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Company Perspectives on Innovation

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CANADIAN SPEAKER

*H. Douglas Barber**

Okay. It is a pleasure to be participating here this morning. I have been learning a lot as I've listened to the presentations that have been made here. It is rare that you get such a breadth of expertise on a topic interacting with other expertise, and I found that particularly stimulating. Until this morning, however, in this conference on innovation, the words "innovator" and "customer" each occurred only once in the presentations. I think that says something about our culture of innovation, and I hope that the two of us that are in the trenches are probably going to use those words a little bit more.

Just to give you some perspective, I was one of the founders of Gennum Corporation, and also in Bob Crow's definition a complete company. We do everything, in fact, as an integrated circuit microchip manufacturer. Even when we started with 23 people, we made our own masks and fabricated our own wafers and designed our own chips, and we still do that today with about 650 people, which is a fair change from when we started in 1973 as a spinout from Canadian Westinghouse. Gennum is a niche market company, so we select markets, and we typically select them so that we can dominate them because we are a company that strives or aims to be excellent, and we figure you can't tell if you are excellent or not. Unless you have more than 50 percent of the total world market, you can hardly say you are compelling with any confidence. The company has grown for 35 years with every quarter profitable. We have never had an unprofitable quarter in our history, and we have never had to finance the company except to give liquidity to the original angels that helped us get going at the beginning.

I guess two other things I should say in terms of those niches: Gennum started out making chips for hearing aids and still makes over half the chips of the world that go into hearing aids, which puts you into very miniature low voltage circuits. We worked on one voltage circuits all our life and it is only

* H. Douglas Barber was the President and CEO of Gennum Corporation until 2000; he now serves on its Board of Directors. He is a past Chair of the Council of Ontario Deans of Engineering and of the Board of Governors, McMaster University. He is a past Vice Chair of the Ontario Science and Innovation Council and past Co-chair of the National Information Technology Initiative (eMPOWER Canada Inc.), as well as a member of the National Innovation Strategy — Regional Coordinating Committee. He currently serves as a director for Golden Horseshoe Venture Forum, Canadian Academy of Engineering, Micralyne Inc., Netaccess Systems Inc., AllerGen and DALSA Corporation. In 2005, he received the McMaster University Faculty of Engineering Leadership Award. Mr. Barber writes and speaks on learning, innovation, productivity, value creation, the knowledge-based economy and entrepreneurship.

within the last five years or so that microcircuits, in general, as the dimensions have got down very low, work on one volt.¹ The second niche that we went into was signal transport in the television broadcast studios, and you can't watch television today without those signals having gone over Gennum, at least three times, because we are in the cameras, in the recorders, everywhere that video signals move in the broadcast studio. What separates the broadcast studio from the rest of the world is they have to work with uncompressed signals, which means the data rates are very much higher in the studio than they are once they go out through the wall.² You can actually take out 95 percent of the information before you send it out to the consumer.

After retiring as CEO in 2000 and after the announcement of the Canadian Government, which is in your big volume, about the innovation strategy that was made in January of 2001, I began to look carefully at Canada's performance in the knowledge based economy of the world. I found a number of things. First of all, Canada was investing heavily in research and in education.³ Where we sit low in the world, in terms of total R & D,⁴ as a percentage of gross domestic product in education and publicly funded research we are on the competitive level of any other country in the world.⁵ So our area of underperformance is actually in the commercial enterprises of the country, and as a result of that, we are still underperforming in the knowledge-based or the knowledge-intensive commerce of the world. When I say we are underperforming, we buy more of the knowledge-based products and services than we sell,⁶ so we run a deficit in Canada on knowledge-based commerce. And that has not improved over the years. That reflects itself in a declining

¹ See Albert C. Van Der Woerd & Aarnout C. Pluygers, *Biasing a Differential Pair in Low-Voltage Analog Circuits: A Systematic Approach*, ANALOG INTEGRATED CIRCUITS AND SIGNAL PROCESSING, March 1993 (discussing in part low-voltage microcircuits).

