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Chair

Mr. David Sweet

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● (1105)

[*English*]

The Chair (Mr. David Sweet (Ancaster—Dundas—Flamborough—Westdale, CPC)): Good morning, ladies and gentlemen. *Bonjour à tous*. Welcome to the 44th meeting of the Standing Committee on Industry, Science and Technology. We are beginning our study on the state of disruptive technologies. We have some very distinguished guests in front of us here to give us some information in that regard.

From the National Research Council we have Danial Wayner, vice-president of emerging technologies, and Duncan Stewart, general manager of security and disruptive technologies. From the Natural Sciences and Engineering Research Council of Canada we have Kevin Fitzgibbons, associate vice-president of corporate planning and policy, and from the Social Sciences and Humanities Research Council of Canada, we have Ted Hewitt, president.

Why don't we follow the order that's before us? We'll begin with Mr. Wayner for his opening remarks. Of course, gentlemen, I think you know how it works, but once you do your opening remarks we'll go to a rotation of questions.

Colleagues, we're going to go in camera for the last 10 minutes. We have some quick business to do at the end, just to give you a heads up.

Please go ahead, Mr. Wayner.

Dr. Danial Wayner (Vice-President, Emerging Technologies, National Research Council of Canada): Thank you very much, Mr. Chair.

Good afternoon. My name is Dan Wayner. I am vice-president for emerging technologies at the National Research Council of Canada. I have with me Dr. Duncan Stewart who is our general manager of the NRC's security and disruptive technologies portfolio. I am pleased to be here on behalf of NRC to talk about disruptive technologies today.

NRC is Canada’s research and technology organization. RTOs, as we call them, are market-driven organizations whose primary job is to develop and deploy technology. In a way, we act as a link in the innovation system by stimulating business investment in R and D, adding value to research investments, reducing risks, and in many cases developing market-focused technologies in our research facilities across Canada.

[*Translation*]

The NRC has more than 2,000 employees working in research and development. They are experts in a multitude of scientific and technical fields and they are equipped to respond to the current and future needs of Canadian industry. The NRC is able to quickly put together multidisciplinary teams to help people in industry to overcome any difficulties they are facing. These may be in meeting urgent short-term needs or in establishing basic knowledge and technology that will allow them to tackle new markets.

[*English*]

NRC has a track record in advancing and delivering technology solutions in collaboration with Canadian industry. Some of the examples include flying the world’s first civil jet flight powered by 100% biofuel; pioneering the Internet in Canada; launching the world’s first national optical R and D network; inventing 3-D laser scanning technologies that are now used extensively by the film industry; medical breakthroughs, including an infant meningitis vaccine, the world’s first cardiac pacemaker, and the first medical isotopes for use in nuclear medicine; and inventing the fastest lasers in the world with light pulses now approaching a billionth of a billionth of a second.

[*Translation*]

As Vice-President of Emerging Technologies, I have as one of my duties to make sure that the NRC's long-term investments in science and technology are focused on the technological issues that may threaten or stimulate Canada's economy or improve the lives of Canadians in the next two decades.

In order to do that, we are implementing and supporting certain capabilities, by which I mean expertise and research and development platforms in various fields, such as high-volume data analytics, quantum technologies, optical technologies and nanotechnologies, to mention but a few.

[*English*]

The term disruptive technology typically refers to a technology that creates a profound, discontinuous change or quantum jump in capability or cost performance. It is important to understand the impacts are economic and social, affecting how we live, work, and communicate. We are really talking about disruptive innovations. I want to introduce that term. The technology in itself is not disruptive until it is deployed into the marketplace and used.

There are many examples from the past of how technologies or combinations of technologies have driven disruptions. The discovery of the double helix in the early 1950s was transformational for science, but not disruptive. However, combined with rapid DNA sequencing, proteomics, and big data, we find ourselves in the early days of personalized medicine, which we believe will be disruptive. The transistor led to the demise of the vacuum tube industry, which might be considered a disruption for that industry, but combined with the laser, fibre optic data transmission, data analytics, and business innovation, we have e-retail. E-retail is truly a disruption in economies today. In the more recent past we could look at smartphones, a Canadian invention, as an example of a technology that has had a huge economic impact and has driven societal changes.

The idea of a disruptive technology or innovation is not about the technology itself, but about the impact it has on our lives. Will the self-driven car be a disruptive innovation? Maybe, but we won't know until it's developed and deployed and we actually see the impact it will have on the way we work and live.

● (1110)

[*Translation*]

What will Canada need to continue its influence in the development and deployment of the so-called “disruptive”, that is to say revolutionary, innovations of the future? Identifying the innovations that will get to the finish line is difficult, but choosing the right race to enter is even more so.

When we know that we are in the right race, it will be easier to establish which technological platforms we really have to have in order to clear the track for those innovations.

[*English*]

I want to focus on a key ingredient. We're here in part to talk about what it is going to take for Canada to be competitive in the development of potentially disruptive technology, and the key ingredient for me is collaboration.

A well-organized innovation system can be like a professional hockey team. There are a number of players on the innovation landscape, universities, RTOs like NRC or CNL, for example, and others at the provincial level, all of whom have a role to play. The goalies don’t try to score goals, the right wingers don’t try to do the left wingers' jobs, but we do back each other up when it's needed. In the absence of collaboration, the innovation system feels like kids’ hockey, if I could use that analogy; that is, we all chase the puck and we end up competing with each other instead of organizing ourselves to win the game.

There are, in fact, examples of collaboration excellence in Canada focused on disruptive innovation. I'll refer to just one, and that is the quantum computing public-private partnership, which is really centred in Waterloo. It's a tremendous example of technology being driven by a vision of the future. In my view, collaboration between universities, RTOs such as NRC, and industry is the key success factor. In one direction, emerging science can lead to new technologies that have the potential to address market opportunities, but looking in the other direction, industry knows where the market opportunities actually are and has the opportunity to influence the direction of S and T.

RTOs like NRC have the capability to be the link, taking emerging science ideas and integrating them into new technology prototypes and processes. When it works well, it's a virtuous circle with industry motivating scientists to address key knowledge and technology gaps, and scientists working with industry to integrate emerging technologies into their products and processes, thus giving them the competitive edge in a global market.

As an RTO, how is NRC supporting Canadian industry to develop disruptive technologies? The NRC's printable electronics program is a good example of an initiative to foster a new industry ecosystem for Canada. Printable electronics is an emerging, advanced manufacturing technology, really part of an additive manufacturing family that's enabling lower cost digital fabrication of electronic devices. It has the potential to be a key component to enable potentially disruptive innovations such as the Internet of things.

The program is integrated into an industry-driven printable electronics consortium that was launched in 2012 and has company members from across the entire value chain. The consortium sets the R and D priorities, and NRC carries out R and D in collaboration with the industry partners on technology demonstrations that de-risk the advancement and deployment of the technologies. The goal is to catalyze a globally competitive pivotal electronic sector in Canada. To date, 11 technologies have been developed in collaboration with NRC that have been transferred to Canadian industry to commercialize PE products.

One of our licensees, Raymor Industries from Boisbriand, Quebec, won the award for the world’s best new material at the IDTechEx USA 2014 conference, which is the world’s largest printed electronics conference and trade show. The material, now marketed by Raymor, is the highest purity semiconducting nanotube ink to be commercially available today, a potentially disruptive innovation for the flexible electronics industry.

Another example comes from the National Institute for Nanotechnology, a collaboration between NRC and the University of Alberta. We have collaborated together for some years, working at the cutting edge of nanotechnology. One of these collaborations has led to the creation of a new company, QSi, to develop and commercialize a fundamentally new approach to atomic-scale, ultra-low-power computing circuits and devices that are faster than existing devices while consuming orders of magnitude less power. NRC’s role was to take a concept developed at the laboratory and demonstrate the possibility of being able to scale this up into a manufacturing process, a critical milestone to attract investors.

In closing, I'd like to reiterate that Canada is well positioned to be a major player in the development and deployment of potentially disruptive technologies. Collaboration across the innovation landscape is key, bringing together universities, RTOs such as NRC, and industry to ensure that we have a robust innovation pipeline focused on Canadian and global opportunities.

Thank you very much.

● (1115)

The Chair: Thank you very much, Mr. Wayner.

Now on to Mr. Fitzgibbons.

Mr. Kevin Fitzgibbons (Associate Vice-President, Corporate Planning and Policy, Natural Sciences and Engineering Research Council of Canada): Thank you, Mr. Chairman, for your warm welcome. Thank you, members of the committee, for your invitation to speak here today.

