An Impact Brief
November 2018

# Physical Technologies – Part 2

The results of a forum held to discuss commercialization challenges

IMPACT CENTRE
SCIENCE TO SOCIETY

UNIVERSITY OF TORONTO

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# Summary

"One potential path to overcome some of the barriers holding back entrepreneurs and innovators is the creation of small local clusters focused on individual physical technologies."

In November 2017, we issued a report on the challenges that companies in the physical technologies face in obtaining government support for commercialization. This was followed by a forum held in January 2018 with over 100 entrepreneurs, academics, government officials, advisors, investors and other interested parties. They had a robust discussion around the challenges outlined in that report and identified a number of other hurdles, including:

1. Weak institutional support structure
2. Knowledge and information gaps
3. Lack of critical mass
4. Lack of prototyping facilities
5. Absence of short-run manufacturing
6. A missing global perspective
7. Regulatory challenges
8. Difficulties sourcing talent
9. Lack of government support
10. Problems with access to capital

Participants offered a range of creative solutions to these and other challenges. What emerged from these discussions is summarized in the remainder of the report. One potential path to overcome some of the barriers holding back entrepreneurs and innovators is the creation of small local clusters focused on individual physical technologies.

Not to be confused with the Innovation Superclusters launched recently by Innovation, Science and Economic Development Canada (ISED), the creation of local clusters can be done simply and cost effectively. Access to resources and services for cluster members such as peer-to-peer sessions, events, and training is a good starting point to address the challenges identified by the physical technology community. With small local clusters in place there are opportunities for further growth through the provision of centrally developed services and government support that can reach cluster members efficiently.

# Introduction

In our report on the interplay between physical technologies and government support for commercialization, we defined these technologies as arising from academic research in faculties or departments of engineering, chemistry, physics, earth sciences, and space sciences (Plant, *Physical Technologies. Challenges in Obtaining Government Support for Commercialization*, November 2017).

Physical technologies are distinct from other types of technology because of their commercialization path. Information technologies (IT) have a simple and well-known commercialization path without significant technological risk. The risk in IT is usually in market acceptance, and it is possible to obtain private capital to fund development as soon as some market traction is shown.

Life science commercialization is typically lengthy and costly. High technological risks require substantial testing both of efficacy and harm potential before market entry. But there is a well-established system in place to support the path from research to market—albeit a complex system with multiple entries to federal and provincial funds, each of which require some matching. In biotechnology, the market is relatively well known and can easily be assessed prior to commercialization. Thus, much of the risk is technological.

In the physical technology space, the path to commercialization is relatively long and complex and is understood best by the set of activities needed to take a scientific discovery through the nine different Technology Readiness Levels (TRLs) to market readiness. The TRLs range from level 1 where basic scientific principles of the potential technology are observed, through proof of concept and validation, and all the way to level 9, where the technology is tested under real-world settings. While the market for IT and biotechnology innovations can be identified very early in the path to commercialization, physical technologies necessitate the reduction of the technological risk to some extent before testing for market acceptance; and this is typically done through the creation of a prototype.

To identify other challenges encountered during physical technology commercialization, we held a forum in January 2018 following the release of our preliminary report. Participants included over 100 entrepreneurs, academics, government officials, advisors, investors, and other interested parties. They had a robust discussion and it became clear that several of the biggest challenges for Canadian startups, particularly in physical technologies, are finding the talent for their teams and securing enough funding.

While the scramble for funding is fundamental to all startups, attendees felt that Canadian physical technology companies faced unique challenges. The relatively small Canadian market next to the very large US market makes some investors timid about taking risks on Canadian innovations. The talent shortage was acutely felt by the participants and was tied back to funding. If they wish to attract top talent, Canadian companies need to be able to offer salaries that are competitive with other global technology hubs.

Two other challenges also stood out in the conversations: the difficulty in finding a facility where startups can create prototypes; and regulatory hurdles, particularly those faced by medical device businesses.

Attendees emphasized that the challenges discussed in the workshops lead some startups to move from Canada to the US closer to a dense talent pool and to venture capitalists (VCs) with more willingness to take a risk on an untested innovation.

