Highly Qualified Canadians: Demand and Supply

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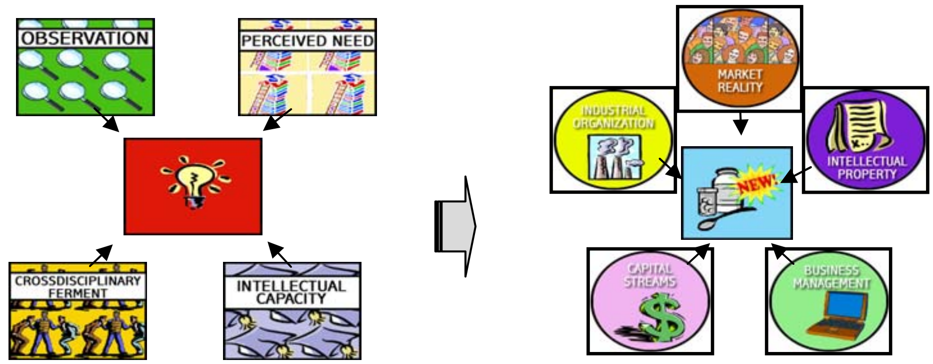
Canada: the demand for HQP

It is by now commonplace to assert that an economy's capacity to create wealth is a function of its capacity for innovation, and that such a capacity depends importantly on the supply of highly qualified people (HQP). We argue, in part from recent experience in the biotechnology sector in Canada, that it is insufficient to have a few world-leading specialists. Rather, high qualifications are needed in a variety of fields, and to be effective, these skills need to be present sufficiently widely in the working population as to allow numbers of specialized and smoothly interoperating entities to exist. A thin slice of HQP is not the route to success in the 21st century.

Managing human resource development for technologically advanced economies is a substantial challenge. Fostering innovation from initial idea or observation of a phenomenon through to a viable product in the marketplace requires time, patience, foresight and the ability to successfully transform a research and development environment into a market responsive business. The talent sets required are quite different, and from an historical perspective, often opposed. The research scientist is driven by curiosity, and less concerned about immediate practicality or marketplace notions like intellectual property, return on investment or market forces. Business success depends less on the idea than the execution: creating an asset, establishing a perception of value, and generating returns on investment efficiently and for as long as possible. The commercial success of innovation depends on satisfying both scientific and business needs, in effect translating from one culture to the other.



INNOVATORS → *SKILL SET* → ENTREPRENEURS

SPECULATIVE $ → *$* → BUDGETED $

PHD'S → *TALENT* → ENGINEERS

RECRUIT → *MOBILIZATION* → RETAIN

This schematic represents ten areas of human capacity, grouped in two sets, innovation and market execution required to make that translation.

Innovation Capacities

Observation represents environments where curiosity-driven research is encouraged. This human capital environment has the longest horizon, the highest risk, and offers the least predictable path from innovation to application. Governments and major research institutions have typically assumed this responsibility.

Intellectual Capacity represents the resources allocated to career development and training, re-training and updating. Typically educational institutions play the primary role at the beginning of careers, with both industry and the educational sector sharing in later career development.

Cross-Disciplinary Ferment is the bringing to bear of significantly different disciplines on a problem. Much successful innovation comes from the complex exercise of 'explaining' an issue in jargon-free language so that others outside the narrow field of expertise can understand it. Biology and engineering represent a recent successful interface. Incubators and convergence centers are one approach to providing this facility.

Perceived Need is the practical eye that can translate an observed phenomenon into a potential application. Universities and applied research institutes are typically the foci of such activity.

Intellectual Property capacity is the task of describing an innovation in a way that adds market value, the establishing a legal and corporate framework to assure that a significant proportion of the value added reverts back to the innovators. It is more than simply devising patents.

Market Execution Capacities

Industrial Organization refers to the working world and its capacity to absorb or make use of an innovation. It is common for an innovation of obvious benefit to fail as a commercial entity because it does not fit into, or even disrupts current processes. Vehicles that both assess market translatability and assist in creating markets are required.