² See SOC'Y OF MOTION PICTURE AND TELEVISION ENG'RS, EUROPEAN BROAD. UNION, TASK FORCE FOR HARMONIZED STANDARDS FOR THE EXCHANGE OF PROGRAM MATERIAL AS BITSTREAMS (1998), http://www.smpte.org/engineering_committees/pdf/tftrpt2w6.pdf (last visited Oct. 24, 2006) (providing a good overview of innovative broadcast technology, including the conversion of uncompressed signals).

³ See CAN. CONSORTIUM FOR RESEARCH, THE NEXT STEPS (2003), http://www.cpa.ca/CCR/Brief_2003-CCR.htm (last visited Oct. 24, 2006) (discussing in part Canada's increased funding of research and education).

⁴ *Id.* (discussing how Canada was fourteenth in the world in terms of research and development as of 2003).

⁵ See NAT'L SCIENCE BOARD, SCIENCE AND ENG'G INDICATORS 2004, CH. 4, <http://www.nsf.gov/statistics/seind04/c4/c4s4.htm> (last visited Oct. 24, 2006) (discussing how Canada is fifteenth in the world in terms of its research and development to GDP ratio).

⁶ See The Honourable David L. Emerson, Can. Minister of Indus., Address to e-Commerce to e-Economy: Strategies for the 21st Century (Sept. 27, 2004), <http://www.ic.gc.ca/cmb/welcomeic.nsf/503cec39324f7372852564820068b211/85256a5d006b972085256f1c0075ab91!OpenDocument> (last visited Oct. 24, 2006) (discussing the need to improve in the production of knowledge-based commerce).

prosperity in Canada. If we measure it in the purchasing power parity, gross domestic product per capita, we have slipped from being second or third in the world in the '60s to being twelfth in the world in 2003.⁷ We might have come up a little notch in the last couple of years because we are really pumping oil out,⁸ but our prosperity has been declining, and it has been declining on a resource-based economy, not a knowledge based economy.

The interesting thing is that in that prosperity of nations, except for the United States, all other countries above us are smaller in population than we are and typically smaller in population than the province of Ontario.⁹ So sometimes we get carried away with this critical mass argument in Canada, and it is not supported in terms of innovation, where innovation is about prosperity. In fact, I should tell you that I'm working on a fairly broad definition of innovation all the time, and you will hear that at the end. For me, innovation is what humans do to find new ways within their circumstances to maintain or improve their lives. It is driven by a desire to prosper, and if you've been prospering, innovation has its own negative feedback. If it succeeds in increasing prosperity, it tends to decrease the drive to innovate. So there is nothing that kills innovation like prosperity. So the big thing for Canada is that we have had declining prosperity, and our prosperity has been dependent on our natural resources.¹⁰ We are a country with six and-a-half percent of the world's land mass, and the equivalent resources,¹¹ and a half percent of the world's population,¹² and we do two percent of the world's

⁷ CIA, THE WORLD FACTBOOK, RANK ORDER – GDP – PER CAPITA (2006), <https://www.cia.gov/cia/publications/factbook/rankorder/2004rank.html> (last visited Oct. 24, 2006) (showing Canada is fourteenth in the world in terms of GDP per capita in 2005).

⁸ See APEC, APEC ENERGY DEMAND AND SUPPLY OUTLOOK 2006, CANADA (2006), http://www.ieej.or.jp/aperc/2006pdf/Outlook2006//ER_Canada.pdf (last visited Oct. 24, 2006) (discussing how Canada's crude oil production had risen from 84 MTOE in 1990 to 144 MTOE in 2003; also, discussing how Canada is exporting large amounts of crude oil and other energy).

⁹ RANK ORDER – GDP – PER CAPITA, *supra* note 7 (other than the United States, the countries ahead of Canada in terms of GDP per capita are Bermuda, Luxembourg, Equatorial Guinea, United Arab Emirates, Norway, Ireland, Guernsey, Jersey, British Virgin Islands, Iceland, Denmark, San Marino); See CIA, THE WORLD FACTBOOK, RANK ORDER – POPULATION (2006), <https://www.cia.gov/cia/publications/factbook/rankorder/2119rank.html> (last visited Oct. 24, 2006) (showing in terms of population Canada is ranked higher than any country ranked above them on the rank of GDP per capita, other than the United States).