Participants offered a range of creative solutions to these and other challenges. To keep entrepreneurs in Canada, they suggested:

- government assistance with funding for and early adoption of new Canadian physical technology products,
- more workshop facilities for prototyping products,
- streamlining regulations and providing better information about regulations, and
- creating mechanisms to share information about funding and resources available to startups.

The next section summarizes all the challenges identified during our workshop.

# Barriers to the Development of Physical Technologies

### Weak Institutional Support Structure

Since we were particularly interested in innovations derived from university research, we have to look at institutional supports available to potential entrepreneurs.

Workshop participants noted the relatively weak structure, culture, policies, funding or incentives within universities that prevent them from doing the heavy lifting needed for commercializing scientific advancements. While participants identified a lack of institutional support, it may be possible that the support does exist but that they just are not aware of it. Their comments included issues such as:

- Academic institutions in Canada miss out on the kind of tech transfer income enjoyed by some US schools.
- Canada lacks the supports that the US has that facilitates the transfer of technology from a research and institutional setting to commercial development.
- A lack of funding was also mentioned as a barrier to tech transfer.

The participants in the discussion recognized a fundamental mismatch between the basis upon which universities have been established and our expectations for them as commercializers of research. As one participant noted:

> "I'm going to take sort of a contrary approach. I'm going to make a controversial statement. I'm going to say that the cultural gap at universities cannot be bridged by another grant program… I would argue philosophically: 'Should professors even be doing this?' I think the answer is: no. If we accept that premise, and it's an arguable premise, then the answer is not to put more money in TTOs [technology transfer offices] or encourage universities, it's to get [technologies] out of there as soon as possible, and encourage entrepreneurship in some different structure, away from the universities."

As we stated in our previous report on health technology development, this fundamental misalignment is a tremendous challenge that will be difficult to overcome (Plant, *The Land of Stranded Pilots. Challenges Facing the Health Technology Innovation System in Canada*, October 2018):

> "This description suggests that the first problem with the system is an inherent misalignment of objectives. If our goal as a nation is to improve our economic condition through commercialization of university research, then our research system, deeply rooted in its academic values and core mandate of research and teaching, will certainly not be equipped or ready to respond fully, if a commercialization objective were thrust on it from the top down. Without alignment, no amount of research money pushed into the system will result in commercialization efforts unless commercialization becomes a priority, and this objective is aligned with the purpose of each player in the system."

The problem is exacerbated by the number of universities and community colleges, all responsible for their own commercialization and tech transfer efforts. Instead of creating a system of centralized specialists in technology transfer, we have created a regionally based set of both specialists and generalists, only some of which will have the resources and experienced personnel to properly address each speciality area of research in sufficient depth to be able to commercialize successfully. Even efforts such as the creation of MaRS Innovation, the commercialization arm of the Toronto-based universities and hospitals, is likely to suffer similar problems as they were set up as generalists, not sectoral specialists.

### Knowledge and Information Gaps

Physical technology entrepreneurs are not aware of the breadth of supports available to them when they start. This challenge boils down to a lack of communication and a lack of a community, and workshop attendees pointed to a number of issues on this front:

- There is scant information available about sources for assistance, particularly in the private sector, and this slows down the development of firms.
- Because the ecosystem of Canadian entrepreneurs is not fully developed, relevant knowledge is not exchanged among startups.
- Researchers developing new physical technologies benefit from more information sharing as well, so they do not replicate mistakes or duplicate another inventor's efforts.
- There was some thought expressed that the government could help facilitate better information sharing among startups.

One participant noted that:

> "So, we're all trying the same thing, but information is not available amongst the collective. So, company A or even research A tries this solution, is unsuccessful. Well, this guy over here doesn't know that that guy over there did that. Why would he repeat the same thing? That information's just not shared."

Part of the problem is the structure of government support programs. Because they are regionally—rather than sectorally—based, the knowledge of available resources is spread thinly over many players. Ontario's regional system is the ONE network, a network of regional innovation centres including MaRS and Communitech that helps technology entrepreneurs start, grow, and finance their businesses. As long as we continue to have a regional innovation structure then we will have a lack of centralized knowledge that is available to all entrepreneurs in one sector. We will also end up creating multiple structures that are layered on each other to solve information-sharing problems. As we noted in our review of the health technology environment:

> "This complexity has also been recognized by the stakeholders in the system. There are regular meetings between organizations to try to coordinate their activities with a client. The collective programs have become so complicated for beneficiaries to navigate that there are three bodies to help companies navigate the system: IRAP's Concierge system, Accelerated Growth services from Innovation, Science and Economic Development Canada (ISED), and the Ontario Investment Office."