Capital Streams are funding mechanisms aligned to the stage of development of an innovation, and are in tune with the particular requirements to sustain a project at each stage of development. Gaps in the capital stream chain may offer as great a barrier to development as overall capital shortage. The expertise to raise and manage such capital is an essential innovation requirement.

Business Management is a particular skill set distinct from scientific innovation. Organizational financial, human resources, marketing and other business skills have to be introduced as seamlessly as possible, balancing the transition between constant innovation and improvement with market reality.

Market Reality is the ability to set the innovation in the context of the global market. It includes the ability to find the common themes that expand the reach of an innovation, and the local particularities that much be addressed for success in each environment.

The skills sets for each of these innovation capabilities are different. Training, and re-training needs may be sector-specific, and are likely to be shared across the innovation and entrepreneurial divide. For the innovator, the critical measures are that all the parts are there, that the requirement for each is appreciated, and that as both the specific innovation and the enterprise fostering it progress along the development and marketing path, the shift in balance is carefully maintained.

Canada: the Supply of HQP

If the foregoing represents the demand side of the equation, how is Canada doing on supply? We turn now to the education and training systems in place, first describing them, then noting some of the main critiques of the present system and possible routes for improvement.

Schools, colleges and universities

Canada's school system would be familiar to observers from many countries. Constitutionally, education is a provincial matter, so the school systems are set up under legislation of the ten provinces and three territories. Results are fairly good: overall literacy is high, and in standard international tests, Canadian students place well above the OECD mean in reading, mathematics and science, second only to Japan.[1]

Each province runs a system of universities. Perhaps ten or twelve could be classified as internationally competitive research-oriented universities offering a full range of professional and graduate programs. As of 1999, 18 percent of Canadians aged 25 to 64 had completed a university degree.

There is also a system of colleges and institutes of technology that offers (generally two-year) diplomas in a wide variety of technical areas. These colleges are more closely associated with preparation for particular jobs than are the universities, and represent the single most important shift in the pattern of post-secondary education over

[1] Programme for International Student Assessment, as quoted in *Measuring Up: The Performance of Canada's Youth in Reading, Mathematics and Science*, Human Resources Development Canada, Statistics Canada, and Council of Ministers of Education of Canada, 2001

the last 40 years. In part they have grown at the expense of traditional apprenticeships, which have declined in importance in recent decades. About 20 percent of the 1999 working-age population had completed a college or technical school qualification, which means that Canada's 38 percent who have some kind of post-secondary qualification leads OECD.

On the other hand, skill requirements keep rising across all sectors. Knowledge and management jobs as a share of total employment have more than doubled in the period from 1971 to 1996, even in such hitherto quotidian trades as mining, construction and transportation. Developing the cross-disciplinary skills and aptitudes required for innovation remains a higher education challenge. One the one hand, new areas of specialization, such as nanotechnology, require a melding of formerly distinct disciplines, only to become new 'silos' themselves. On the other, both of our major post-secondary education streams are structuring cross-disciplinary programs, such as medicine/engineering, medicine/business and health sector management/business in order to produce managers competent to advance innovation from lab to market.

On-the-job training

"Continuous learning," it is now widely recognized, has to be part of any country's toolbox for improving the quality of its human capital. Fewer and fewer Canadians will spend their careers with a single employer or in a single occupation. The school, college and university systems, traditionally focused on young people, must be seen as merely opening cards in a lifelong game. Despite formal recognition of the requirement, however, the adequacy of the present Canadian effort is open to question. There is a certain amount of formal on-the-job training (OJT), especially in larger firms. Mentoring, both formal and informal, is a principal route to advancement, especially in large corporate or professional firms. However, relatively few companies have formal programs of either kind. Only the banks and a few of the larger manufacturing companies can be said to have really distinguished records in this respect, though regulatory requirements are increasing the investment by professional firms. Tax or other financial assistance to individuals willing to invest in themselves is minor.

At the corporate level, the usual excuse is similar to the traditional explanation for a relatively low level of corporate research and development: in a highly mobile economy it may be difficult for the firm that bears the cost to reap the reward. There is also the tendency of foreign-owned companies, of which Canada has a more than ordinary share, to concentrate both R&D and training expenditures at home.