[*Translation*]

I am very pleased to be here to present information in support of the committee's recently launched study on the state of disruptive technologies in Canada. This is certainly an important subject worthy of serious study.

[*English*]

In the time I have been allotted I wish to talk more about how NSERC perceives and defines disruptive technologies. I would also like to discuss the role NSERC plays as Canada's largest investor in discovery research and as an enabler of partnerships with industry that ultimately contribute to the development of enabling disruptive technologies.

When it comes to defining disruptive technologies I think the committee received an excellent primer earlier this week with the presentation by Industry Canada, and my colleague, Danial, of course, has also done a good job of that.

[*Translation*]

I had the opportunity to review this material prior to my appearance before you today and, as was pointed out, a single, standard definition of disruptive technology is lacking. Whether it's McKinsey, the World Economic Forum, MIT or others, there was no consensus on those technologies that would be the most disruptive.

But, looking at the list, I did see several common areas that, because of the breadth of research that NSERC invests in, we are very familiar with.

[*English*]

For example, we support the technologies that relate to how we access, manipulate, and represent information, such as secure computing; technologies that relate to how we power the world, such as new battery technologies, and new renewable sources of energy, for example solar cells that are capable of capturing the full spectrum and energy of sunlight; and technologies that relate to how we build the world, such as advanced materials, including nanomaterials which, again, you've heard about earlier today, additive manufacturing, and 3-D printing.

At NSERC we view disruptive technologies more as the application of the discoveries that have a transformative impact, and less on making guesses about which technology will trade or how the business is done.

NSERC has a major role to play in this process. To begin with, disruptive technologies start from a foundation of discovery research. By discovery research I'm referring to research generally taking place in a non-industry setting and focused on a question or problem that has interest from a purely scientific perspective. It is discovery because the knowledge created is literally a world first

What makes the findings from this work disruptive is when someone else looks at this information in the context of a problem they are trying to solve with a possible application in mind. Context is everything and suddenly there is a new and potentially better way of doing something.

If we think about 3-D printing, this came out of fundamental work on photocurable liquid polymers. In other words, being able to use light to harden plastics. The innovation was to develop a better way to apply computer control to draw 3-D parts, layer by layer. One of the key reasons we see so much attention to 3-D printing at the present time is that the basic patents have expired, meaning that we are seeing lots of lower-cost competitors entering the market.

To get back to NSERC, our vision is to help make Canada a country of discoverers and innovators for the benefit of all Canadians.

● (1120)

[*Translation*]

NSERC funding fuels 11,300 professors working across numerous fields. This is an incredibly productive, inventive and world-class workforce that consistently delivers discoveries. Our president, Dr. Mario Pinto, calls this Canada's brain trust.

If we look back to some of the areas labelled as disruptive, such as new manufacturing technologies, discovery investments by NSERC are clearly in the picture.

For example, if we examine data from our discovery funding program for the past 10 years, the program that supports purely curiosity-driven research, we invested in approximately $425 million in manufacturing-related nanotechnology research programs by Canadian researchers.

[*English*]

We invest in programs to drive innovation. We are helping industry to use these world firsts in knowledge to drive R and D and to create new firsts in the marketplace. By doing this, NSERC plays a key role in adding value to knowledge and reducing the overall risks of innovation. It's a very client-driven approach that has led to over 3,000 partnerships between industry and the research sector annually. With these partnerships, we are creating the time and space to establish the context that I mentioned earlier.

If the catchphrase for discovery is "eureka" then perhaps a corresponding name for invention is "I hadn't thought of that before."

As I conclude my remarks, let me say thank you again to the committee for the opportunity to present this information. I look forward to your questions.

[*Translation*]

Thank you.

[*English*]

The Chair: Thank you very much, Mr. Fitzgibbons.

Now to Mr. Hewitt.

[*Translation*]

Dr. Ted Hewitt (President, Social Sciences and Humanities Research Council of Canada): Good morning, Mr. Chair, and thank you.

[*English*]

On behalf of the Social Sciences and Humanities Research Council, I want to thank you and the committee members for the opportunity to appear before you today with respect to additive manufacturing and other disruptive technologies.

[*Translation*]

At SSHRC, we recognize the enormous potential that these fields possess in terms of stimulating the Canadian economy.

[*English*]

lt goes without saying that they create jobs and exports. When I think in terms of using 3-D printers to create custom-fit hip replacements, it's clear they can also improve Canadians' quality of life. At the same time, the rapid development of technologies like 3-D printing and robotics is generating the need for a better understanding of the economic, social, environmental, and legal implications of their adoption and use. More importantly, it can be argued that their very adoption depends on these implications. We know very well that early adopters generally have the competitive edge, but the flip side is that early adopters also face great uncertainty and risk, and their apparent advantages can be short-lived.

[*Translation*]

Societies adapt to rapid technological change best by understanding its impacts, capabilities and complexities. Social scientists and humanities scholars are uniquely positioned to address these issues with made-in-Canada solutions.

[*English*]

By that, I mean they bring critical and creative thinking to complex issues such as disruptive technologies. At SSHRC we understand that government, industry, and academia must work together to advance disruptive technology but also to embrace its enormous potential. With the launch of its renewed partnerships funding opportunities, SSHRC has reinforced its commitment to the power of all types of collaborations—multi-sector, multidisciplinary, and multi-institutional—to bring intellectual, cultural, social and economic benefits to Canada and to the world.

● (1125)

[*Translation*]

In our 2013-2016 strategic plan, SSHRC has identified multi-sector partnerships as an area where potential exists for improved and enhanced participation, development and sharing of best practices, and communication of results and impacts among a variety of stakeholders.

[*English*]

Multi-sector partnerships engage the users of research in the design and implementation of research projects at the start, thereby increasing the potential for that research to contribute directly to innovation in the public, private, and not-for-profit sectors.

For example, take Aaron Sprecher, assistant professor at the school of architecture at McGill University and recipient of a SSHRC partnership development grant. Dr. Sprecher's laboratory for integrated prototyping and hybrid environments is helping to change the ways architects design, collaborate, and build. Working with an interdisciplinary team, as well as with external partners and companies, his work is advancing innovation in design, optimization process, the performance of materials, and fabrication. lt is a game-changing initiative with the end user in mind. Moreover, SSHRC-funded graduate students, whose research includes 3-D printing and additive manufacturing, are aligned with interdisciplinary practices in architecture, fine arts, and historical studies.

[*Translation*]

For example, François Leblanc is a doctoral candidate funded by SSHRC. He is exploring how 3D printing facilitates the design and production of complex and optimized structures that were inconceivable not too long ago. He is also looking at how this technology effectively optimizes the amount of material used in construction with a precise distribution of materials.

[*English*]

SSHRC's partnership with Mitacs will also continue to support the development of talent through support for internships for social science and humanities graduate students with both industry and community organizations. Further opportunities to provide training opportunities for students with industry involved with additive manufacturing can be explored to help Canadian businesses become more innovative, competitive, and productive.

[*Translation*]

At SSHRC, we recognize that dynamic new technologies are enabling, accelerating and influencing deep conceptual changes in the research environment, the economy and society.

[*English*]

As such, in collaboration with NSERC, CIHR, as well as with CFI, Genome Canada, and NRC, SSHRC has also been leading the creation of a new policy framework to address digital infrastructure challenges. The policy, which is being developed with the extensive engagement of multi-sector stakeholders, will enable best practices to manage and to grow the digital ecosystem required to meet 21st-century research needs, and thus contribute to Canada's social and economic prosperity.

In the absence of a standard definition, disruptive technology may perhaps be best described as lying at the intersection of various fields of research. In this regard, SSHRC will continue to explore opportunities to continue its efforts, and to coordinate its efforts, with federal agency partners as well as with the research community, industry, and organizations to create an enabling environment that advances research and the development of talent in this area.

[*Translation*]

I might add that these efforts are particularly well aligned with SSHRC's Imagining Canada's Future initiative, through which we are seeking to advance the contributions of the social sciences and humanities to future societal challenges and opportunities.

[*English*]

Following a comprehensive two-year exercise, six future challenge areas have been identified for Canada in an evolving global context that is likely to emerge in the next five, 10, 15, or 20 years.

The issue of leveraging digital technologies for the benefit of Canadians is one of those important challenges for SSHRC. This includes the need to understand the opportunities and risks associated with the adoption of emerging and disruptive technologies, as well as the need for effective training and tools that would maximize their utilization and enable equitable access to them.

