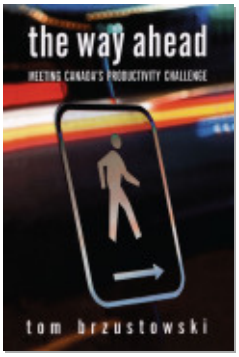
The Way Ahead

Brzustowski, Tom



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 5

Time Is of the Essence

"Timing is everything," said the actress to the bishop.[1]

Things are moving faster and faster in the world of business. New products appear, quickly evolve, become commonplace, and disappear, only to be replaced by something newer, better, faster ... Trading algorithms enable computers to follow fluctuations in share price and make split-second decisions to buy or sell. New companies appear, grow, dominate their markets, and suddenly reinvent themselves as something quite different. Many companies of all ages disappear. Whole economies emerge into global prominence, as if born full-grown, racing past others that seem to be standing still. But nothing is static, and even those that seem to be standing still are actually working their way up a down escalator. Change is everywhere, continually arriving faster and going deeper.

Nowhere is this more evident than in the consumer electronics industry. As already mentioned in the last chapter, the VCR appeared as an exciting innovation more than three decades ago. There was a brief struggle between the Beta and VHS formats, and VHS won. In the 1990s, the VCR became a commodity product, available as the four-head, hi-fi stereo machine for less than $100 in many brands, including the house brands of store chains. The manufacture of VHS tapes was to stop in 2006, and the only VHS

machines to be left on the market were those that could dub VHS tape content onto the next medium, namely the DVD disk. DVD players themselves were introduced only about a decade ago and became a commodity about four years ago. And we already hear the approaching footsteps of another new recording medium of even greater capacity, the next-generation DVD, with another struggle between competing formats. We can keep a record of all these changes with a digital camera, a high-tech product itself now in the process of becoming a commodity.

The Porter Admonition

This pressure for constant change presents a great challenge to business, perhaps nowhere greater than in high-tech consumer goods and services. The following words of Porter and Stern, quoted from the 2002 book *Innovation – Driving Product, Process, and Market Change*,[2] describe that challenge particularly well:

> The defining challenge for competitiveness has shifted, especially in advanced nations and regions. The challenges of a decade ago were to restructure, lower cost, and raise quality. Today, continued operational improvement is a given, and many companies are able to acquire and deploy the best current technology. In advanced nations, producing standard products using standard methods will not sustain competitive advantage. Companies must be able to innovate at the global frontier. *They must create and commercialize a stream of new products and processes that shift the technology frontier, progressing as fast as their rivals catch up.* [emphasis added]

There it is. It's not enough to market a successful innovation; the producer has to keep running to get out the next one, and the

next one after that, because competition eventually reduces every innovation to a commodity, and "eventually" is getting sooner and sooner. There's a lot of money to be made in this game because successful innovations can bring high margins, as detailed in the last chapter. But the only way to stay in the game is to keep innovating, refreshing the product to keep it from becoming obsolete, and at some point replacing it with something newer and better. And that can be done only with R&D.

It takes a lot of money spent on R&D to stay in the game. For example, companies that want to thrive in a market that sees new products introduced every year must plan to spend about 16% of sales revenue on their R&D. And the more often new products are introduced, the larger the percentage of sales revenues that must be spent on R&D.

That cuts two ways, of course. A company needs to spend that kind of money on R&D to stay in a fast-moving market. But if it has that much money, or more, for R&D, it has a good chance to become a market leader. Needless to say, both outcomes depend on spending the R&D money to good effect, and that in turn depends on having very good people working on it.

The Innovation Strategy, R.I.P.

In early 2002 the federal government proposed an "Innovation Strategy" with an ambitious and measurable goal. By 2010, Canada was to be fifth in the world on the scale of annual R&D spending per capita. At the time of the announcement, Canada was 15th. The R&D spending was about $20 billion per year, half of that in the private sector and half in the public. The ratio of Gross Expenditure on R&D to GDP, or GERD/GDP, was slipping below 2%, compared with 3 to 4% in the other

major economies, and with the goal of 3% averaged over all member countries announced by the European Union.

What would it take to meet the goal of the Innovation Strategy? Obviously, the rest of the world wouldn't be standing still for eight years. Economists who look into crystal balls for a living were able to come up with some rough numbers. They were impressive for some, scary for others. To meet the goal of the Innovation Strategy, Canadian R&D spending would have to be about $50 billion per year in 2010. $20 billion of that would be public, largely from the federal government, and $30 billion per year would be private. In the Innovation Strategy documents, the federal government promised doubling its own contribution, but the private-sector share was left to be found. And that share needed to be massive: a tripling from $10 billion to $30 billion, or an increase of $20 billion per year to be achieved in eight years.