¹⁰ See GOVERNMENT OF CANADA, NATURAL RESOURCES CANADA, RESPONSIBILITIES, http://infosource.gc.ca/inst/rsn/fed02_e.asp (last visited Oct. 24, 2006) (confirming that natural resources are a cornerstone of Canadian prosperity).

¹¹ See INTERVAC CANADA, KEY FACTS ABOUT CANADA, http://www.intervac.ca/why_visit_canada_key_facts.htm (last visited Oct. 24, 2006) (noting that Canada comprises approximately 7% of the world's land mass).

¹² See RANK ORDER – POPULATION, *supra* note 9 (noting that Canada's population of about 33.1 million people is about .5% of the world's population).

economy.¹³ So in terms of those resources, that's not spectacular, but in terms of half percent of the world's population, it puts us into a fairly prosperous position.

Using R & D as a surrogate for innovation – and in a conference like this, we have really concentrated as much on research as anything. There has been some emphasis on the development side, too, but I'm using it as a surrogate because my definition of innovation is much bigger than the scientific or technical side of the picture.

I teamed up with a chap in Toronto, who has a database on all the companies that do R & D in Canada, Dr. Jeff Carlinton, and the two of us began to have a look at the companies doing R & D in Canada and how they performed and how they did. Now, that study ended up gathering the interest of Statistics Canada, which gave us a much bigger and more complete database, and – there we are – this is a very quick kind of diagram if I can get this over into this notch here. First of all, we took all the companies in Canada doing R & D because this is all the companies that report or apply for R & D tax credits. So it is a complete statistics Canada dump if you like, only it is not just a dump. They actually did a study for us over eight years, from 1994 to 2001, and what we learned from that study because we wanted to know where things were going or where things had been going, if that's the right term, so we divided up the companies based on the intensity of their R & D activities, which is the bottom axis here. That is the percentage of their revenue that they invested in research and development.

Because the goal of the national innovation strategy was to get into the top five innovative economies of the world, as measured by this parameter, we knew we had to get above 3 percent to get into that league. So we put all the companies doing under 3 percent in a category that we thought we couldn't do without them, but they were not going to help us a whole lot in getting to the goal, so they are what is called the low research intensity companies. What I want to say about them is they had a big part of the sales, and the total sales of this whole picture is about \$530 billion, and the total number of companies in this picture is about 9,000. It was typically probably about 10,000 over the eight years. The interesting thing is that the low intensity research group had most of the sales, but they were declining on every measure, declining on the amount of R & D they were doing, declining on their R & D intensity, which was only .4 percent, declining on the number of people they employed. So there is decline going on. These are the big resource-based companies. These are the mining companies, the lumber companies,

¹³ CIA, *THE WORLD FACTBOOK, RANK ORDER – GDP* (2006), <https://www.cia.gov/cia/publications/factbook/rankorder/2001rank.html> (last visited Oct. 24, 2006) (noting that Canada's GDP of \$1.114 trillion is almost 2% of the world's GDP).

the automotive companies, the steel companies. They are these kinds of companies.

We then chose from 3 percent to 50 percent as another group because I figured any company doing spending over 50 percent of their revenue in R & D was in a startup phase.¹⁴ They were being funded from somewhere. They couldn't handle that with their business. And we picked what we thought were a significant group, that if they were going to help us get into any sort of economic performance by 2010, it would be this group here of R & D leaders who spent more than \$3 million but between 3 and 50 percent of their revenue in R & D. The amazing thing, it is a very small number of companies, but when we did the calculations – and you can see, they were growing on every parameter,¹⁵ and they were growing rapidly enough so that we figured they could get Canada into the top ten innovative economies by around 2011 or 2012. So it is a very marginal group, a very marginal kind of thing in terms of the goal we had but much better than I thought they would be.

These other two groups, the early stage and the startup companies, composed of about 6,000 companies all told, really are early stage and startup. And the thing about them is that over eight years that we studied them there was really not very much happening other than a whole lot of churn, like their sales didn't change very much. Their investment in R & D didn't change very much. Their employee numbers didn't change very much, but there was a huge amount of churn in the companies. In the 6,000, there was somewhere between 2000 and 2,500 that disappeared every year, and new ones replaced them. So there was churn, but there was less than 20 companies moving into the R & D leaders every year.¹⁶ My conclusion about that was that there is something very unacceptable about that behavior.