### Lack of Critical Mass

Workshop attendees were in agreement that there is a lack of critical mass in the community, few successful entrepreneurs and senior executives as reference points for early advice or to assist by becoming employees and executives at new startups. Comments from attendees focused around the following points:

- Participants expressed a desire for more mentorship. They reported that other countries (UK, US) have deeper pools of experienced mentors to draw on than Canada does.
- There was a general feeling that there were not enough Canadian entrepreneurs who have succeeded and are willing to share their knowledge with the next generation of up-and-comers.
- Part of the problem is that entrepreneurs whose companies leave Canada once their companies grow do not come back, resulting in an entrepreneurial brain drain.
- Participants would like to see events as gathering points for entrepreneurs and others working on physical technologies to share their experiences and knowledge.
- There are some programs in place for education and advice, most notably at incubators, but more are needed.

One participant noted:

> "I don't know what the real solution is but one of the things that I'm hearing is this notion of critical mass and nucleation, being able to bring together very driven, confident people who execute across the different aspects of what physical technologies mean via product buy ins …and bringing them in a way where there's pressure and there's also transparency and there's also some level of trust. How do you bring that critical mass?"

### Lack of Prototyping Facilities

Physical technology entrepreneurs emphasized that there are few facilities in place that enable startups commercializing physical technologies to create working prototypes. Those that do exist, such as in the community colleges, work on different timelines and with different resources than are needed by startup firms. Private facilities are typically too expensive for startups. This challenge generated a great deal of discussion.

- Participants noted that many small machine shops willing to create prototypes were going out of business. As these shops vanish, we also lose the talent with the skill set to fulfill these service requests.
- For an established company bringing a new product to market, prototyping can be done at a facility that manufactures its other products. This existing relationship provides an advantage during new product development. There are currently some facilities that handle prototyping for small companies and startups, and participants shared these resources with the audience.
- Another suggestion for entrepreneurs was to create more facilities based on the "Village Workshop" model: co-op facilities where a community of designers could have access to tools and equipment to build prototypes. (At the time of the event, a microfactory cooperative was being explored in Northumberland County at Venture 13.)

One participant suggested building capacity at the front end of the development process:

> "That's actually where our opportunity is: to own that front end. It's the design. It's the prototyping in terms of the manufacturing. It's the assembly. It's the build. It's the entire front-end process that basically allows a company to say: 'This is ready to go. Hey, TSMC [Taiwan Semiconductor Manufacturing Company Limited], I've got 50 million units for my company. Ramp it. It's prototyped, fully baked in Canada.' That's really what I think would have been helpful, to be able to do that. We ended up having to fly back and forth and prototype in Taiwan, and then China, and then Korea. It's like, why didn't we just do that here?"

### Absence of Short-Run Manufacturing

Access to small-scale, short-run manufacturing is limited and unknown. Instead of sourcing manufacturing locally, companies need to access foreign markets in a process that adds risks and lengthens startup times.

- While there is a great deal of manufacturing in Canada, especially automobile plants, those large operations are not likely to shut down a busy production line to create a prototype for a Canadian inventor. This sends some inventors to Asia to get prototypes created. For others, it increases their startup costs.
- Participants suggested that, in exchange for government funding of new, large manufacturing plants, the operators be required to give a certain amount of money into a facility that can undertake prototyping for physical technology startups.

As one participant noted:

> "The other thing is the ecosystem here, in terms of where you build your boards and all of that kind of stuff ... I'm going to contradict myself. You don't need a site that runs at a volume of 50 million chips, but you need something, somewhere, where you get enough of a test run that you can work out the manufacturing defects in enough of a volume... A big, in our case it was LG, would say, 'Yeah, okay. We're good. We'll take that.'"