Who would do that $30 billion worth of additional R&D? Additional R&D employees, of course, and lots of them. In 2002, there were about 100,000 R&D employees in Canadian industry. That includes people qualified in the skilled trades, technology, and science at the college diploma and university first degree levels, people with master's degrees, and right up to Ph.D.'s. The average annual spending per R&D employee was about $100,000. Assuming that by 2010 that average spending might increase to $150,000, the number of additional R&D employees required in the private sector by then would be in the range of 100,000. It would take an effective strategy involving universities, community colleges, and immigration to meet this need for highly qualified people in industry. But this is still not the whole challenge. At the same time, the workforce in the public sector, including all the categories of workers listed above and also graduate students and postdoctoral fellows,

would have to expand—possibly double—to increase public R&D activity by $10 billion per year.

And where was that new $20 billion for industrial R&D going to come from? Not from the government. With a total annual federal budget of less than $200 billion at that time, of which about a quarter remained for program spending after the national debt was serviced and transfers to governments, institutions, and individuals were looked after, there was no fiscal capacity for that kind of assistance to industry. But even if the fiscal capacity had been there, the political capacity certainly wouldn't have been. And investors don't provide much of the answer either. There are numerous multi-billion-dollar pools of capital, but the additional $20 billion is an annual expenditure—a burn rate, if you will. All things considered, there is only one source of new money for industrial R&D on that scale, and that is an increase in sales revenue on an even larger scale.

How big an increase? To be conservative, assume that the whole sales increase is achieved by the most innovative of Canadian companies, ones that spend 10% of sales revenue on R&D,[3] and come out with new products about every year and a half. Their sales would have to increase by $200 billion per year! That's a huge number, in the range of 15% of current GDP. That kind of growth over eight years is not an unimaginable number, but it would take the co-ordinated effort of industry and government to turn Canada into a world marketing powerhouse at the same time as we were becoming one of the world's R&D powers.

To help make that happen, government would have to expand its role beyond supporting research and sharing the risk on some industrial R&D. It would have to start helping Canadian companies bring new products to world markets in many more

ways. This would need to include tax assistance with product development beyond the experimental development activities that fall under the current program of tax credits for spending on "scientific research and experimental development," the SRED program. It would require assistance with developing market intelligence and with market development that would include strategic procurement to make the federal government the lead customer for new products that meet its own needs. It would demand support of a non-financial sort, involving simpler regulations and faster decisions. And it would also require significant improvements in the transportation infrastructure to speed the movement of Canadian goods to export markets. So if the goal of the Innovation Strategy was to create "Smart Canada, we needed to become "Prompt Canada" as well.

At the same time, for many Canadian companies there would have to be a change in mindset back at the office. Those new sales would have to be largely exports. And to achieve that scale of increase in export sales of new value-added products, there would have to be a new stress on world-first innovations. Company-first innovations might be necessary, and Canada-first would be attractive, but world-first innovations would be essential. The capacity for international marketing of those new products would have to grow at the same time, with a great need for innovation in that domain as well.

Anyway, 2002 has come and gone, and so has the Innovation Strategy, not because it wasn't needed but because ... who knows? All the conditions that made it necessary in 2002 still exist in 2007, we've lost five years and some ground, and the requirements for success are still of the same order of magnitude as estimated above. Canadian industry now spends $14 to 15 billion

per year on R&D, a number that has remained virtually flat for five years. We continue to see many great Canadian companies doing great things, creating new products and succeeding with them in world markets, but we don't see enough of them. The world continues to change, and Canada can't call time out.

Industrial R&D is changing too. Industry is now finding that it has to spend more and more of their R&D money on the D—developing new products faster. That leaves less and less for the R—research separate from current product development and creating the new knowledge that might be the basis of future product development. There will be more about this in later chapters. But note that this spending trend is changing the time scale of research that industry pays for; the short-term is crowding out the long-term. Industry leaders readily acknowledge the need for basic research as the long-term source of entirely new ideas and of people educated in generating and using new knowledge, but many of them now explicitly state that they can't afford to support it any more, and that basic research must be supported by public funds.

That's not news, of course. Vannevar Bush made that point 60 years ago, and the record of the US economy since then has proven him right.

Forgacs' Conjecture[4]

Several times now, I have linked R&D spending to the frequency of innovation, almost in passing. However, that link is very important to the understanding of industrial innovation, and we will now make it more explicit. It takes a particularly simple and very useful form in Forgacs' Conjecture.

Otto Forgacs had been a senior vice-president of the forest products company, McMillan-Bloedel, in charge of the

company's R&D. He has been a thoughtful observer of industrial R&D for many years. Forgacs suggested that companies invest in R&D to keep ahead of their competition in precisely the sense of the Porter Admonition. In other words, they do R&D so that they might always offer innovations in the market, even as their competitors eventually develop products much like theirs and turn the earlier innovations into commodities.