In fact, emerging technology and how best to take advantage of it is the subject of a knowledge synthesis grant opportunity that SSHRC will be launching this fall. This funding opportunity will help our state of knowledge about emerging technology, as well as identify gaps in our knowledge and the most promising policies and practices related to it. More than ever Canada needs social scientists and humanists to focus on these matters.

In closing, a key point I want to emphasize is that in and of itself technology—disruptive or otherwise—is largely neutral. At the end of the day, innovation is a human endeavour. Technology is critical, but what makes it sing are the value-added elements that largely come from the research we fund at SSHRC—design, business planning, marketing, content, and training. To this end, SSHRC is focusing its efforts to encourage and promote research, talent development, and the mobilization of knowledge in this area, and we will be closely monitoring and assessing research capacity and the range of insights that are being developed across all our funding opportunities.

● (1130)

[*Translation*]

Thank you for this opportunity to discuss what SSHRC and its research community can bring to this important issue.

[*English*]

I'd be happy to answer questions you may have.

Thank you very much.

The Chair: Thank you very much, Mr. Hewitt.

Colleagues, if you will allow me to be relatively disciplined on the time, I think we can get eight minutes each and still get the business in at the end of the meeting.

Please go ahead, Madam Gallant.

Mrs. Cheryl Gallant (Renfrew—Nipissing—Pembroke, CPC): Thank you, Mr. Chairman

First of all, I'd like Dr. Wayner to explain the role the National Research Council played in developing medical isotopes, which he mentioned in his opening remarks.

Dr. Danial Wayner: In fact, NRC was the site of generating the first sustained nuclear reaction, and the work we did led to the initial creation of AECL.

We also pioneered work many years ago to demonstrate the creation of isotopes, which led to the creation of another company, Eldorado Nuclear, which eventually has led to the industry that we now see. It's largely done through Nordion, and with the support of AECL, now CNL. This was many years ago, but it was work that was started at NRC, and then organizations were in fact eventually spun out of NRC and took on lives of their own.

Mrs. Cheryl Gallant: Did NRC play a role in the initial pile reactor, the NRX, the NRU?

Dr. Danial Wayner: To be honest with you, that goes a little bit beyond my specific knowledge.

What I do know is that, as I said, the first sustained nuclear reaction was demonstrated by NRC, which actually led to the innovations that eventually became nuclear-powered reactors.

Mrs. Cheryl Gallant: You described this as a disruptive technology. Was there a lag time in commercializing the medical isotope aspect, which you referred to, from the point where it was discovered that it could have medical use to the point that it was actually commercialized? Did we have the people with the skills in place to further that along?

Dr. Danial Wayner: That's actually a really interesting question. I'm going to take the risk of generalizing my answer because to me it's really fundamental to understanding that inventions lag the innovations sometimes by decades. The double helix was actually discovered in 1953. It was 75 years before we actually pulled together the knowledge that we gained from that information into industries that I think will revolutionize health care in the coming decades.

As I said, I'm not deeply knowledgeable about what happened in the fifties around the nuclear industry, but we see the same issue with the transistor, which was first discovered in the forties. The solid-state revolution, as we called it, was actually in the sixties, 20 years later. The creation of the first computers, the first XT computer landed on my desk in the early eighties.

So there is a lag, and the lag really depends on the types of technology, but there's also the issue that in fact it isn't one invention, it's actually the bringing together of many inventions that lead to new innovations. As I mentioned before in terms of the disruption of e-retail, it comes from the transistor, from the laser, from optical telecom, from analytics. There are a number of advances in our knowledge that have come together.

I wanted to address what you were asking about in terms of skilling, because it is true that in many cases disruptions lead to significant economic changes, which require a re-skilling of our workforce. I was having a conversation with one of my provincial colleagues recently where I asked the question, “What are we doing right now about the likelihood that in 20 or 30 years factories may not employ very many people, or if they do they won't clearly have the same skills that people have today who are working?” I think we need to get ahead of that. I think we need to not just think about invention and technologies leading to innovations, but in fact we should be thinking holistically about what we are doing about re-skilling our workforces. What are the types of skills they'll need?

I won't go on too much longer, but only to say there's always a lag between invention and innovation. If the innovations are truly disruptive, it often means that in fact we need a re-skilled workforce in order to really take advantage of it.

● (1135)

Mrs. Cheryl Gallant: Does your department communicate with departments involved in human resources to let them know what sorts of skills may be looked at and needed on the horizon?

Dr. Danial Wayner: One example is, in fact, the digital economy strategy, which really has an innovation component, a content component, and a skills component, where it's recognized from the beginning that if we really want to capitalize on the advent of new big data and analytics applications we need to have all of those working together. Of course, when I talked about collaboration, what's critical is to recognize that in the team that I talked about we don't want to be a kids' hockey team, that we work with universities who are, as Kevin Fitzgibbons was saying, a source of creativity, new ideas, and invention.

NRC's role is to be able to take ideas that are really demonstrated in the laboratory and incorporate them, integrate them, into technology demonstrations and applications, and then to work with industry to ensure that we actually understand where the market opportunities are. All three components of the innovation system ideally need to be working together if we want to really optimize our ability to capitalize on technology disruptions.

Mrs. Cheryl Gallant: In your opening remarks, you didn't say “isotope”; you said “isotopes”, plural. What other medical isotopes are you aware of that were discovered, and still used today, in terms of NRU in the background?

Dr. Danial Wayner: What I can say is what I know about medical isotopes isn't very deep.

NRC participated, for example, in some of the projects to find new non-nuclear sources of technetium-99. We just happened to have some in-house expertise that allowed us to collaborate with Canadian Light Source, in this case. There are a number of organizations from across the country looking at the same thing. That was very much more opportunistic, from our perspective, because we had in-house expertise in nuclear science and technology.

Mrs. Cheryl Gallant: In addition to the medical isotopes, you very well know that there are non-medical isotopes, ones that are used to make computer chips more robust and smaller, as well as tritium, for the back lighting on some of our non-Apple watches.

Are you aware of any disruptive technologies that will take the place of the NRU, the National Research Universal reactor? As you know, it has far exceeded it's expected life, going on 70 years, but we'll still need to be able to move neutrons out of atoms.

I'm wondering whether or not there's anything you're aware of on the horizon.

Dr. Danial Wayner: It's really hard for me to comment on that. I certainly don't have the expertise. I would really prefer to refer you to my colleagues at NRCan, who are really the ones who are thinking about this on a day-to-day basis.

The Chair: Thank you, Mr. Wayner.

Thank you, Madam Gallant.

Now, on to Ms. Nash, for eight minutes, please.

Ms. Peggy Nash (Parkdale—High Park, NDP): Thank you to all of the witnesses for being here. I have many questions to ask.

Let me start off with something Dr. Fitzgibbons said. He said we have a world-class workforce and we have Canada's brain trust. I wanted to ask you about basic research. What is the climate like for basic research today in Canada? Because to me, that's the starting point, I guess. We don't know what we're going to discover until we actually find it.

Having this world-class brain trust, as you put it, to me seems incredibly important. Are we investing at a competitive level in basic research? Are we offering enough post-doctoral fellowships? How do we stack up with the rest of the world in terms of this important starting point, which is basic research?

Mr. Kevin Fitzgibbons: Well, thank you very much. It's a very fascinating question and one that I think had policy-makers in Canada and around the world asking similar questions.

In specific response to the level of research that is being funded in universities, I think within universities it's somewhat difficult to make a clean distinction of what is basic and what is applied. I believe earlier in the week when you heard from Industry Canada, it did make mention of the fact that although our business expenditures in research and development are not at the top of the list, if you like, our investments in higher education research and development are among the top, certainly in the G-7, as we call it now.

I think a very good example of the results of that and of where Canada stands in the world was a study released two years ago by the Council of Canadian Academies, called “The State of Science & Technology in Canada”. In that, they outlined fields where Canada is respected internationally, for example, in the publication of journals and their citations, the groundbreaking work. They came up and pretty much reinforced the message that Canada certainly does have some of the top research minds.

The concept that our president likes to point to is that it's not the individual researcher working at the University of Toronto, or UBC, but rather it's looking at it from the context of those 11,000 who have been doing this work over decades, and not just in Canada but collaborating internationally. I think that is a really key ingredient for moving forward.

In much of the research that NRC has referred to, it's quite often the researchers at NRC who have either been funded by NSERC in their academic careers or have collaborated with universities. It's a combination of things.

