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"Subtle Linkages"

by Andrew H. Wilson
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EIC HISTORY AND ARCHIVES

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Abstract

This article was written originally in June 1978 (almost 40 years ago) for the Canadian magazine *Business Quarterly*, which declined to publish it. I 'rediscovered' it recently. A decision was quickly made to preserve it, lightly edited, in the Cedargrove Series, since it reminded me of the 'rants' I used to have as a relative youngster (and writer).

The linkages of most concern in the article are related to science and technology policy and innovation, and Canada's performance in both, which were my economic/political preoccupations at the time, and by the fact that, when the article was written, these subjects had not yet been examined in a sufficiently detailed way. These were also the days when Japan, rather than China, in addition to the United States, loomed very large on the world's science policy/innovation scene.

The thing is that some of the concerns expressed in this article are still relevant to Canada's situation - in 2014 - in spite of the Apples, Samsungs, Googles and entrepreneurs like the late Steve Jobs. There have been several recent Canadian reports on S&T policy and innovation that have provided more relevance than the ones published around 1978. Progress? Perhaps. One day, I might write an up-dated 'linkages' article. Meanwhile, this one is a piece of nostalgia...and of history!

About the 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. It is therefore a modern-day variant of the privately-published books and pamphlets written by his forebears, such as his paternal grandfather and grandmother, and his grandfather's brother John.

About the Author

He is a graduate in mechanical engineering and the liberal arts and has held technical, administrative, research and management positions in industry in the United Kingdom and the public service of Canada, from which he retired over 25 years ago.

He spent many years researching what became known as 'science and technology policy' for the Economic, Science and National Research Councils of Canada and has written and published many reports and articles in this field. Some of the material has still to be published, including this present document.

I like the story about the centipede with rheumatism in its legs, because it sums up the thrust of this article.

The centipede had a problem, and he knew it. His friends suggested he consult the wise old owl, which he did.

"The answer is simple," the owl said. "You just turn yourself into a mouse and, with only four legs, you'll have reduced your problem by 96 per cent!" The centipede was delighted, at first. But by next morning he was quite concerned. He went back to see the owl and asked, "How do I go about turning myself into a mouse?" The owl replied, "I only give policy advice. How you do it is *your* business!"

A lot of institutions and individuals give policy advice, especially to governments, in the way the owl did, and they do not always take the trouble to consider if the advice is implementable. It's *logical*, they say, so it must be!

How often have we read economic advice that opines that the inflation rate should be reduced or the productivity growth rate improved as matters of policy, followed by a rider to the effect that appropriate programs must be devised to do so. No words are given about what constitutes appropriateness, nor about the spin-off effects that should be expected unless avoided, the institutions that should be involved in putting the programs into action, and the other government policies that will have to be adjusted.

Relatively speaking, giving this kind of unexamined policy advice is fairly visible and easy, so easy in fact that it can often be used as a 'cop-out' in a problem area where economic, political or social ramifications are complicated or conflicting and the adviser has neither the time nor the inclination to unravel them. Politicians up for election or re-election use this kind of advice all the time.

Science policy is not exempt from the owl-and-the-centipede syndrome. For example, the Special Committee of the Senate on Science Policy made the recommendation in 1973 that Canada should, as a matter of policy, spend 2.2 percent of its GNP on research and development by 1985, that 10 percent of this sum should be devoted to basic research and that 60 per cent of it should be performed in industry. How - and why - these things were to be done was not really spelled out. The Science Council of Canada, in 1971, said that the federal government - in collaboration with the provinces, industry and the universities - should develop an industrial strategy for Canada that recognized the importance of innovation. How this was to be done, what kinds of things should go into the strategy, and the political aspects of developing such a national strategy were not really discussed. The Minister of State for Science and Technology announced in 1984 that Canada would have an Oceans Policy, but failed to fill in the details.

In practice, there are many subtle linkages between broad policy statements and their implementation in practice. There are, of course, occasions when such statements, when made, ought not to reveal all the details of implementation because these are still under negotiation. And there are occasions when the advisory institution has limited jurisdiction - or none at all - as in the cases of the Senate Committee and the Science Council. But neither of these situations fully absolve the advisors from studying and understanding the impact and the implications of the policy recommendations they are making and take these into account or, when possible, spell them out at the time the policy advice is given.