Immigration not the answer

There is a widespread belief that Canada's relatively generous immigration program will make up for lacunae in the skill sets of resident Canadians. Canada takes in a comparatively high ~0.7 percent of its population from the rest of the world each year. However, these new Canadians are only selectively a contributor to Canada's supply of highly qualified people. Family members of persons already resident and international refugees constitute the bulk of the flow, while those who qualify by reason of scarce skills are less than 15 percent of the ~250,000 new entrants each year. As the source of immigrants shifts to poorer countries, the proportion bringing high economic qualifications and fluency in either of Canada's official languages shrinks. This is not a reason to slow immigration, as some critics would have it, as there are other valid reasons for accepting those whose presence has added a great deal of spice and flavour to the national stew, but it is erroneous to think that, in the global competition for the best and the brightest, immigration will ever be a substitute for serious investment in Canadians already there.

Problems and solutions

Problems with OJT have already been referred to: low corporate involvement, relatively few large firms in an economy dominated by small and medium-sized enterprises, foreign ownership, and the problems for firms in appropriating the fruit of their investment in a labour-mobile economy. There are however some examples of real excellence. The Bank of Montreal, for instance, decided a decade ago that its future prospects and competitive edge in a service business depended on a workforce that was better trained than its competitors. The bank invested $50 million in an architecturally distinctive new facility in Toronto and hired a renowned business educator from one of the universities to direct it. Today, the bank offers resident and distant learning courses, using the latest in educational technology as well as instructors whose grasp of pedagogy is as good as their grasp of their subjects – not a common outcome in universities – to teach its people everything from how to be a teller in a small town to highly sophisticated risk management techniques for managing billion-dollar asset blocks. The thought that they are creating competitive advantage for their firm is so embedded in management's mind that they decline to reduce their costs by allowing employees from other banks to audit their classes, or to rent the facilities to those competitors.

Elementary and secondary schools in Canada have not been immune to the educational fads that have swept North American education in recent decades. The failures of "whole language learning," curricula that in the search for innovation or political correctness neglect the basics, and a general lowering of scholarly and even disciplinary standards have meant that the path of reform has not been unidirectional. There have been the usual social distractions for young people, manifested in uncomfortably high drop-out rates, behavioural problems, and indifferent economic success later in life.[2] On the other hand, provincial (as opposed to national) control, and within many provinces, separate school systems based on religious affiliation or language, has meant that there has been considerable experimentation. The system as a whole exhibits a healthy capacity to learn from this kind of accidental competition.

Canada's universities, after a great acceleration in capacity to handle the "baby boom" in the 1960s and 1970s, have not fully kept up with the demand for higher education. Despite ongoing investment, there are problems of crowding, inadequate funding, and an aging professorate across the country. In the age-old debate over the appropriate balance between 'equal opportunity' and excellence, equity has generally won. All Canadian universities are overwhelmingly dependent on provincial funding, and

[2] On the other hand, literacy among Canadian youth has never been higher, second only to young Swedes among nations, and there is evidence that the tide of computer fashion might have peaked, as the number of hours spent in front of the screen is slightly declining and the proportion of young people who read books is rising. R. Wright, *Hip and trivial: youth culture, book publishing and the greying of Canadian nationalism,* Canadian Scholars' Press, 2001

when the provincial and federal governments descended into fiscal improvidence in the years before 1995, universities were among the public services that had to be constrained in order to balance the books. As finances have improved, investment has risen, especially investment in university research facilities, people and equipment by the federal government.

Despite new governmental spending and rising tuition fees, however, there is reason to be concerned about Canada's universities. The great pulse of professors hired in the heady years 25-35 years ago are approaching retirement, and in many of the fields most relevant to future national economic success, their successors are not in sight. The usual and on the whole healthy tension between town and gown, the competing demands of the job market and the ivory tower, persists. But there are signs of a deeper sclerosis, as the ancient tradition of tenure is overlaid by faculty unionization, collective bargaining, and a diminution of the emphasis on teaching and research quality.