● (1140)

Ms. Peggy Nash: Okay. Do any of the other witnesses want to comment on that aspect of basic research and our initial brain trust in this area?

Dr. Danial Wayner: From my perspective, Canada actually produces, I think, a disproportionate amount of the world's knowledge. We have some of the best universities in the world. I think if you look at the report from the Council of Canadian Academies that talks about where Canada excels, we should be really proud of what we have as the brain trust.

I think where we struggled as a country is on the innovation side. That is, how do we actually capture the value of the knowledge that we're creating and also the knowledge created elsewhere in the world and turn that into social and economic advantages for Canadians?

Getting back to disruptive technologies, that's really the key outcome of being able to really understand where the disruption is, focus, and put something into the marketplace.

Ms. Peggy Nash: Let me just pursue that. Sorry, Dr. Hewitt, you might have wanted to get in on that.

Where are we falling down on that? I heard that maybe business isn't seizing opportunities as effectively as it might, and there are lots of reasons for that. What is the gap between this wonderful world-class pool of scientists and researchers and the transformation into successful innovation and effective businesses? What is breaking down there?

Dr. Danial Wayner: You know what? It would make all of our lives so much easier if there were an easy answer to that question.

Ms. Peggy Nash: I'm sure it's complex.

Mr. Kevin Fitzgibbons: I would say that you've really hit the core of the issue for Canada, nevertheless; and I think it's an issue that's been bedevilling not just this government but governments going back for several decades.

Also, as I'm sure this committee can appreciate, the nature of the Canadian economy has a lot to do with the level of research, development, and innovation. When we look at our exports and their trade, we do have a very strong resource-based economy that traditionally, in its own right, is not considered to be a performer of research and development. However, it is an adopter—in fact, a very sophisticated adopter—of information technologies, for example.

But I think, really, what you're getting at is something we consider to be an ongoing struggle, and that is connecting the two worlds closer together. Much of that can be done through the partnerships. At NSERC, for example, we have developed a number of programs that are not just pushing the technologies out to say that there's something really cool here that people in industry should be looking at, but having discussions with them about what their issues are, and exposing them to knowledge and connections where they could get the information and turn that into something much more effective.

But that comes in a whole ecosystem of other things. For example, people in the NRC's IRAP, the industrial research assistance program, will be working constantly with the small and medium-sized enterprises, in particular, to help them get to that point.

Our job at NSERC is on the funding side to ensure that, on the one hand, we have a very rich, diverse, and high-quality research base, and on the other, it is connected.

● (1145)

Ms. Peggy Nash: Yes, I would like you to answer this, Dr. Hewitt.

Dr. Ted Hewitt: Thank you.

I would just simply agree with much of what's been said. From the perspective of SSHRC and the social sciences and humanities, we tend to see the basic versus applied issue as more of a continuum. People do work that may be seen as very basic but then it leads to applications through others and the work of others. Some people do work that spans the entire spectrum.

We've designed our programs in such a way as to allow for individuals to seek funding at both ends of the spectrum and in between, whether that's through our insight grant program, more on the basic side, or through partnerships, more on the applied side.

One of the things I would add, though, just in terms of your question about innovation and impact, is that particularly in our disciplines it's very difficult sometimes to show what that impact is. In terms of work, for example, that may lead to policy change, that then becomes incorporated, and that then is taken advantage of within industry. It's quite often difficult to understand precisely what the pathways were. Personally, I would advocate for a bit more forensic investigation, in terms of working back.

I can give you a brief example of a disruptive technology that has a profoundly social science question attached to it, and that is that in the forestry industry it is now possible to build tall structures completely of wood. So you could build a 20-storey tower or a 40-storey tower, I think, completely out of wood. I'm not sure who'd want to live on the 39th floor, so it's a disruptive technology with no home.

Ontario has determined that now you can build a six-storey structure out of wood, so policy has changed, and that was as a result of research, undoubtedly. Perhaps on the safety side, that's reasonable. But the question is whether you would want to live on the 39th floor and what research would change Canadian attitudes about that, or not.

The Chair: Thank you, Dr. Hewitt.

I'm sorry. That's all the time you have.

I apologize to our witnesses. Certainly you should be addressed by your titles, and I'm sorry for any of those who have a doctorate that I did not recognize. I don't have it listed here, and I apologize for that. I always live by the axiom, “give honour where honour's due”.

Here is somebody who deserves honour, the honourable Mr. Regan. Please go ahead for eight minutes.

Maybe I should err on the side of caution and just say, “Doctor, Doctor, Doctor, and Doctor”.

Hon. Geoff Regan (Halifax West, Lib.): Thanks very much for being here this morning.

Dr. Wayner...?

Dr. Danial Wayner: Yes. It is in fact.

Hon. Geoff Regan: How about that. That's pretty safe.

When you're looking at a new technology, how do you assess it's potential to disrupt?

Dr. Danial Wayner: I need to go back to the challenge of recognizing that it's not a disruption, in my view anyway, until it's in the marketplace. I think it's okay to ask how do we understand the potential to either create a new market, or to displace technologies that are in an existing market. Normally the way most of the business assessments start is by asking if there is a market demand.

In the deck I presented there are a couple of diagrams. One of them.... Where we like to start is by asking: what are the market opportunities? If we understand market opportunities then we can ask what the technology gaps are that are preventing us from accessing those markets. If we understand the technology gaps then we can ask what the knowledge gaps are that are stopping us from inventing that technology. That's where the collaboration comes in.

One of the things I said in my remarks was that it is dangerous to try to pick the horse, but I think it's okay to pick the race.

When I say it's okay to pick the race, what I mean is that I'm reasonably sure there are going to be significant disruptions around the human-machine interface. I think artificial intelligence is one of those areas where Canada needs to build some good platform technologies because that's one of the places where we expect technologies to emerge that will be disruptive.

We can say the same for robotics and for additive manufacturing, with 3-D printing being one example.

When I look at the world, and if I look in the short term.... First you need to understand from the NRC perspective. We have work that is absolutely geared to support companies in the two- to five-year timeframe and sometimes even faster. We have work that is really in the midterm, although my particular division is trying to look a little more over the horizon. I learn from the markets that we currently understand, and that allows us to look forward and ask what the emerging market opportunities are.

That may be an indirect answer to your question. The disruptiveness of a technology has to do with our ability to think about how it's going to be used.

● (1150)

Hon. Geoff Regan: On the continuum line from basic to applied research, is it possible to identify an area at the point at which you're likely to be able to do that?

It seems to me that sometimes with basic research, and with discoveries in basic research, when you're trying to identify market opportunities, initially that may be difficult and it may take time for it to become clear.

One discovery that occurs to me in its development—where that may not be the case so much, I don't know—was the digital sensor for cameras. It took quite a while after it was first discovered—I think it was at MIT—before they started making cameras out of that. There may have been other discoveries that led to it that were key, but at that time were not.

That's the question about—

Dr. Danial Wayner: I want to refer to some of the remarks from Dr. Hewitt because he said at the end of his comments that in a way technologies are agnostic.

We develop a technology almost always because we see at least an opportunity for some low-hanging fruit. We don't always see at the time when we're developing the technology and it's being initially deployed how it's going to be used in the end. What is the killer application isn't always the first thing that we've done. It's almost never a single technology that leads to that killer application and disruption.

One of the challenges is that what we need to do is create the ecosystem and the environment that encourages the creativity to push new ideas out as far as they can. Some of them will die because it turns out that either the technology isn't viable or the market isn't there, and others will go forward.

I feel it's the ecosystem, the people in it, and the ability to identify and advance the state of a technology from an initial discovery in a laboratory all the way to a prototype that's integrated so that we can put into the hands of industry; that's what we need to focus on.

Hon. Geoff Regan: Dr. Fitzgibbons.

Mr. Kevin Fitzgibbons: I'll take it, but no, I'm actually a Mr.

Hon. Geoff Regan: We'll give you an honorary today, okay?

Mr. Kevin Fitzgibbons: I'll take it, honorary.

Hon. Geoff Regan: What do you view as the roles of applied versus basic research in the development of a disruptive technology?

Mr. Kevin Fitzgibbons: Well, I think it's important for us, at least from NSERC, to.... We tend not to use that kind of terminology because in many cases it's really up to the research itself as to where it goes and the course. That being said, and maybe to build on some of the discussions we've had earlier, our job at NSERC first and foremost is, for example, how to identify what's going on. Through the process of peer review we have 3,000 to 12,000 applications a year that come in from researchers around the country proposing ideas that they consider to be world class, ideas on science and knowledge that are above the grade. That's not only in Canada; we're talking globally.