Let us look at some of the subtle linkages in the science policy business.

Take R&D percentage-of-GNP figures, for example. Such figures, in retrospect, indicate the resources a country or a major economic sector has allocated to R&D out of the total national pie and says something about the relative importance of R&D to that country or sector. As targets, in prospect, these figures show how the allocation of resources to R&D in the country or sector will change, or ought to change. These are useful comparisons. But it should be remembered that two countries with similar GNP percentages but different GNP sizes - in a common currency - may be spending considerably different aggregate amounts on research and development. One country may be spending, for example, $3 for every $1 in the other. It is therefore able to buy, on the surface at least, three times as much new information which, if used for industrial purposes, might provide an advantage in commerce, prestige, or some other way of the same magnitude. On the other hand, the $3 country could waste #2.50 on projects of little commercial or intellectual value, in which case the $1 country could enjoy a two-fold advantage. In other words, the percentage-of-GNP figure is all very well, but it is necessary to look also at the total amount to be spent and what it is to be spent on. And it is appropriate to know if the sector will be able to afford the amount in question from its own revenues or if it will also need help from public sources, such as tax deductions, grants or other subsidies.

In any event, the United States spends so much more on R&D by *any* measure than all other countries that, for the others, comparison to the U.S. makes little practical sense.

In the 1960s, especially, when times were better than they are now, increasing national R&D expenditures was an objective of most governments, and private institutions supported this. In Canada there was a whole portfolio of federal assistance programs for industrial R&D and heavy support for university research. The R&D activities of the federal government also increased. The situation now (in 1978) is rather different. The growth of R&D in government laboratories and the universities has slowed down considerably, and spending by industry from its own funds has also declined. Might these reductions be sensible?

Reductions in these expenditures have not been limited to Canada. They have taken place in the United States also, to the apparent concern of economists in that country who have become interested in the linkages between research, productivity improvement, profitability and economic growth. Why, they ask, has industry reduced its spending when the available evidence suggests that the return on money invested in research and development can often - how often? - be in the region of 30 to 40 percent? There are many aspects to the answer to this question. One is that the companies concerned no longer feel that such investments will continue to pay off so handsomely. Another is that the pay-offs are too far into the future. Another is that inflation, which was not so much in evidence in the 1960s, has upset the resource allocation process in the 1970s. The game may have changed, in other words. And yet another is that R&D, by itself, will not bring in fatter profits.

I have suggested elsewhere (*Productivity and Science Policy*, Chemistry in Canada, September 1976) that science policy has evolved in three stages - R&D, innovation and productivity. Nowadays, in 1978, science policy advice that is geared to the economy ought to be framed in terms of the productivity stage, taking into account not only the science but all of the *additional activities* needed to take a product to

market. Or, as the nursery rhyme used to put it: for want of a nail, the shoe, the rider, the horse and the kingdom were lost. The nail could be something like poor design, the shoe could be poor quality control, the rider could be insufficient financing, the horse could be ineffective marketing, and the kingdom could be poor technical after-service. The fact remains that, even now, little is known in aggregate about the linkages between R&D, at one end of the spectrum, and profitability or economic effectiveness at the other. And we know even less about situations in which the eventual manufacturer has done none of the needed research or development, or about those involving technical information that has been in use for years, decades or even centuries. When, and in what circumstances, is it necessary to re-invent the wheel? Why must *new* technology be used when it is not needed?

This brings us to the problem of technology transfer. In the Canadian context, a great deal of fuss is made about the supposed deadening effect of foreign ownership, and the lack of R&D activities in, Canadian subsidiaries. Each study that creates this fuss is met with a litany of counter arguments, for example: we are fully plugged in to our parent's R&D; we have the world-wide mandate for our product lines, so we are bound to pay attention to the required technology; we actually *do* R&D but don't call it that; time is money and sometimes we have to save time. The real question asks if the *technical competence* within the subsidiary is adequate for the market challenges that are being met. The same might be asked with regard to Canadian companies that are not foreign-owned.