The satisficing behaviour exhibited by Canadians in respect of higher education is symptomatic of a broader tendency in Canadian culture, which is to fail to approach investment in human capital with the single-mindedness that a few of the world's leading economies do. This lack of perceived urgency is not, in our view, an adequate response in an economy that has had the luxury of living off natural resource rents for too long and which has consequently neglected productivity, or which faces the common problem of advanced economies of an increasing dependency ratio in an aging and stagnating population.

In several areas of basic research, particularly the biologic sciences, electronics, computer sciences and telecommunications, the Canadian economy performs excellently. Its relative weakness is one of execution, translating scientific observations into market successes. Sometimes, as in the biosciences, we are culturally constrained by conflicting views of the profit motive: new technology is good, but 'profit' within our national health system is often seen as not. In other instances Canadians seem averse to risk, preferring to export nascent innovation for development elsewhere, only to re-import the finished product later at a considerably higher price. But it may not be simple risk aversion. Rather, an unbalanced supply of the ten streams noted above and an inadequate capacity to "translate" among them may be at issue. A critical objective that needs to underlie long-term planning for HQP in Canada is the nurturing of a cohort of leaders who can manage the whole spectrum of innovation risk.

New directions

Clearly improvements are possible in the existing system of schools, colleges, universities and on-the-job training; and regiments if not whole armies of people are working to bring them about. A recent federal government white paper provides excellent diagnosis and moderately useful cures.[3] After a period of some decline, Canadian per capita investment in post-secondary education, according to the Economist, is now the greatest in the G7. There are, in addition, two relatively recent developments of note.

About fifteen years ago, the federal government realized it was purchasing, principally through the unemployment insurance system, a large number of training "seats" in community and technical colleges without much sense of what the outcomes were, or even if the training so expensively purchased had relevance in real job markets. An experimental "sector council" was set up in the steel industry, explicitly bringing together the steel producers and the unions in order to make educated forecasts about future labour demands, and to bias federal training purchases accordingly. The steel sector council experiment was a great success.[4] It was emulated in 25 other sectors, but not all have been as successful. According to participants, the principal differentiating factor has been the enthusiastic engagement of the unions: where this has occurred, the sector councils have been highly effective in building human capital with critically important relevance to real-world conditions. Not least, the supply side of the training industry has been galvanized by a clear articulation of demand.

A second innovation has been even more recent. New understandings in developmental neurobiology have led to the conclusion that the minds of young children

[3] Canada, Human Resources Development, *Knowledge matters*, Ottawa, 2002; available online at www.hrdc-drhc.gc.ca. See also Canada, Prime Minister's Advisory Council on Science and Technology, *Stepping up: skills and opportunities in the knowledge economy*, Ottawa, 1999.
[4] See www.cstec.ca.

need multi-sensory stimulation at certain critical moments in their development if long-term capabilities are to be as unconstrained as possible.[5] The new insights have given rise to a movement called early childhood development (ECD), which aims to fill some of the gap between birth and kindergarten, not with schools or day-care centers, but with higher-quality parenting and an assurance that critical developmental stimuli are not inadvertently overlooked, or supplied at the wrong time in the child's life.

At the other end of the spectrum, the federal government has recently created a series of new, well-funded institutions that together come close to asserting biotechnology as a national strategic asset. The Canadian Institutes of Health Research have inherited the granting functions of the old Medical Research Council, but with additional resources to advance cross-disciplinary collaboration and seed new companies. Genome Canada is establishing new platforms where researchers from all disciplines can work together not just on basic science but on commercially interesting applications. Several networks of centers of excellence have been funded in the biosciences to bridge Canada's often formidable distances; they too have a mandate to look toward the commercialization of their discoveries. The national Business Development Bank of Canada has established a biotechnology window in its venture capital operations. And the Canada Foundation for Innovation has invested several billion dollars in renewing and extending the instrumentation of the nation's university laboratories. Together, these new investments may signal a shift in Canada's cultural perspective, toward innovation capacity being a national strategic asset.