The job of the peer reviewers, the people who understand those fields, is to understand whether they are actually working in areas that are exciting. Are they working in areas where there's growth? That's on the one side, and you need to continually have that because every other country in the world is doing the same thing. This is a constant of development that we can't miss out on.

The crux of the issue always comes down to how you apply that effectively. Again, we're back to the question of talking to those who are actually facing problems, be it market, be it social, and being able to say the knowledge that you have or the discoveries that you've made can help with what my issue may be.

Perhaps I may pick up a little bit on your discussion with Dan here about how you can tell when we're going to move to a disruptive piece. I think one of the things that is very evident here is that there's a price point. Probably the best example of that is in the information and communication technologies. Some of you may be familiar with what's called Moore's law, where the principle basically is a straight line—for every year there's a doubling in the power and halving of the price.

We're now into the third decade of Moore's law, and we're being able to do things that were unimaginable even two years ago. It's not only one little device that's involved. It's the whole knowledge that's come back and forth from the university community. Basic research, by the way, is not only done in universities. It is done in other institutions.

● (1155)

The Chair: Thank you very much, Mr. Fitzgibbons and Mr. Regan.

I was disruptive in the sense of messing up the schedule so it will seem like I'm playing favourites, but I'm not. It should have been a Conservative when I recognized Mr. Regan, so it will be two Conservatives now.

Mr. Carmichael.

Mr. John Carmichael (Don Valley West, CPC): Thank you, Mr. Chair, and I'm entirely forgiving of transgressions, etc.

Good morning to our witnesses.

I have several questions I'd like to embark on. I like the idea of starting with a definition. Both Mr. Fitzgibbons and Dr. Hewitt provided some definition and I liked Dr. Wayner's description of that hockey team. I have a young grandson who I've watched many times playing this season in a house league. You watch 10 little people chasing a puck into a corner and colliding, and everybody is on the ice and nobody is quite sure what to do. So I like the idea of finding a sort of foundational definition that we can work with to help keep us focused as well.

Both Mr. Fitzgibbon and Dr. Hewitt, I thought, took good stabs at that. I come from the car business and I remember back to my days long ago. You would visit the factory and you'd see models cutting clay. We're all very excited about seeing those models today; they're all developed on CAD or CAM today. You never see a clay model or you seldom see a clay model today. What was a seven to 10-year process, today is 24 to 30 months, and maybe even hours in some cases in terms of refinements and whatnot. So I find the definitions of applying these technologies interesting.

I wonder if the two of you could take a minute to expand or help us to synthesize the definition of where you would encourage us to embark.

Dr. Ted Hewitt: I think this is a very good question, and as you noted, it gets at something I talked about that I want to emphasize once again.

In this model that we tend to apply we think of basic research moving down a continuum to application. Then we ask the question about where the eureka moment lies.

What I want to suggest, and this comes back to something Kevin had said and Dan had emphasized as well, is that eureka moment quite often doesn't come from the scientist himself or herself. It may not even come from the research process itself, but from other members of the team so to speak, as you put it, who through their own lens have a look at a particular technology or consider some technology as disruptive through the lens of what a market might like, what might in fact generate significant interest from investors, what might in fact change the game completely.

That involves, and that implies, as you suggest, a team approach whereby scientists are working with social scientists and experts from business, economics, or anthropology, in order to develop those disruptive elements, because we know for example there are lots of technologies that wouldn't be considered disruptive until somebody gets the idea of how to make them disruptive. That speaks to Dan's point.

If you think about the automobile as a good example, a design is another key aspect of this. The automobile we currently know in some respects fulfills the same function as it has since the very beginning of its invention, for 100 years. In fact, apparently it doesn't even get much better gas mileage somebody told me.

But in terms of the design elements within the car, I would be willing to bet—you know the industry better than I do—most of the design elements have less to do with driving the car and more to do with the driver's experience. Whether your Bluetooth hooks into this or whether you can surf the web or how comfortable your seating is or how much attention you're paying to the road, or in my car, I have a system that will brake automatically for me in the event I'm not paying attention.

These things came from engineers but they also came from other social scientists, even humanists, who would have been able to provide the human aspect to the inventions or to the technology that was developed. It is a team effort, and it focuses on a lot more than the technology itself. The last point I would make, just to reiterate, is that quite often the disruptive element really comes from thinking about how these things are going to be used at the end of the day.

● (1200)

Mr. Kevin Fitzgibbons: I'll probably be saying very much the same thing but through a slightly different lens. I actually harken back to a couple of days ago when I read the presentation that was given by Industry Canada. They talk very much about disruptive as having a certain number of characteristics in terms of its impact.

First of all there is a market impact. Is it changing the way you do business or what you buy significantly? Does it put other people out of business? That's a disruption in the market. Is it changing the way people behave, for example to access to information both good and bad?

The second thing is that it's moving very quickly, and it's moving globally. I think if you're looking at it from an impact at those kinds of levels, I think it allows you to get a better feeling on how we're going to do that.

I'm coming back to the same thing that I think all three of us are saying. In and of itself, the technology is only a technology that does things. It's to do something, how and what. It is from the brilliance of innovation and innovators, but it's a neutral thing. It's just an advancing of things that get smaller, that are more intelligent.

How they are used...totally. The best example that struck me was the Arab Spring. They called it the Facebook.... No one could have possibly imagined that having these kinds of technologies in hand would have changed so significantly the course of history in many cases, in Egypt for example. We have no way. But certainly that was disruptive.

Mr. John Carmichael: Sorry, I don't mean to cut you off, but I know the chair's going to cut me off.

Dr. Wayner, in your opening remarks you passed very quickly by personalized medicine as being an area that will be disruptive. I wonder if you could expand on that thought a bit.

Dr. Danial Wayner: The genomics era allows us to understand the machinery that is responsible for our health, our welfare, and our well-being.

The initial views of personalized medicine are that, because we are mostly genetically the same but there are small differences, it's those small differences that change the way, for example, we would respond to a certain drug. If we could actually understand those to the point where your physician would be able to say, “You should take this therapeutic instead of that one because I know that this one you'll respond to and that one you won't”....

That's sort of the initial stage, and we're starting to see evidence of that now just from the sheer volume of genetic information we have. We hear about initiatives around the world like the $1,000 genome. You'd be able to map each individual's genome for $1,000. We're not there yet, but when we are there and when we learn how to mine the information—and I want to refer to Dr. Hewitt when I say this—and when we understand how we're going to manage that information....

There are huge social issues related to somebody else having my entire genome in their hands, but those are the types of advances we'll see over the next decade or two or three. I think that will fundamentally change the way we approach health care and wellness.

The Chair: Thank you very much, Mr. Wayner and Mr. Carmichael.

Now we'll go on to Mr. Daniel for eight minutes.

Mr. Joe Daniel (Don Valley East, CPC): Thank you, Chair.

Thank you, witnesses, for being here.

It's obviously been quite an interesting discussion.

My thoughts are that everything we've talked about so far are things that have already occurred. Looking forward into the future, what criteria do you think you should be looking at in terms of what the next generation of disruptive technologies would be, and how are they going to impact the research funding that we're putting into all these universities?

That's open to each of you.

● (1205)

Dr. Ted Hewitt: I think they'll have slightly different answers than mine, because I want to talk a bit more about process.

The kinds of things that I was talking about—design, the content piece, the things that really make technologies sing, that create the disruptions—quite often are not regarded in this society as research per se. It's quite interesting. If you think about design, I have this iPhone. It's my own iPhone, and it makes a great flashlight until you start to get into it and see what I have in there. I have books, movies, music, and a lot of cultural products and content. That all was added to the element to kind of make it sing.

Some of the research they do, and particularly within companies, for example, in marketing and international markets and design, quite often, is not recognized as research per se. I can bet you it's not counted as an investment in research by our public accounts.

I know for example—and this is without comment—that our industrial tax credit system does not count research that would be done for business planning or marketing or content or design as an eligible expense for a tax credit. I said I would say this without comment, so I would just suggest that we need to start thinking a lot more about these elements in terms of managing and promoting disruptive technologies, or creating disruptive technologies from technologies that one might not consider so, as viable elements of the research process, value them, fund them, support them, and value them in industry. I think that's going to take us down the road.

Mr. Kevin Fitzgibbons: Mr. Chairman, I know you can't plead the fifth amendment in a place like this, but I am going to say something that may be unpopular with some of the scientific community.