## A Missing Global Perspective

Many entrepreneurs start out with a local perspective and are wary of the risks which they associate with foreign markets; but that is where buyers are. Given the reluctance to go global, they need assistance navigating foreign markets.

- Participants felt that, for startups to succeed, particularly in the physical technologies, they need to look beyond a purely Canadian customer base to international markets, in the US and beyond.
- Some Canadian companies do not have a "global mindset", which can slow their growth.
- The Canadian market is not big enough to support growth; global sales are a key ingredient to the success of Canadian startups.

One participant stated that:

> "In a stage of development of that product, from the beginning, you have to think about, 'Okay, where do I want to take this product?' If I just limit myself... [to the] US market and just design it to meet the UL requirement and do all the development and go through the stages. And after that, okay you launch it and say: 'Well, wait a second. We have opportunity in India or Japan or elsewhere.'"

Building a global mindset is not something that will be done overnight. In fact, there probably is not an easy formula for doing this. What worked to develop massive success in the San Francisco area is that a large, highly globally networked group of people in the software sector came to try and out-perform each other.

## Regulatory Challenges

It is often more challenging to get regulatory approval in Canada than it is in foreign markets. Some companies avoid sales of products in Canada for this reason, but this lengthens launch times as entering foreign markets can be more complex and those markets want to know how the product was validated in local markets.

- Navigating the different regulations in each Canadian province as well as the US and other countries is a particular challenge for new medical technologies.
- Complying with regulations adds to the cost of bringing a product to market and affects the speed with which an invention can be monetized.
- Participants suggested streamlining and standardizing Canadian regulations and providing better access to regulatory information.

According to one participant:

> “Canada is a small market and it has all kinds of specific regulatory barriers. Language being one, but now you’ve got to get Health Canada approval. Why would I get Health Canada approval if I can get FDA approval and access 10 times, or arguably 100 times, the market size.“

Solving the regulatory burden will be difficult unless we adopt a global mindset and allow approval to flow from work done in other jurisdictions. This could be permitted for a period of time so that companies will benefit from larger foreign approvals, at least until they have grown sufficiently to earn a return in the Canadian market.

### Difficulty Sourcing Talent

One of the key struggles identified by startups is finding the right talent at the right stage in their development. Then the challenge turns into having enough funding on hand to pay for the expertise needed.

- Participants wanted the flexibility to hire people with different skill sets at different stages of development without being locked into employing those people long-term.
- Participants mentioned the difficulty of finding talent with the right skill sets in Canada.
- The quality of the team that develops and markets the product is just as important to the success of a new company as the quality of the technology; investors should look more closely at the team to assess risk.
- Canadian companies are at a disadvantage in attracting the most talented team members because they usually cannot offer competitive salaries relative to the US.
- Some felt that a reluctance to move to Canada also made it harder to assemble an optimal team.

On the topic of talent, one participant stated:

> "What's missing [here is] that there's not any means to provide the right skill set, or ensuring that: (a) there's a team that comes together, and (b) that the team develops or has the right skill set to go forward. There were projects on the OCE side, that I thought, despite what you're saying about the technical risk, the people risk was in the end much higher. It was an interesting technology, but the people risk is what killed it on there ... Most of these teams that are coming out of there, their ability to assess product-market fit is not good. They're very fixated on the technology and the product, and don't know how to adequately go out and assess whether there's a need for it. "

This struggle to obtain talent goes beyond physical technologies and extends to most high-tech sectors across the country.

### Lack of Government Support

Workshop participants noted the scarcity of government programs that support early-stage physical technology commercialization without requiring some external matching of funding. However, since no matching funds are available from VCs at such an early stage, in many cases, it is easier for universities to license the technology to a third party organization that can afford the investment.

- Some challenges highlighted involved securing a level of investment that will get a new company through product development and testing and to the point where it can launch and bring in revenue.
- Participants noted that the complexity of the paperwork to access government funds holds some startups back. They suggested streamlining administrative requirements and providing more government programs as a way to jumpstart Canadian entrepreneurship in physical technologies.
- The specific requirements to get funding can be a disincentive for some entrepreneurs as well; the requirement to only use Canadian resources was mentioned several times.