In other words, we don't really know very much (again, in 1978) about the business of technology transfer or the diffusion of science and technology, or of its real cost and impact at the micro- or macro-economic levels - in spite of all the studies done, interviews held and articles written.

Again, it does not make much sense to spend a lot of money on unnecessary research, although basic researchers - while they lean on colleagues in adjacent fields - like to check up on the results of those working in their own fields, providing the costs and times for doing so are bearable. Industrial researchers and developers, however, must usually juggle with constrained costs and timing and rely on experience to a greater extent. They may therefore be more dependent on others.

The Science Council's industrial strategy work may have stopped short of being helpful, but it did bring attention clearly to the existence of impediments than can intervene to slow down or eliminate a new industrially innovative product or render it insufficiently profitable. Prominent among these were regulatory and tax burdens, the potential domestic market size, and the lack of ready access to markets abroad - all or most of which have no direct connection with R&D, science or technology. A linkage of sorts was therefore established between the technical and non-technical aspects of innovative work. But these were left largely unexplored.

By the same token, the Council assumed that past experience in Canadian innovation has been of limited use in the design of future policies, without analysing in sufficient detail the history of Canadian innovation to identify its positive aspects and successes, as well as its market limitations. With regard to innovation, specifically, it has been widely lamented by many policy groups and individual and international commentators (such as OECD) that - since Canada is at the bottom of just about everyone's list of innovative manufacturing nations - we have little or nothing that is usable in the future and must start again more or less from scratch. The Council's report *Innovation in a Cold Climate* concluded from

the evidence unearthed that the 'climate' was indeed cold. Part of the problem here is that the Council, and the others, have made their comparisons with the United States, Germany, Japan, the United Kingdom and other countries that have had viable and much larger manufacturing industries for very much longer than Canada has had. In other words, history has not been admitted to partnership. And the 'ones that got away' have been described superficially by commentators like J.J. Brown, in his book *Ideas in Exile* about invention in Canada, without due attention being paid to the *whole* stories. Those for the Avro *Jetliner* and *Arrow* - assumed Canadian technical successes - have similarly remained incomplete.

What has so often been overlooked by OECD and other commentators and by political people is the role played, and power exerted, by the United States in particular in highly visible revolutionary or disruptive innovations such as transistor applications, computers, xerography, and small electronic devices. The emphasis has been on process rather than substance...and on laying blame. What has been done significantly on less spectacular, evolutionary levels technically and commercially has been ignored. The innovation *process* in Canada and the markets for it have, simply, not been properly explored.

Undoubtedly, Canada's record in science and technology activities seems miserable set alongside that of the United States, West Germany and Japan. Undoubtedly, also, there are excuses for this, many of them valid. But this tells us little of what we have done well and of what we can build upon in the future. We could go broke trying to imitate the U.S. and Japan over the next two decades. After all, the advice *every* industrialized country is being given is to get into the high technology business and, if you can't cover the waterfront, you should specialize. But how big are the markets going to be, even for specialization? And, if we put all our Canadian eggs in a half-dozen baskets, how do we know that we will be able to defeat - in the marketplace, where the game is actually played - the other countries producing the same eggs? Non-tariff barriers are, after all, much more subtile and dangerous than tariff ones. The fact is that we have, or should have, a great deal more control over what goes on in our own market than over what we can do in o5ther markets.

One of the most important links that we do not fully appreciate is the one between the entrepreneur and success in the marketplace. In Canada, there is a tendency to look critically at enterprise and to discourage it in the cause of equity. However, economic success in the Western world has been closely linked to enterprise, both corporate and individual, and linked to 'muscle' and the willingness to take risks. But it is not necessary to start an enterprise with an innovation; a less expensive/sophisticated product might do the trick. After all, most enterprises start to fill a market need or to change the buying behaviour of people in the market. And most enterprises require, for reasons of continuity and stability, to have bread-and-butter products first and foremost. The risky ones come later.

What is not fully understood in the context of S&T policy and innovation is disaggregated risk, how it affects the different industries and technologies, and the part it can play in the encouragement of enterprise. Nor is the dampening effect of government fully examined or understood. We suspect we know how other countries encourage their own companies, but do we *really* know? Can enterprise be institutionalized in a Western-type society? We cannot say, for example, that we will just encourage entrepreneurs in the electronics business because, knowing this, another country or company may decide to protect its share of the Canadian market.