I think you're asking a very interesting question. My strong feeling, and that of others, is that the disruption is going to happen at the interface of disciplines as opposed to hyper-specialization in one specific discipline in itself.

I can give you an example of where it gets interesting. The big enabler for this is not just the computational biology, as you would call it. The application of computing into the biological processes has the potential for change and understanding to be accelerated at a pace that is really quite fantastic, and the importance for us is being able to have the processes in play that allow for that kind of interaction, where the really exciting unthought-of areas can explain themselves.

I think from our point of view, we want to reinforce strong basic science in the fields that they're experts in. I think also what we need to do is challenge that community to branch out, so if you're a physicist or a chemist, to work in other disciplines. The social sciences also apply to that as well. Certainly, there are debates in the community in that regard, but I do think it's something that probably is a bit of a game-changer in its own right.

Dr. Danial Wayner: I'll give maybe a different perspective. In the information I handed out there was a deck and there was a quadrant diagram with a bunch of circles on it. I'm not going to go through that, but I will just say that the horizontal axis in this, which really is trying to describe how I view the innovation landscape in Canada and around the world, has two extremes. One is the discovery end, where we would often find university research, and the other is the problem end. I think what we really need is to be able to get our heads around what the key problems are that we need to solve as Canadians, and which are the ones that have potentially technological solutions and for which we actually have no known solution yet.

We have an academic community that needs to stay focused in my view on the discovery side and we can't expect that every science or engineering problem that we tackle has to have a direct line to a problem to be solved, but we need that hopper of creative ideas so that we can actually start to connect the dots.

I am going to ask Dr. Stewart to talk a little about how we see the whole world of quantum information, for example, from the academic side compared to how we're looking at it from the problem side and what we're doing to try to bring those two things together.

● (1210)

Mr. Joe Daniel: Very briefly, because I have one more question.

Dr. Duncan Stewart (General Manager, Security and Disruptive Technologies, National Research Council of Canada): I'm a kid from Kingston. I spent 15 years in Silicon Valley and I came back to Canada. I also don't see this distinction between basic and applied.

To speak to Kevin's comments, I worked in a group that combined material science, computer science, electrical engineering, and physics to try to invent some new computer pieces at Hewlett-Packard, new components. But the key idea there is that it's only when you join together that scientific frontier work with the intention of delivering something, a new technology at the frontier of technology, that you can make progress.

In the case of quantum information, Canada has invested perhaps more than $300 million in generating scientific leadership and the question is whether we at a tipping point where this will go into a disruptive technology landslide in quantum technology. Waterloo is certainly one of the centres, so my goal is to partner, collaborate, in a hockey team, multiple passes of the puck back and forth. In the group in which I had the pleasure to participate in California, we produced scientific papers and patents at the same time.

Mr. Joe Daniel: Okay. I'm going to cut you off because I have one more question.

One of my questions is whether we are missing the boat a little here, because the common denominator seems to be money. All of these disruptive technologies will change and change the value of money to everybody, etc., but there are technologies that exist now that can be applied that could save us billions of dollars. Are we actually missing the boat there?

My example is fairly simple. If you take an insulin pump, it's quite expensive. It's great, but if you supplied everybody in Canada who is insulin dependent with an insulin pump, we could probably save billions in kidney failures and therefore kidney dialysis. I'm just using that as an example, but there have to be other existing technologies. What's your opinion?

The Chair: You have 20 seconds.

Dr. Danial Wayner: Okay.

From my perspective there's no question that we have to draw on the existing capabilities. In my view, you're asking not so much a technology question as a policy question, and I'm not really qualified to respond to that.

But from the perspective that there are technologies that currently exist and combinations of existing technologies that require a high level of ingenuity in order to be able to extract even more value from them, absolutely, we do that and we continue to do that. The R and D that we do is quite often to push the boundaries of the limitations of the technology that we know.

[*Translation*]

The Chair: Thank you, Mr. Wayner.

The floor now goes to Ms. Papillon, for eight minutes.

Ms. Annick Papillon (Québec, NDP): Thank you, Mr. Chair.

Mr. Hewitt, I was listening to you earlier and I fully understood your comments about the gap between invention and innovation. There is certainly something to be said about the importance of training and of resources, as well as the importance of having a strategy on how our resources must be used.

I am not sure if Canada really has the best leaders to do that. Certainly, we are missing something. Let me read to you from an article in the *Globe and Mail*. It reads:

[*English*]

> Canada is falling behind global leaders in R&D....

[*Translation*]

Let me quote the *Globe and Mail* again.

[*English*]

> Canada is the only developed country with an intellectual property deficit—meaning we spend more to acquire other peoples' technology than the world buys from us—

That's maybe a point.

> And most disappointingly, the private sector continues to underinvest, in spite of repeated warnings about the consequences. Business spending on R&D stands at 0.88 per cent of GDP, near the bottom among OECD countries.

I would like to hear more from you about this, because it seems there's no obvious sense of urgency. Maybe that's the problem here. That's probably something we should do.

I'll give you an example from the article:

> Taiwan, which spent half of what Canada did in 2002, now tops this country by nearly $3-billion a year.

There's probably something that should be done about this.

● (1215)

[*Translation*]

Dr. Ted Hewitt: I agree with you. That said, our organization funds research, so I am not sure we have the solution.

We encourage partnerships with industry. There are also internships and training under our Mitacs partnerships. But we do not control the activities of industries and companies.

However, in terms of training, I feel that we could do a little more to encourage that kind of entrepreneurship and that kind of commitment from students and researchers. What really counts, actually, is collaboration between sectors.

Mr. Kevin Fitzgibbons: We do recognize that there is a innovation gap. In Canada, the gap is a major one, to such an extent that the government established the Jenkins panel to address the issue. Your committee rightly refers to its report in your work on the issue.

In its report, the panel indicated that work must be done in various areas. First, the tax system and the way it is administered. Second, access must be much more closely linked to the market, an idea which will, in a way, be reflected by transforming the NRC. For NSERC, this means, without losing the richness of purely scientific inquiry, creating links to the programs we are conducting with industry.

For example, in 2009, the number of industrial partners with projects funded by NSERC was 1,500 companies per year. Five years later, that number climbed to 3,000 companies per year. We have put a lot of effort into adjusting our programming to create those funds.

In a way, I feel that you have touched upon the subject that is critical in this area, the labour force and the human resources. Those changes are made in people's minds. We are trying to do it more and more. With the emergence of Mitacs as—

Ms. Annick Papillon: Mr. Fitzgibbons, let's stay very specific and talk about investments in training. Do you really have anything there? This is not just about encouraging people to become entrepreneurs, and so forth. We need really concrete solutions.

Mr. Kevin Fitzgibbons: We organize project-based internships with companies. They are often short-term, but some are for a longer term. More and more, we are seeing the emergence of new organizations like Mitacs. That, specifically, is the main way that university internships with companies are funded.

Ms. Annick Papillon: An important point needs to be emphasized here.

Since 2011, the government has wanted to encourage companies to invest in research and development. We were just talking about how Canadian companies are underperforming in R and D. We have to admit that the results are not yet up to snuff. According to Statistics Canada, R and D investments by companies went from $16.5 billion in 2006 to $15.5 billion in 2014. When a government invests in applied research because its private sector is not doing so enough, it seems that two options arise. It either stimulates R and D or the private sector decides to spend as little as possible on it and to take advantage of government subsidies so that its own innovation costs are as low as possible.

In the light of those figures, therefore, would this not be the time to question the strategy once more? Would it let Canada be competitive enough internationally and also with the United States, our closest neighbour?

Mr. Kevin Fitzgibbons: I am not sure whether I want to monopolize this discussion or hand things over to my colleague Danial.

I will let Danial make a comment and I will come back to the topic later.

● (1220)

Dr. Danial Wayner: Thank you, Kevin.

I fully agree with what my colleagues have said previously.

[*English*]

The challenge of BERD is an interesting one because it's something that's been on our radar for many years. What will it take? It is partly a business culture challenge and partly a capacity challenge. From that perspective the transformation of NRC has been critical to be able to focus our expertise, resources, and capabilities on the needs of industry.

One of the opportunities there and one of the outcomes that we would see is that by helping industry in different ways.... When we're working with them on very short-term problems, they pay the entire cost of research. We're not doing it for nothing. By working with them and helping them solve problems it helps to build into their organizations a stronger culture of why R and D is important to advance the innovation agenda in their firms. We see at least a few examples of increased internal spending on R and D. We know, for example, generally speaking, for every dollar that a company would invest to contract R and D, they would spend $1 to $4 within their organizations on R and D.