It was noted that:

> "But you're missing one of the obvious things that Canadian entrepreneurs also face, which is: we go out for money, we spout that initial money from government and that 99 times out of 100 we have to have a matching equal amount, or anywhere from 25–50% has to be matched… [T]hat means chasing the private money… and we only get so far, because often there's strings attached to development here[.]"

The issue of matching funds is easily rectified, but funding organizations have to be the drivers of this change.

### Problems With Access to Capital

It is well known that Canada lacks the deep pockets of US investors and that the VC community in Canada is not mature enough to fill in the gaps. Although Canadian inventors rely heavily on US capital and US markets to monetize their ideas, it can sometimes be challenging to lure capital to Canadian startups. Some US investment in physical technologies comes from the military or other governmental entities.

The Canadian government has some good programs to incentivize startups but could do more on this front. There are several public and private initiatives underway to provide funding, but participants still recognized a gap between the creative potential of Canadian startups and the funding available to get them off the ground. There were numerous comments about this topic, which appears to be one of the biggest challenges for Canadian startups.

There were, however, dissenting opinions. At least one speaker felt the problem was not the lack of funding as much as access to and distribution of those resources. One venture capitalist present noted:

> "I'm a late-stage investor. We screen companies as they come in. So, we have two buckets. The first branch is basically software and SaaS, and all that stuff goes there, low-capital requirement. We can reach commercial really fast. Then there's hardware, semi[conductor]s, clean tech, medical devices. We don't have the capital to carry these things through, typically. I think that's not unique to Canada, but it's accentuated in Canada. In places like semi[conductors], there's not even a decent foundry. There's no ecosystem to build on. "

A consequence of this challenge is best illustrated with a recent example: the only VC firm in Canada devoted to physical technologies is moving to the US. Pangea Ventures, a Canadian VC which has invested in over 20 companies in advanced materials, is moving its head office to the US after 18 years in Canada. They will continue to do Canadian deals, but as their investors and clients are mostly American, it simply makes more business sense to move locations.

# The Opportunity for Cluster Creation

With the Ontario Network of Entrepreneurs (ONE) review ongoing and Innovation, Science and Economic Development Canada's (ISED) mandate to review its programs, we have an opportunity to revamp our strategy.

One potential avenue is to move from geographically-based government programs to ones based on sectors, thus creating multiple foci for bringing together companies into a more cohesive whole.

Why is this a positive approach?

The only way that we can move from a locally to a globally-focused environment is to create similar networks or clusters of like-minded entrepreneurs all working in the same area. This has worked in Canada in the Kitchener–Waterloo area for software, and we could replicate this model by creating several mini-clusters in physical technologies across the Province.

Creation of formal clusters in major locales focused on specific physical technologies such as a health tech cluster in Mississauga and artificial intelligence cluster in Montreal could answer many of the problems identified by participants in our forum.

By definition, an economic cluster is a dense network of companies and institutions in a certain geographic sphere. Michael Porter began the focus on clusters in 1990 by defining how local economies benefit from clusters by increasing productivity of the companies in the cluster, by driving innovation, and by stimulating new businesses. Clusters can be identified in several ways, depending on scope:

1. Geographical clusters: composed of businesses concentrated in a specific region.
2. Sectoral clusters: composed of businesses operating in similar industries.
3. Horizontal clusters: composed of businesses connected by sharing resources.
4. Vertical clusters: composed of businesses connected via supply chains.

The Government of Ontario, through the creation and development of the Ontario Network of Entrepreneurs, chose to develop clusters geographically. The flaw in this model is that this causes duplication of resources, misalignments, and gaps in coverage. For instance, there will be resources for AI based companies in major areas such as Toronto and Waterloo when they could perhaps be covered by one centralized expert resource. At the same time, because all hubs must provide general resources there may be no expertise in the system to deal with physical technologies. It also results in a lack of specialized knowledge as each cluster participant is expected to service the development needs of companies in radically different industries within their geographic area (e.g. the way MaRS covers both pharma and blockchain and everything in between). It may be the creation of geographical clusters of service providers that has contributed to some of the problems in the physical technology sphere.