We are, in practice, called upon to deal with a series of moving targets. The main point about policy-making, however, is to reduce the movement, to give relative stability of direction and purpose. But do we know how this can be done? And what will cause the motions in the years ahead? Some believe this to be the 'wired city' or the 'information society' or the 'conserver society.' Others put more weight on the 'new economic policy' and the growing influence of Third World countries in economic affairs. And still others point to high rates of inflation and their consequences and the policies adopted to control them.

We know now that new products do not often fail for technical reasons. Indeed, there are already convincing statistics in this field. Why, then, do we bother so much about technology? In the U.S. context, the objective is continuing leadership in the world in technology - something that country will not give up without a fight. In Japan's case, it is a question of growth and influence on world markets. In Canada's case, it seems to be the means whereby more control can be exerted on foreign-owned companies. Some of us want to lay down the rules about how much research, design and so on are done here. Others say these are unimportant provided the free-flow of technical information is encouraged.

The fact remains that the emphasis placed on technology differs from country to country and we should understand this when making international comparisons and policy statements. After all, it has been understood for a long time that national situations tend to be unique and, in consequence, require unique solutions, different trade-offs, different freedoms and controls, and so on. So why try to follow others - unless they can teach us new tricks.

While much of the difficulty we have in policy formulation comes from moving targets, much also comes from the wish to avoid surprises in the future, and especially nasty ones. Economists are not very good at predicting or forecasting surprises. Indeed, much of what they forecast is not surprising. And there are other kinds of forecasters who are equally devoted to a lack of surprise. At the same time, policies designed to be surprise-free are about as flexible as a knight in shining armour walking towards his horse.

There are other aspects of the linkage problem that need study. For example, how much policy *coherence* is possible in Canada? In addition to the federal government, there are ten policy-making provinces. We know it is difficult to achieve, but can we say to what degree it can be expected in view of the different objectives of the various jurisdictions? It is very easy for policy advisers to call for coherence and for the political will to accomplish it.

Then again, we cannot fully discuss the parts played by individual people in the policy business. If Joe Clark were P.M., he would do things differently from Pierre Trudeau. But policy advice has to be geared to performers. Otherwise, it simply takes the form of disguised criticism with no thought of change. Few policy people are honest about this.

It is also important to remember that, normally, only one company gets an order; the others lose the time and money they spent in tendering. So everybody cannot be successful. The trick for the performer becomes one of winning enough business to stay in business profitably. In other words, the game can't be rigged so that *everybody* wins, as governments have often seemed to build into their programs.

Again, a lot of problems need technical solutions, but they do not always need *new* technical ones. Also, much of the cost of a product may well be the cost of the administrative burden placed on the producer by

his/her own technical inefficiency or his/her government's inefficiency or thoughtlessness. Few companies can be successful without objectives, and it is to these that their individual policy objectives should be directed - and the same principle applies to governments and to countries. In other words, we don't yet know enough about the causes and effects that make for commercially successful innovations in Canada.

Basically, a policy should really involve the process of adjustment from an old reality to a new one. It should be deeply concerned with relationships, which is another way of saying relationships as well as 'linkages' can be subtle. At the same time, experience teaches that 'progress' can be made through experiencing trouble; it may be postulated that he who never experiences trouble never makes progress. We should not, therefore, underestimate trouble as a teacher, just as we should learn to cope with surprises. Nor should we wonder that companies want to attend more to their businesses than to the attempts of governments to influence how they are doing this. And we should understand the importance of timing in regard to the production of goods and services for markets.

Finally, Chris Sherwell wrote this recently in *Nature* (12 April 1977):

> Straightened economic circumstances concentrate the minds of policy-makers wonderfully. The problems of those involved in science policy are worse than most, however, for the additional reason that, with science seemingly everywhere, science policy is seemingly nowhere. But with the research base an important pillar of support for the developed countries' economies, the need for science advice in government rightly remains undisputed, and the need to deal with problems with scientific content is undiminished.

The most subtle of all linkages affecting science policy is the need for a policy about *science* and a separate policy about the *application* of science. The points made above apply to both.