The Chair: Thank you very much, Dr. Wayner.

I'm sorry. Time is always our enemy here.

We'll move on to Mr. Warawa for eight minutes.

Mr. Mark Warawa (Langley, CPC): Thank you, Mr. Chair.

Thank you to the witnesses for being here.

I think of the old adage “necessity is the mother of invention”. We may need to come up with a new adage because it's not often necessity. It's dreaming and research and being surprised at what we find and how these new technologies are then applied.

I'm not sure who touched on the lag. I think it was Dr. Wayner. The lag, in the examples you used, was a 20-year pause from when the technology was found to when we had an application. Mr. Carmichael talked about how we used to make clay models of cars and now it's all done digitally. Are we seeing generally a reduced lag time from discovery to commercial application?

Dr. Danial Wayner: My experience is, yes, we're seeing the cycle shortening.

The shortening of the cycle may well be driven by the technologies, for example, moving from clay models to being able to do digital CAD, sometimes in just hours. Also, from our deeper understanding of global markets and global market opportunities, we're very much more a global enterprise from the industry perspective than we were 50 years ago. That knowledge also drives the competitive cycle. The lag is shrinking. It's really important to understand that the lag between discovering a scientific principle and then understanding how to embody it into a technology is still longer than our ability to take a nascent technology and drive it into the marketplace. That part is getting faster. I think the time between discovery and understanding the technological implications is still longer.

Mr. Mark Warawa: In the field of science the collaboration that you referred to occurs within our own country but there's also international collaboration within the scientific field. How does Canada become leaders in the commercialization of those new technologies instead of being followers in using that technology?

Mr. Kevin Fitzgibbons: This is one of my pet pieces.

First and foremost, Canada by necessity does collaborate quite extensively internationally, at least at the academic level. It's partly because of the size of our country. It's natural recognizing that for most of that knowledge—and I think Dan made reference to it earlier on—we have 0.5% of the population in the world. We have 4% of the knowledge that is produced. In 2013, for the first time, more than 50% of published journals in natural sciences and engineering had a co-author from someone outside Canada. What's also interesting, however, is that the percentage with the United States, which has been our traditional collaborator, has dropped. That's saying that all of a sudden there's an explosion of new knowledge that's coming from places we never thought of before. It's primarily but not only from Asia. We're seeing a rapid rise, particularly with China and South Korea, of investments in cutting-edge research and development. We definitely need to be connected in a very serious way if we want to stay on that track.

● (1225)

Mr. Mark Warawa: Thank you.

What stands in the way of a safer way of using these new technologies, these disruptive or paradigm-changing technologies? Is it politics or ideologies? What is standing in the way of our remaining a leader? If you have a lag time, somebody else will move on more quickly. I'm going to use an example so you can understand the point I'm trying to discuss here.

It was highlighted that Canada is a natural resource rich country, and part of our economy is based on exports of our natural resources. We, I believe, are constantly looking at new, safer, and more sustainable ways of using those natural resources. Are there situations where there are safer and more sustainable ways to do things, yet they're not permitted to move ahead and be used because of politics or whatever? Can you elaborate on that?

Dr. Ted Hewitt: I'd be happy to. I'm glad you looped back to something I wanted to touch on.

On the safety issue per se, I could come back to the example that I gave with the Forest Products Association of Canada and their 40-storey wooden buildings. A lot of that is, again, simply research that will help us to better understand these issues and help to lead the public to accept, in fact, what that shows.

But one of the things I wanted to touch on was the way in which we still maintain a fairly linear sense of discovery to invention, innovation, and application. I just want to give you an example of how the world really doesn't look like that, and it touches on your question of what the gap is.

In my former life, I was the vice-president of research at a major Canadian university. I can assure you that in Canada there are likely hundreds and hundreds of patents for amazing technologies sitting on the shelves of Canadian university technology transfer offices and being maintained at some considerable cost.

These are a couple of examples. An inventor had a 360-degree digital camera—amazing. The other one was a hand-held 3-D digital scanner, so he just basically moved the scanner. This goes back to a comment that was made by Madam Papillon. Have those technologies been adopted? No. Why? They're clearly disruptive somehow in the imagination, but the problem is that these things exist as scientific advances without a business planning culture, innovative thinking, or market savvy that would take them where they need to go. Sometimes we talk about receptivity, risk-taking on behalf of companies, who just haven't taken them up.

That's not a perfect answer to your question, but in part my feeling is that the gap exists, not with the development of the technology and our capacity to do that, because I think we're eminently capable given the things that we've done; it exists with the individuals who have the savvy, the ability, and the risk-taking attitudes that can take these technologies and imagine how they can be used in order to succeed in the marketplace. That is a gap in this country.

The Chair: Thank you, Mr. Warawa.

Now on to Ms. Nash for eight minutes.

Ms. Peggy Nash: Thank you. I'm pleased to have another crack at questions.

I'd like to just continue on, Dr. Hewitt, with your comments. It sounds as though, from your perspective, we're doing a great job at generating technology, generating new possibilities, but somehow there's a drivetrain that's missing to get that actually into a useful contribution for our society and for our economy, and you're saying that the kind of work that you do is in fact trying to make those connections. It would seem to me that, for a lot of businesses, they won't know that a lot of this technology exists. They may not even fully understand they have a problem for which there might be a technological solution. That lack of connection seems to be key.

I was noticing that in your remarks you said that you've done a two-year exercise to identify six future challenge areas that have been identified in the evolving global context for Canada, and how we leverage digital technologies is one of them. It seems to me the digitization of our overall economy is going to increasingly be a major initiative. Can you talk about what you've learned from this two-year exercise and how possibly part of it can serve as that drivetrain that uses this technology effectively for our society?

● (1230)

Dr. Ted Hewitt: Absolutely. In part it's an exercise conceived to help impress upon Canadians from all walks of life the importance of the research that's done in social sciences and humanities for the future of our country.

In terms of the specific areas, the intention was to engage Canadians, researchers, and all of us in precisely the discussion we're having today. If you take digital technologies, for example, we've been having discussions around the importance of big data and how big data can be mined the same way as gold, or iron ore, or oil to the benefit of Canadians to create jobs.

Ms. Peggy Nash: Subject to the same ups and downs of commodity prices?

Dr. Ted Hewitt: Subject to the same ups and downs, but the exercise was very focused on encouraging that discussion. Some things have come out of that. With NSERC, CIHR, Genome, and others, we're developing a framework policy for data management that will include an open data element at the end of the day. When these policies are implemented, researchers from all of our councils, who are funded with federal dollars, will be required to make their data freely available after a period of time on open sites.

We think that will encourage the exchange of information for collaboration and research. The reuse of data will have profound effects on the way data is used by companies, by researchers, and by anybody, which we think will help facilitate innovative uses of that data once it becomes available. That's one way we've acted to put that into place, based on a future challenges perspective.

Ms. Peggy Nash: Thank you.

Dr. Stewart, maybe I can ask you a question because it sounds like you were coming at this from the other end, which is from a corporate perspective, and trying to marshal a number of different disciplines in order to solve problems within a company. Is it your sense we need to foster more of that interdisciplinary collaboration within companies in order to problem solve, but also to move forward and be as innovative as possible?

Mr. Duncan Stewart: Yes, thank you for the question, Madam.

Let me tell a short personal story. When I left school in Silicon Valley, the question was, “Are you going to work for me, or am I going to work for you?” That's what everyone asked, and that question was possible because there were so many different pieces of the system in place there. There was a knowledge base. There was the spirit that you can do it, a kind of Texan six-gun “we can do it“ attitude. There was ready access to venture capital funding. You knew it was just up the road. There were repeated examples of success, so you knew where to find mentorship. There were buyers for when you built your company. There were sellers who would sell you the infrastructure you needed to build that company. What I'm looking for in Canada are locations where those things come together within a specific field and with a specific technology focus. It's that interdisciplinary approach, not only on the technology side, which I spoke to, but as my colleagues mentioned, on the social science side as well. It's the market and the business side. It's that ecosystem.

There's no single answer and that's why I'm here. That's the problem I want to help with and contribute to in Canada: that innovation gap. I want every person leaving school saying, “Hey, am I going to work for you, or are you going to work for me?”