Three examples

There are many examples of wholly new industries developed to supply technologies undreamed of a generation ago to markets similarly new, and Canada has its share of firms that do these things. An early example was built around a quintessential Canadian geographic reality: a thinly spread population requiring specialist health services across forbidding distances in a harsh climate. Manitoba, a central Canadian province with a population of 1.1 million, had no cancer treatment expertise outside the

[5] D.P. Keating and C. Hertzman, eds., *Developmental health and the wealth of nations: social, biological and educational dynamics,* Guilford, 1999

capital, Winnipeg, where half of the population resided. In about 1980, in anticipation of the development of the personal computer, an innovative cross-disciplinary group linking computer scientists, oncologists and telecommunications engineers sought to develop expert software systems to delegate a significant proportion of cancer treatment to community physicians without compromising care quality. A working prototype was developed and proven, but the ultimate success of the company that was formed came only with the investment of foreign capital and a move of the corporate headquarters to the United States, from which the state of the art product is now sold back into Canada. It is noteworthy that much of the research and development is still done in Winnipeg.

Perhaps more interesting is what can happen when intellect is applied to traditional industries. It is hard to be more traditional, un-green or low-tech – truly Canadian? – than forestry and mining, as commonly understood. But high-tech sawmills and underground automation are transforming parts of these traditional industries, leading to considerably increased economic value added.

The British Columbia coastal forest industry traditionally made lumber by gang-cutting green logs with large-kerf rotary saws and visually inspecting the cants for quality. Starting about 20 years ago, low-kerf bandsaws were substituted for rotary blades and computerized optimization of cuts was introduced. This meant that only one cant was taken at a time from a given log, and that computerized measurement of the wood quality revealed by the last cut was used to provide direction for the next. CAE, a Canadian firm prominent in the design and manufacture of aircraft simulators, pioneered in developing the technology.

An early customer was Canfor, a major BC coastal wood products company with contracts to supply the rapidly growing Home Depot chain selling hardware and do-it-yourself supplies in (at that time) the United States. Now, wood for carpentry and cabinet-making entails a huge number of storekeeping units (SKUs) for any retailer. Species, grade, moisture content, dimensions, prices: all matter to the ultimate buyer, and the aggregate desires of buyers differ markedly geographically, even from store to store in a metropolitan region. Canfor's bright minds decided to tag each single piece of lumber at the mill with a barcode whose SKU code included all relevant information. By

1990, cash registers at each of the hundreds of Home Depot stores registered these barcodes and uploaded the results to a geostationary satellite several times a day. Aggregated, and modified for seasonal and price elasticity information, these became the new cutting and shipping lists for the Vancouver mills. The important point to note is that the value added through inventory control was 4.5 times the value of raw commodity lumber, as measured by the price Canfor was able to charge. By 1998, sawmill programs were in place that optimized the cut based on the spot and future prices of each SKU, and revelations from each cut of each log. Wood plus intellectual capital is not now worth as much as 4.5 times the price of wood alone, because the success of Canfor has led to widespread emulation, but it is still a great deal more than commodity wood.

A second and so far less successful innovation has been telemining. Here, Inco and a few other large mining firms began experimenting a decade ago with robotic mining machinery that could be operated from the surface. For underground mines, the potential improvements in costs through the use of smaller shafts and stopes, as well as freedom from air, lighting and temperature constraints, have opened the possibility of mining smaller seams in more dangerous rock with great improvements in worker safety. However, Inco is a mining company, not a machinery manufacturer, and indeed there are few domestic firms that have the capacity to develop such novel machinery. The answer, if there is one, may lie within the nascent contract mining sector. The potential, however, remains large.

To summarize, these value-added approaches to traditional industries depend on highly qualified people who can span innovation and industrial application: who are good at boundary crossing, in a word. The new approaches are remarkably green, improve worker safety, in general seem to produce high yields rather than low costs, and require industrial entities that are capable (in all senses of the word) of applying them. Success, in other words, requires more than HQP, but without HQP not even a start can be made.

Conclusions

A key message from the Canadian experience is that a breadth of vision across the innovation through market implementation spectrum is a pre-requisite for linking innovation to national economic growth. Moreover, strategies to train, motivate and retrain HQP are both central to economic transformation and require the longest horizons. In broad summary, Canada's approach to HQP is not bad, on the whole, but it could be improved by (1) a culture of urgency and necessity; (2) clearer thinking about population age structure and about migration; and (3) by filling three key gaps – in early childhood development and on-the-job training, and in industrial structure.