The federal government has taken another approach to the creation of clusters by creating five Innovation Superclusters:

- Digital Technology Supercluster focuses on virtual, mixed and augmented reality, data collection and analytics, and quantum computing. This is neither a sectoral or vertical cluster but agglomeration of businesses roughly in the same technological base.

- Protein Industries Supercluster is based on agri-food enabling technologies, including genomics, processing, and related IT. Similarly, this cluster cannot be well defined using the classic definition of clusters. It represents the concentration of companies based on a scientific knowledge base.

- Advanced Manufacturing Supercluster will build up next-generation manufacturing capabilities, incorporating technologies like advanced robotics and 3D printing. This might loosely be defined as a sectoral cluster that is made up of a wide range of companies.

- SCALE.AI supercluster focuses on AI-powered supply chains, bringing the retail, manufacturing, transportation, infrastructure, and information and communications technology sectors together to build intelligent supply chains based on advances in artificial intelligence and robotics. Like the protein cluster, this cluster is centred on a set of techniques, methods and knowledge derived from AI and robotics.

- Oceans Supercluster will advance digital sensors and monitoring, autonomous marine vehicles, energy generation, automation, marine biotechnology and marine engineering technologies. This could perhaps be defined as a horizontal cluster with the ocean as a shared (and driving) resource.

It is very challenging to apply the classic cluster definition to Canada's superclusters initiative. Although the funding was roughly distributed among the main regions across Canada, the clusters can effectively expand their reach by permitting access to members beyond their immediate geographic focus. The program also encouraged the mixing of companies in vastly different industries within each cluster.

But with such a disparate mix of companies, it is difficult to say how a shared experience or opportunity to build a single cohesive network will be realized in practice. Michael Porter emphasizes that economic activities are embedded in social activities: that social glue binds the companies together. When companies cannot interact locally and do not share the same vertical, horizontal, or sectoral interests, then a network or cluster is difficult to create.

The best example of a cluster in Canada is the Kitchener–Waterloo region, which is made up predominantly of companies operating in computer software (and some hardware). The firms all work within a tight geographic boundary with the University of Waterloo and Wilfred Laurier University as the academic anchors and well-known companies like Blackberry and OpenText as the business anchors. Communitech serves as a not-for-profit anchor: it was spawned from within the cluster and is governed as a member-based organization by business leaders from within the cluster. In the classic definition of a cluster, the community is brought together through social activities in which they can all share and within which they all have related interests.

### Norway

An example of a country with a well-developed framework for innovation clusters is Norway. (There is nothing to say that this framework is successful but it is offered as an alternative to the Canadian approach.) The Norwegian government defines clusters as

> "a geographical concentration of enterprises and related knowledge communities linked by complementarity or a similarity of interests and needs. The enterprises can gain easier access to important production factors and ideas for and impulses to innovation through interaction and cooperation. A cluster emerges over time, on the basis of location advantages and natural development dynamics." (http://www.innovationclusters.no/english/)

Norway has three levels of clusters:

1. Immature clusters: "Clusters that are in an early phase of organised cluster collaboration. They can be clusters with different preconditions and potential: they can be small or large, and the participants can be in a regional, national or international position." There are 19 such cluster projects spread throughout the country that are funded on a 3–5 year cycle. Examples of clusters include: arctic maintenance, maritime, smart care, and education tech.

2. Norwegian Centres of Expertise or "mature clusters with a national position": "Clusters that have established a systematic collaboration and that have developed dynamic relations with high interaction and a broad strategic action area. The participants in the clusters have considerable potential for growth in national and international markets. Within their respective sectors or technology areas, the clusters have a strong

national position and the participants normally have clear and strong international ambitions." There are 14 such initiatives, funded in 10-year cycles. Examples of clusters include: aquaculture, micro- and nanotechnology, and medtech.

3. Global Centres of Expertise or "mature clusters with a global position": "Clusters that have already established systematic collaboration and that have developed dynamic relations with high interaction and a broad strategic action area. The clusters have considerable potential for growth in national and international markets. They form part of a strong innovation system, based on both publicly funded R&D and the participants' privately-funded R&D. Educational programmes of a high international calibre are available that have clear professional relevance to the cluster, and the cluster comprises global market and technology leaders that are integrated in and have a strong position in global knowledge networks." The Norwegian government has established three global centres of expertise that are also funded in 10-year cycles: oceans technology, subsea installations, and offshore drilling.