● (1235)

Ms. Peggy Nash: We hear a lot of discussion about hubs, about sectoral hubs and technology hubs. Is that the kind of approach you think Canada needs to engage in more? You could more easily foster that kind of collaboration by having all of those elements that you described in the air—it's all available to people—around higher education and research facilities, but also the practical business application of that research so you have that drivetrain for people going into the private sectors. Is that the kind of thing that you think we need more of?

Mr. Duncan Stewart: Yes. Can I phrase it as a *Jeopardy* question?

If I'm a young aggressive entrepreneur in biotech and—forgive me, my Toronto friends—I'm living in Toronto, the smartest thing I might be able to do is move to Boston. Okay? I want to know, to what question is the answer: “move to Toronto”, “move to Vancouver”, or “move to Montreal”?

Ms. Peggy Nash: You're not asking me to do an Alex Trebek hosting, or even make a joke of that.

That is our big challenge, yet we excel in all of those cities at so many things. Saying to the world, “This is where you need to come for this”, I think is part of our challenge, which again gets to Dr. Hewitt's—

Yes.

Dr. Ted Hewitt: If I might, one thing I want to point out is that these types of subjects are precisely the subject matter of much of the research in social science today. I would refer you to Professor David Wolfe, from the University of Toronto, who has done extensive work on clusters and hubs.

This research is generally available and the international examples are clear, so the questions are these: can we access it; how do we need to access it; and what can we learn from that? It is available.

The Chair: Thank you very much, Dr. Hewitt.

Thank you, Madam Nash.

Now we go on to our last questioner, Mr. Lake.

Hon. Mike Lake (Edmonton—Mill Woods—Beaumont, CPC): Thank you very much. It's great to have you all here.

I wrote down a whole bunch of notes and I have a whole bunch of different thoughts, and then Peggy, in her question, kind of threw me for a little bit of a loop.

I had the opportunity to meet with Jacob Barnett, a 16-year-old Ph.D. student who is on the autism spectrum, working at the Perimeter Institute. He has chosen to come up to Canada from Indiana and wants to continue working here.

I'm going to actually continue on Peggy's line of questioning before I get to some of my own.

Ted, we talked before about the Canada first research excellence fund and the idea of taking things that Canada is really good at and going from being one of the top in the world in an area, to being the best in the world. Maybe you could speak to the idea behind the fund, perhaps in the context of Peggy's question.

Dr. Ted Hewitt: Thanks, Mike. I think that's a great question.

This program is absolutely unique, in my understanding of the types of programs that have been established worldwide. But what's interesting here—and I will relate it back to the conversation we've been having—is that it begins with the starting point of Canadian excellence. It purports to fund those institutions and research at those institutions that is already very close to being world-leading, and to provide those elements through research funding that will allow these institutions to push across the barrier and take the lead globally.

It's a very broad program. It will fund people, some infrastructure, students for training, and knowledge transfer and commercialization. It's really a one-stop, one-shop shot for institutions that are close in terms of technology development, new practices, and different contributions that would put Canada at the lead, whether in the service sector or otherwise.

The first round was held this spring. We expect the results to be released sometime about mid-summer, and we have another major round planned for the fall. But it will be a game-changer for a number of Canadian institutions that are able to demonstrate not only their existing capacity but their capacity to now shoot for the moon, so it's a tremendous program.

Hon. Mike Lake: I'm going to stick with you, if I can.

It's interesting that, when we talk about disruptive technology and we use that expression, there seem to be different ideas of what the definition would be, and they're really hard to define, in a sense. I think of it as when you say, “Life is completely different because of...” and name some technology. Historically when you think of big things you think of the car, electricity, air travel, the telephone—the original telephone, not the BlackBerry, but then the BlackBerry modifying that, in a sense.

Then you have things like Google Maps, which is not necessarily in the same category but takes a paper map and.... I know we're going to have the opportunity to talk to witnesses from Google and maybe we can ask them about this, because it's fascinating when they talk about how they determine the traffic patterns so that you know which route to take, based on where traffic has slowed down and sped up. It kind of revolutionizes the way we travel in our vehicles and those kinds of things.

This is why I'm going to come to you, Ted. I'm going to ask a question based on my personal experience. If we're going to talk about things that change lives completely, we're talking mostly here about things as opposed to ways of dealing with things, like autism. I have a 19-year-old son with autism and I think about in the seventies, when Dr. Lovaas in the United States developed an intensive behavioural intervention for people with autism, which changed the way we thought about people with autism and the possibilities for them.

Given that you're representing the social sciences and humanities, could you maybe speak to that in the sense of the notion of disruptive innovation, perhaps, in those types of areas?

● (1240)

Dr. Ted Hewitt: Totally, and it's another great point because it's not always about technology. When we think of disruptive innovation, I tend to think of the market, things that are disruptive in the market and turn things on their head. Not all those things go anywhere. I don't know how many of you still have Beta tape machines at home. That was very disruptive, but it really didn't go anywhere. But the things you're talking about, Mike, if you think about it, you're right. Attitudes towards people with mental health problems have been disruptive in the sense that we now tend to view that differently than we viewed it in the past.

If you look at the effects of social programs over the years, support for the elderly, support for people with disabilities, these are in effect disruptive practices in the sense that they're changing attitudes and they're changing the ways that Canadians are participating in society significantly. So I think this is an important aspect to keep in mind, that these disruptions are occurring right across the entire fabric of Canadian society. Not all of them will make money in the sense that these are commercial ventures, but they could save money in terms of disruptive technologies that could reduce hospital wait times, for example.

I have a colleague who is working on a project that we just funded for bar-coding medical devices and pharmaceuticals. You may not know, but most are not currently bar-coded. They're not bar-coded. If you look at a dose of X, there's no bar code. Everything we buy in the store typically is bar-coded. Imagine how disruptive that would be to have everything bar-coded and therefore every dose and every medical device being able to be recorded and all the information there. It's hugely disruptive. I wonder on the commercial side whether that's going to make a huge difference but certainly in the lives of Canadians in terms of tracing dosages and tracing faulty medical devices and so forth it will be hugely transforming.

Thanks, Mike.

Hon. Mike Lake: I'm going to follow up on another line of conversation, talking about, in a sense, how when we're trying to organize ourselves we have—as I often say to students when talking to them—960 minutes every day that we individually have to invest and how we organize those 960 minutes is going to be vital to how we get the most out of our time.

In our world, we get a lot of balls in the air sometimes and it's easy to go in a whole bunch of different directions and then not really accomplish anything. Sometimes I think that's analogous to research in a sense. I go across the country and get the chance to meet researchers or innovative start-ups, and organizations that have unbelievable ideas. Then a few years later I'm looking back and nothing really came of them. It seems like there are thousands and thousands of them out there and just a whole bunch of balls in the air.

What do we do as a society, not just as a government but as a society, to organize ourselves to catch those balls, to keep track of them all, to try to harness that energy that's out there? I think this seems to be a big part of the challenge. It's not that incredible research isn't being done, but we're missing it. There's almost sometimes a cacophony of it and we can't make sense of it all.

Mr. Kevin Fitzgibbons: I'll take a crack at that. It's certainly a tough question to answer.

I think there's a cultural aspect to all of this. When you look at some of the countries that have been some of the most innovative in the world, maybe a very good example of that would have been Israel about which there's a book called *Start-Up Nation*. The truth is that they have no choice. If they want to survive in a very hostile geopolitical and even temporal environment, they have to innovate or they won't exist. We don't have that problem in Canada, I would say. I think that's part of the thing.

Are we too comfortable? I don't know. I don't think that's a fair assessment. But that drive in just doing that, being sure that spirit of entrepreneurship actually leads to something.... Quite often what happens with these companies when they go is that they do not have access to venture capital that's sufficient. They do not have access to markets that would be able to scale up and do what they do. I think that's very much a core element of what we do. I don't know if you can legislate that. You ask if it's a social issue. I do think that there is a cultural aspect.

● (1245)

The Chair: Thank you, Mr. Fitzgibbons. We've come full circle. Mr. Warawa was saying that it's a lot about dreaming and not necessity being the mother of invention, but to a degree that is still there and still is a big motivator.

I want to say to the witnesses that in my opinion the testimony here has been nothing short of profound. We may want to call you back. I hope you'll welcome that. I know that at least one member has approached me and has additional questions. After we see some other witnesses from industry, maybe we would bring you back and have you comment, not only on some of the questions we have right now but also on what we've heard again too. You know this file quite well and we're very impressed.

Thank you very much for your time

Colleagues, we're going to pause for a minute and go in camera and deal with some business. It will only be a few minutes.

[*Proceedings continue in camera*]