Speed enters the picture through a time scale characteristic of the sector, something Forgacs calls "marketable product life" (MPL). The shorter the MPL, the more quickly new products have to be developed, and the more must be spent on R&D. In that sense, MPL might be thought of as the reciprocal of the frequency of innovation. Normalizing R&D spending by sales revenue to allow for company size gives the R&D Intensity (RDI).

Based on his observations of companies of various sizes in various sectors for many years, Forgacs suggested the correlation shown in the following equation:

$$RDI = 16/MPL$$

where: R&D Intensity (RDI) is R&D spending/sales revenue, given in %
Marketable Product Life (MPL) is in years, and
16 is a parameter obtained by fitting the data

This equation can be thought of as the quantitative form of the Porter Admonition. It shows that companies competing in a market where major new products appear every four years (e.g., new vehicle platforms in the auto industry) must spend 4% of sales revenue on R&D to keep up. In a sector where new products come out every year (e.g., telecom equipment),

16% of sales are spent on R&D. Conversely, in a sector where companies spend less than 1% of revenue on R&D, products last a couple of decades with little change (e.g., natural resource industries). In simple terms, companies with a higher R&D intensity innovate more frequently than those with a lower intensity.

Clearly, the concept of an average marketable product life doesn't fit equally well in all cases. For example, in the early years of a research-based start-up company there are few products and limited revenues, but there may be a great deal of R&D if the whole field is moving fast. Here, MPL could be thought of as the time between major milestones, a few months more likely than years, and the logic of Equation 5.1 still seems relevant. For such companies, RDI may significantly exceed 100%, and they must be financed to continue to do research and product development. As shown below, this happens frequently, and it points the way to understanding another aspect of the time dimension in innovation.

The cadence of innovation in industry

Forgacs' Conjecture suggests that the R&D Intensity (RDI) might be very useful in studying the dynamics of innovation in industry. The RDI is readily calculated from reported data on R&D spending and sales revenue; it is the ratio of the two. Any two of those numbers yield the third. However, the RDI introduces additional information through its connection to the frequency of innovation as described above.

Figure 5.1 is a plot of longitudinal data about the pharmaceutical and biotech companies that are among Canada's Top 100 R&D Spenders. The data are the annual values of RDI plotted on a log scale. They were taken from the very useful annual publication by RE$EARCH Infosource.[5] The data cover the years 2000

to 2005, inclusive. Forty-seven companies in this sector appeared among the Top 100 at some time in that period, and every such appearance is marked by one of the annual symbols. Each one of the companies shown spent at least $14 million[6] on R&D each year.

The first thing to note is that the companies fall into two groups. Almost precisely one half of them always had the RDI well below 100%. The other half exceeded 100% in at least one year. The companies with RDI below 100% showed little variation from year to year. Indeed, companies 5 to 19 appear to be clustered around an RDI of 10%. They can be called the "mainstream" of the sector, and here the mainstream MPL is about 1.6 years, or 19 months. So the mainstream of the Canadian pharma/biotech sector produce new products on the average about once every year and a half or so.

To the left of the mainstream are several companies that innovate less frequently, with the lowest one introducing a new product every four years or so. These companies might be called the "commodity end" of the sector.

The mainstream and the commodity end show little variation in RDI over the six years, and they can be described as operating in the steady state. This does not suggest an absence of growth, just the fact that the companies operate in a pattern that changes little with time.

The right half of Figure 5.1 is very different. The companies shown there often spend more on R&D than their sales revenues, sometimes many times more.[7] Moreover, their RDI varies very significantly from year to year. This is a very volatile region. Some companies drop out of it; new ones enter it. These companies are being financed to do R&D to develop new products. They deal with rapid change: some in their knowledge base as new research

results come out, some in their target market, and some of their own making. Their behaviour can be labelled "transient."

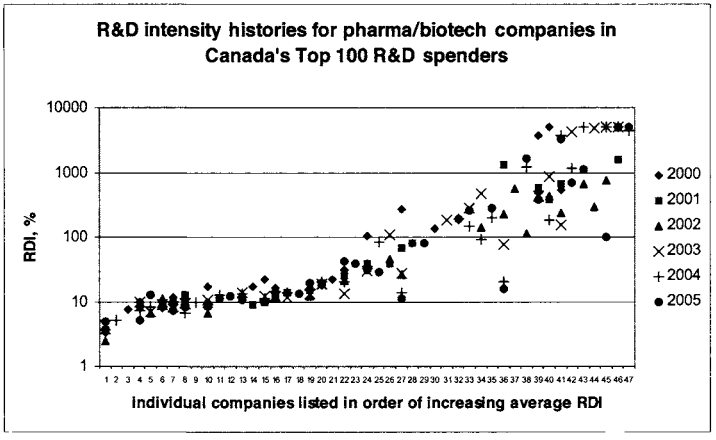


FIGURE 5.1 Innovative companies in pharma/biotech showing steady-state and transient behaviour

The pharma/biotech sector is the largest group in the Top 100, but similar behaviour can be seen among the companies from other sectors.[8] The big difference is that the values of RDI are much lower in many other sectors, such as natural resources, materials, and energy.

