeavor for the common good to the preserve of private industry for private profit. In their wisdom, they seem to be saying, "We've done enough innovating; now let's apply or buy technology and make some money." One of my colleagues further up the ladder suggested that the present distortion exists because our controllers are more concerned

with the process and accountability of science than its originality and progress.

Regardless of the reasoning behind the policy, the result is that Canadian science will stand still or recede. But in the EEC, Japan, Korea, and even China, it will flourish. As a result, Canada will become dependent on foreign technology. Such purchases may allow us to remain in the game, but at a much lower living standard.

However, you can't buy technology wisely without having the necessary experts on the leading edge of that technology to tell you whether it will work or be economic. I think in Saskatchewan, the Gigatext affair is an excellent example as to the costly mess that results when technology is bought without expert advice. It should also be realized that no country has become industrially viable by purchasing technology. Japan is often cited as a country that has succeeded through such purchases. This is not so. Japan has and does her own R & D. All one needs to do is visit Tsukuba, Japan's science city, to realize how dedicated Japan is to fostering science and technology. In addition, Japan's science base is aided significantly by a highly sophisticated information-gathering network that operates worldwide. In contrast, I am lucky if I get one of my scientists to one scientific conference every four years.

It is also worth noting that Japan has no business schools *per se,* as we do in North America. Most of the managers of research rise from the ranks of productive and innovative scientists and engineers. In addition, Japan is probably the only industrialized country in which companies have significant technical expertise on their board of directors. Normally about one-third of the board is made up of scientists and engineers. Contrast that with Canada, where rarely do you find a scientist that is a company director.

In our federal government, deputy ministers are appointed by Privy Council Office, usually on Treasury Board recommendations. One criterion for appointment is that you know nothing about the department that you are going to run. All you have to be is a good manager, as defined by Treasury Board. This form of management without understanding what you are managing was devised some twenty years ago on the recommendation of a retired general and the former heads of the Post Office and the civil service. This arrangement ensures that the deputy ministers owe their allegiance to Treasury Board, not to the department they run.

It is frequently stated that Canada's population is too small for it to be a science power. This is probably true if we try to be experts in all aspects of science. But we can learn from others: Sweden, Denmark, The Netherlands, and Switzerland, all with small populations, are doing well in innovation, development, and export of science and technology. Clearly, population size is not a valid excuse for abandoning research in Canada. These countries have

succeeded because they have channelled their efforts into a limited number of science areas. We in Canada should also exploit certain niches, such as agriculture and forestry (including biotech), power generation and transmission, fisheries, fermentation, and a few others where we have some expertise and a strong industrial base. I am not at all sure that we should be so heavily involved in space science.

To make the necessary policy changes, it is said that we need the support of the public. To cultivate such support is a massive and difficult task, particularly with the media focusing, as it does today, on the misuse or the perceived misuse of technology by industry.

More and more of our scarce resources are being channelled into watchdog and control agencies, such as the departments of Environment and Health and Welfare. Certainly, industry has misused some technologies and controls are necessary. However, over-control is now coming to the fore.

A case in point is in the risk-assessment of biotechnology applications. Certainly, careful control and regulation needs to be exercised on living material that contains genes transferred from non-related plants and animals. We don't want, for example, to create super-weeds, and we certainly want to ensure that any transgenic material would pose no threat to health or the environment. However, Canadian regulatory agencies have now indicated that they want to extend regulatory control to traits resulting from mutational studies. Induced mutation basically speeds up nature's own process of adding genetic diversity. When it was pointed out that since 1955, over a thousand new varieties of improved crop plants had been developed and released as the result of induced mutations and that none of these genetic modifications had caused any deleterious effects, the reaction from the control agencies was rather surprising. Instead of agreeing that there appeared to be little or no risk associated with mutation breeding, the response was, "My God, this has been going on and we haven't been regulating it?"

If regulations continue to be applied to mutations similar to those for evaluating other biotechnology developments, then major additional costs will be added to the development of such varieties. The result will certainly be that such research will be done in and the benefits accrue to other countries that have a more realistic approach to science. Again, we will be buying instead of selling.

What can we do to get a more favorable climate for science in Canada? Everybody says public pressure, but it is not clear that science is a priority in the public mind. When the Ministry for Science and Technology commissioned a survey in 1970, 64.4 percent of the population could not name a Canadian scientist, and 61 percent were unable to name any Canadian scientific achievement. In 1987, a similar survey was conducted in Calgary by

the University of Calgary. Again, 65 percent of Calgarians could not name a Canadian scientist, living or dead. Of those that could name a scientist, less that half could identify the discipline in which he or she worked.

Obviously, we as scientists have a considerable problem on our hands. We seem to be caught between a public that is not interested in science and bureaucrats who misunderstand science and think it can be run wisely by daily measures of profitability.

How can we solve this problem? Perhaps we can mount a massive lobby to persuade CEO's and mandarins of the truth about science and how it works. But in the long run, the only solution is probably for scientists themselves to become more interested in management and to carry the values of science into the boardroom.