And so we ended up interviewing 30 companies, and we talked to CEOs because we wanted the visionaries, and we wanted the people who saw the big picture. So we interviewed 30 CEOs in the R & D leaders and 30 CEOs in the early stage and startup companies, and that taught us quite a lot. And some of the things that came through – and it came through from both the leaders and what we call the greenhouse group – was, number one, the culture of science and technology was strong. They were not concerned about their ability to do the technological and the scientific side of their enterprises. The second thing is that the culture of commerce for them was weak. I might

¹⁴ See *Canada's Top 100 Corporate R&D Spenders List 2003 Analysis*, RESEARCH INFOSOURCE, (2003), <http://www.researchinfosource.com/2003-analysis.shtml> (last visited Oct. 22, 2006) (stating that the start-up companies spend more on research than they earn in revenue).

¹⁵ H. Douglas Barber & Jeffrey Crelinsten, *Growing R&D-Intensive Firms in Canada: Views of CEOs in the "Greenhouse"*, THE IMPACT GROUP, 4 (2005), <http://www.impactg.com/pdf/20050501-01.pdf>.

¹⁶ *Id.* at 5.

say that in the startup group and that startup group of 2000 companies, it looked from our questioning that a thousand of them – in fact, I looked at some of them also on the internet, sort of confirmed that, about a thousand of them didn't have any sales.

The ones we talked to who didn't have any sales had a market in mind but couldn't name one customer, one company or one enterprise that they thought of or targeted as being a customer. So here we come with the customer word. Here we have got enterprises with no sense of who might buy what they do. So the churn is not surprising because that carried on in the early stage companies as well. Many of them were doing research and development, but research was a big thing for them, and they were financing it. And the CEOs were sweating it out all the time, getting the next round of financing to keep their research on the go with no customer in sight. So maybe the culture of science and technology was way too strong and the culture of commerce.

What we found as well when we talked to them was that the startup and early stage companies, the leaders had got a bit beyond this. They survived long enough and were doing well enough, generally speaking, to have gotten a more complete set of knowledge and skills together, to actually make a commercial enterprise operate. They actually were making innovation pay.

Innovation was costing for all the rest, and what they described was a real lack of skills; that there were whole parts that they – they started out with a half full basket on these innovations. And I might say that my impression of this is that we have real risk takers in Canada. These people took incredible risks, more than you can imagine, and I know that some of them have gone on and taken risks again, hopefully with a little bit fuller basket of skills and knowledge to do that with, and none of them, interestingly enough, said that financing was their number one issue. Many of them said that they struggled because financing was tough; interestingly enough, the ones that had the toughest job financing were doing the best.¹⁷ There were quite a number of them that said we got way too much money and spoiled us. We thought we had things going forever, and so the story of money, which often comes up when you talk to them, doesn't feature the same way at all. When we asked them about what the future was for their companies throughout this whole group, including the leaders, the long haul, they saw their future as selling the company,¹⁸ very different from RIM and I might say different from Gennum as well. That was never part of the objective at Gennum.

The other thing that comes out of the whole study is that it is clear that the encouragement that they get from governments is for science and for technology; it is not encouragement for commerce.¹⁹ In fact, there aren't any real

¹⁷ *Id.* at 14.

¹⁸ *Id.*

¹⁹ *Id.* at 18.

incentives or even pats on the back for commerce.²⁰ And the final thing that came out of this was that post secondary education provides very poor learning for human skills, which are needed in commerce, and we asked them about – well a number of them had MBAs, quite a few, and we thought that should have done it, and they said, no, the MBAs are just like taking a course in physics or in engineering.²¹ It is really about numbers and hard facts and all that kind of stuff.²² It is not about the sort of thing that you face when you have to start facing a customer.²³ So what that encouraged me to do was to go back and look at, well, why had Gennum been as successful as it was, and you get the right thing here, and I have drawn up here a model that I put together of Gennum's business process.