The steady-state and transient companies have what I will call a different cadence in their business. And differences in cadence at the company call for differences in cadence on the part of those who deal with them. Consider, for example, a program of government support for R&D. The steady-state companies might be well served by a steady program in which many applications to an agency were all filed by a certain date, evaluation and decision followed at a measured pace, and money eventually flowed to successful applicants.

But that would not work for the transient group. They ride up and down the waves of change. They need quick decisions by people who see and understand their constantly changing situation. They would be served best by "account executives" assigned to them, riding the waves with them, and authorized to make timely decisions. For companies in the volatile region, particularly the smaller ones, such timely response could be a matter of survival.

There is one more thing to notice in Figure 5.1—a tip for investors among the readers. Consider company #27. Its RDI fell continuously from about 300% to the mainstream value of just over 10% in the six years. The full data show that this did not happen because of reduced R&D spending. It happened because sales revenues grew much faster than R&D spending. Clearly, this is a company that is succeeding with the products it developed. The same behaviour of RDI is the hallmark of successful new ventures in the other sectors.

Wasted time

To conclude the discussion of the time dimension in innovation, it is useful to consider unproductive or wasted time. As has just been noted, such wasted time can create very serious problems for the transient companies that must survive in an environment of rapid, and often sudden, change. For that matter, it undoubtedly also presents obstacles to those operating in the steady state.

Here are some sources of unproductive time in the environment where business must operate:

- Traffic jams delaying the road transportation of goods;
- Physical and bureaucratic bottlenecks in sea, air, and rail transport;

- Job action caused by delays in negotiating new labour contracts after the expiration of previous ones;
- Delays in the approval processes of government funding agencies;
- Delays in the legal system;
- Delays in the commercial financial system;
- Delays in routine processing and approval transactions at all levels of government caused by inadequate staffing or training, or both;
- Decision delays by tribunals and other regulatory bodies because of inadequate capacity or incomplete membership;
- Slow transfer of routine information within and between agencies of all kinds.

There is an economic price to pay for all of these sources of delay. Given the importance of time in business, they have no place in "Prompt Canada."

I leave it to the reader to complete the list with some personal pet peeves.

NOTES:

1 ...or was it the bishop to the actress?

2 Michael E. Porter and Scott Stern, in Edward B. Roberts (ed.), *Innovation – Driving Product, Process, and Market Change*, p. 239, Jossey-Bass, 2002.

3 This really is very conservative. The 100 companies that spend the most on R&D in Canada, average slightly less than 5% of sales revenue spent on R&D.

4 In an environment well sprinkled with economists, I had been calling this relationship Forgacs' Law. But having followed some recent developments in mathematics, I have taken to calling it Forgacs' Conjecture. It was most recently discussed in the paper by Otto Forgacs, "Who spends money on R&D

and why?" presented at the Forum "R&D—The Ticket to Wealth Creation," Conférence de Montréal, June 7, 2004. The author first heard the main idea when Dr. Forgacs spoke about it in the author's presence at a meeting of the National Research Council of Canada in 1997.

5 "Canada's Corporate Innovation Leaders," is a well-known report published annually by RE$EARCH Infosource Inc. and distributed as a supplement to numerous daily newspapers in early November in the last three years, and in early July in earlier years. The data consist of the reported values of current and previous year R&D expenditures and current revenues, and the calculated values of percentage change in R&D spending and the R&D Intensity (RDI), i.e., here the ratio of R&D spending to revenue expressed as a percentage. The companies are listed in order of decreasing R&D expenditure. The data for each year contain only a few gaps (typically about 10) where revenue was not reported and RDI could not be calculated. The companies are grouped by industry in these 16 categories (listed alphabetically): aerospace, automotive, chemicals and materials, communications/telecom equipment, computer equipment, electrical power and utilities, electronic parts and components, energy/oil and gas, forest and paper products, health services, machinery, mining and metals, pharmaceuticals/biotechnology, software and computer services, telecommunications services, and transportation.

6 The lower cut-off for membership in the Top 100 R&D spenders stayed very close to $14 million per year over the whole six years.

7 The very high values of RDI at the right edge of Figure 5.1 were arbitrarily capped at 5,000%.

8 T. A. Brzustowski, "R&D intensity as a basis for R&D support policies," Optimum Online, Vol. 37, Issue 1, April 2007.