Thus, Norway, with a population of 5.2 million, supports 36 individually identified, sector-focused clusters. On that basis, Canada could support over 250 individual clusters in locales across the country instead of only five superclusters. This does not mean that this is the optimal usage of resources and it may in fact not be effective but is an illustration of two different approaches.

The creation of local clusters can be done very simply and at low cost. Access to resources and services for cluster members such as peer-to-peer sessions, events, and training is a good starting point to get a cluster off the ground. With member support, such clusters can be created without significant overhead or administration.

### How Establishing Local Clusters Can Help Mitigate Challenges Encountered by Physical Technologies Startups

A more concerted and effective cluster strategy could be used to lower hurdles faced by firms in the physical technology space.

1. **Weak Institutional Support Structure.** By creating clusters, universities may be able to evaluate more easily the opportunity for new technologies and to find customers in the immediate vicinity to whom these can be transferred.

2. **Knowledge and Information Gaps.** Moving to a sectoral framework for commercialization will help address the knowledge gap by providing a focus for information sharing and exchange. Cluster members will have a group to which they can turn to make up for the lack of knowledge.

3. **Lack of Critical Mass.** By definition, locally defined clusters have the critical mass to support members.

4. **Lack of Prototyping Facilities.** With government support for a small local cluster, we may be able to create prototyping facility that can be accessed by cluster members.

5. **Absence of Short-Run Manufacturing.** Similarly, we may be able to create a vertically oriented ecosystem around a cluster that might include or at least promote the opportunity for short-run manufacturing facilities.

6. **A Missing Global Perspective.** While not a formal part of a cluster process, the mingling of smaller local firms with more established, globally oriented ones can create a new impetus for smaller firms to look internationally.

7. **Regulatory Challenges.** The critical mass developed through a cluster could provide an impetus for regulators to consider streamlining and standardizing regulations needed for companies centred on physical technologies.

8. **Difficulties Sourcing Talent.** The existence of a cluster can act as a magnet for talent and provide a conduit for the creation and deployment of education programs within the cluster.

9. **Lack of Government Support.** Establishing and helping a cluster need not be expensive. If the government were to add resources for the clusters to organize themselves and perhaps specific funding for prototyping where applicable, clusters could potentially support themselves through membership fees.

10. **Problems with Access to Capital.** The creation of clusters may improve the visibility of firms to capital and capital providers and boost the ability to access opportunities in an efficient manner.

## Conclusions

Participants to the forum outlined a large number of problems with the commercialization of physical technologies in Canada and made a similarly large number of recommendations. Some of the problems are quite easy to deal with and others more difficult. What we hoped would result from the discussion would be a new dialogue on challenges facing physical technology firms and a new impetus to develop changes to address these challenges.

# About the Impact Centre

## Science to Society

We generate impact through industry projects and partnerships, entrepreneurial companies, training and research.

We bridge the gap between the university and industry to accelerate the development of new or improved products and services based on physical technologies. We work with graduate students and researchers to help them commercialize their discoveries. We provide undergraduate education and training for students at all levels to ease their transition into future careers.

The Impact Centre conducts research on all aspects of innovation, from ideation and commercialization to government policy and broader themes such as the connection between science and international development. We study how companies of all sizes navigate the complex path between a discovery and its market and how their collective innovations add up to create a larger socioeconomic impact.

Our objective is to understand how we can improve our ability to create world-class technology companies, how governments, companies, and academia can identify and adopt best practices in technology commercialization.

## Impact Briefs

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## Contributors


Charles Plant
Author
Senior Fellow
cplant@imc.utoronto.ca
416-458-4850
@cplant

Emina Veletanlic
Editor
Manager, Strategic Initiatives
eveletanlic@imc.utoronto.ca
416-978-1457
@EminaVeletanlic

James Li

Harim Ulfig

UNIVERSITY OF
TORONTO

Impact Centre
Suite 411 - 112 College Street
Toronto, Ontario
Canada M5G 1L6

Tel: 416-978-3875
info@imc.utoronto.ca
www.impactcentre.ca