And it would be interesting to know how close this is to RIM's. I suspect RIM has a lot of parallel to it. The traditional view of innovation and commercialization, which I've put on this graph with the words "innovation" underneath "ideas and research," which is generally what's considered innovation and commercialization, is generally thought of as this business of manufacturing or making it and selling it.²⁴ That view of innovation does not fit Gennum; the innovation has to happen everywhere in this diagram, and we are a company that is set out with a philosophy of excellence.²⁵ We wanted to be an excellent company, which meant that we had to be compelling. That's why we couldn't tell if we were excelling if we didn't have over half of the business of the world in whatever we chose to do. But within the company, that whole business of excelling was something that was driven into the minds and hearts of every person that worked at Gennum; didn't matter what job you were in, you needed to benchmark yourself against people out there in other companies and other enterprises that were doing your kind of job and decide whether you were excelling or whether you were average or mediocre.

The thing I want to say about this diagram is that it starts with the customer. It starts with a need. Innovation is about meeting needs, where you are and with what you have. It is about improving life, and so it starts with somebody who has a need, and then you have to come up with ideas and solutions to meet that need. And if you are going to be in the competitive world, you have to come up with ideas and solutions that are better than the ones that are being offered by anybody else. And then you have to do the

²⁰ *Id.*

²¹ *Id.* at 1.

²² *Id.*

²³ *Id.*

²⁴ Jeffrey Crelinsten, *From Research to Commerce: Changing Our Priorities About Commercialization*, THE IMPACT GROUP, 4 (2005), <http://www.itac.ca/Archive/PolicyandAdvocacy/Innovation/05Jun20FromResearchtoCommerce.pdf>.

²⁵ *Id.* at 6-8.

development, the research and development, whatever it takes to get to a point where you have got a product or service that you can manufacture or put together in a way that you can take to the customers and distribute and deliver them.

Of course, the goal finally is to have a customer who buys and who is fulfilled and satisfied, whose life gets better because of what you've done for them. You have created value for them. And what we have found is that if you start out with ideas – and I can tell you that I lived in that world because I was culturally in it to start out with an idea that I thought would make a good thing. And I remember when I came to the conclusion that we just about finished all the development, that there really wasn't a market out there, it was a fantastic thing we did, but nobody needed it, and nobody wanted it. And what I had learned since then is that when you start with ideas out of a university research lab or something like that, even where they seem to have commercial potential, your chances of ever getting to successful commerce at any level is about 1 in 3,000.²⁶

Now, I can tell you if you are in the competitive world, Gennum typically starts with the customer feedback and the customer connections that we have, which are all human, they are nothing we learned in university or in college, other than inadvertently. When we start out on that basis, we consider that if we have a failure on one out of 20 projects that we start in this cycle we are verging on being uncompetitive. So having 1 in 3,000 versus having 20 or 19 out of 20 is a huge difference. You cannot be successful in an innovative commercial world with those kinds of statistics. The other thing I'd like to say is about the financing world, and things get really mixed up here, and that is in the end this whole thing needs to be financed by the money coming from the customers because money is simply a medium of exchange, and so you have to be able to exchange real value, or you don't get money moving in the exchange.²⁷ And when money does move, whether money comes from governments, banks, equity investors, venture capitalists, or whoever they are, they each have values that are very different from the needs of your customer.²⁸ And if you get money from them, you are going to have to deliver on that value equation; many of these people find that to be true and that value equation diverts them from successful commerce.²⁹

So those are some of the things that we learned from this exercise. I think I mentioned already that these CEOs we talked to, it is the first time in their

²⁶ See *id.* at 4 (noting that it is difficult to find companies to take academic ideas and push them into technology to solve problems for customers).

²⁷ *Id.* at 7.

²⁸ See *id.* at 1, 19 (stating that Canadian firms' growth is uninspiring due in part to the emphasis on financing rather than focusing on customers).

²⁹ *Id.* at 5.

careers that anyone had come to them and asked them about their business or how they got into it or what their problems were or whatever it was. So if you talk about national feedback, we don't have it in Canada, and so, let me see, I want to wind this thing up because I am running out of time. So coming back to that, innovation is what humans do to find new ways within their circumstances to maintain or improve their lives. It is driven by the desire to prosper, and I might say it is not possible to prosper and be self-sufficient; so we do have to trade, and to trade, we have to specialize to create value that we can deliver better than anyone else in exchange for value from them.³⁰ The innovation of technical research and development is not enough for prosperity, and I want to say that again. The innovation of technical research and development is not enough for prosperity. In Canada, our governments think all you have to do is invest more in research and all good things will flow; not true. There are many human needs and values on the objective non-technical level and on the subject of experiential level that must be met for success. In Canada, our educational programs do not provide this learning.³¹ That is our biggest cause of failure in the knowledge-based economy – and I suspect that even though the United States is close to the best in the knowledge-based economy of the world – it also has a huge opportunity in this space.³² Liberal learning on which specialization is chosen has been lost in North America, maybe to a large extent in the world. We have narrowly educated, not broadly learned, people. That impacts innovation into an incomplete process that often fails. The solution is at the beginning, not at the show stopper, but it is difficult to embrace. So I get back to David Crane's thing. It is about how we learn right from the very beginning, and incidentally, it explains that on that research, which is a very, very narrowly focused kind of specialization, that it is both a valuable thing and a very damaging thing because research can very much unbalance the learning environment in which our young people and ourselves develop, even in the ongoing lifelong learning.

So there is a quick view from the Gennum perspective of what it takes to make innovation a success.

DR. KING: Cyndee, would you introduce Craig Maxwell?

³⁰ *Id.* at 1.

³¹ See Janet McFarland, *Education System in Spotlight; Delegates Propose Creative Thinking; Innovative Teaching as national strategy*, GLOBE AND MAIL, June 28, 2002, at B4 (stating that Canada education system should focus more on creativity and not put as much emphasis on research and development).

³² See, e.g., Greg Main, Editorial, *Innovation Becomes Enterprise*, THE OKLAHOMAN, Sept. 4, 2005, at 17A (explaining the opportunity for Oklahoma, a traditionally agricultural-heavy part of the United States to play a larger role in the knowledge based economy by encouraging innovation).

MS. TODGHAM: I did introduce Craig Maxwell. While we are getting up, I can say a few more things about Craig. What I didn't comment on earlier was Parker Hannifin's core competency is in motion and control technologies, and now we get to learn more.

UNITED STATES SPEAKER

Craig Maxwell[†]

Good morning, ladies and gentlemen. Thank you for inviting me to come speak to you.

So what I'm hopefully going to give you a glimpse of this morning is not so much the problem but potentially the solution to some of the challenges you have discussed over the last two days, specifically inside of a large organization, Parker Hannifin.

A little bit about myself: I graduated – I was not the great student that you might imagine I was. I graduated in the half of the class that made the top half possible, and I didn't hit my stride – I didn't really find my passion until I got out into the work force, and in 1981, I graduated. And I have held every position inside the engineering department, starting at the bottom, which I used to chase parts around the factory floor for the prototypes, and then rose to the position I am in now, which in most organizations is referred to as the chief technology officer, and that for me was a great education because I got to see it all. And I have great empathy for what happens in the organization, and quite frankly, no one can pull the wool over my eyes because I have had all the jobs. I know what it takes, and so it gives me a great position to speak to the masses inside of Parker-Hannifin.

So if you thought I was going to speak specifically to the technology that happens inside of Parker-Hannifin, it is impossible to do that because it is so large. My job is involved in four things: I work in the process of innovation, I work on the resource for innovation, the infrastructure, and last but not least, and probably the most fun that I have, is to do culture that fosters innovation. Douglas mentioned it a moment ago, the biggest challenge we have is in separating what innovation really means and what it is. I have heard someone

[†] Craig Maxwell is Corporate Vice President of Technology and Innovation at Parker Hannifin. His responsibilities include leading Parker in new and emerging markets that complement Parker's core competency in motion and control technologies. In addition, Mr. Maxwell will be responsible for helping divisions implement the "Win Strategy," specifically in the areas of innovative products and expanding systems solution expertise worldwide. Previously, he held a number of engineering positions with Stanadyne Corporation's Diesel Systems Group, including development, project, staff and chief engineer assignments.