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100th Issue

Welcome to the November issue of the *Technology Innovation Management Review,* in which we celebrate our one hundredth issue. We welcome your comments on the articles in this issue as well as suggestions for future article topics and issue themes.

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Overview

The *Technology Innovation Management Review* (TIM Review) provides insights about the issues and emerging trends relevant to launching and growing technology businesses. The TIM Review focuses on the theories, strategies, and tools that help small and large technology companies succeed.

Our readers are looking for practical ideas they can apply within their own organizations. The TIM Review brings together diverse viewpoints – from academics, entrepreneurs, companies of all sizes, the public sector, the community sector, and others – to bridge the gap between theory and practice. In particular, we focus on the topics of technology and global entrepreneurship in small and large companies.

We welcome input from readers into upcoming themes. Please visit timreview.ca to suggest themes and nominate authors and guest editors.

Contribute

Contribute to the TIM Review in the following ways:

- Read and comment on articles.
- Review the upcoming themes and tell us what topics you would like to see covered.
- Write an article for a future issue; see the author guidelines and editorial process for details.
- Recommend colleagues as authors or guest editors.
- Give feedback on the website or any other aspect of this publication.
- Sponsor or advertise in the TIM Review.
- Tell a friend or colleague about the TIM Review.

Please contact the Editor if you have any questions or comments: timreview.ca/contact

About TIM

The TIM Review has international contributors and readers, and it is published in association with the Technology Innovation Management program (TIM; timprogram.ca), an international graduate program at Carleton University in Ottawa, Canada.

Editorial: 100th Issue

Chris McPhee, Editor-in-Chief

Welcome to the November 2015 special issue of the *Technology Innovation Management Review*. This is indeed a "special issue" because it is our **100th issue** since the journal first began in July 2007.

In the first article, I look back over these first 100 issues of the TIM Review, the themes they covered, trends in authorship and readership, and future opportunities and challenges for the journal. The other authors in this issue were asked to look forward to the next 100 issues by identifying key unanswered questions in emerging domains where theory and practice are limited. Their articles share insights about lean and global startups, the disruptive impacts of 3D printing on supply chains, an agenda for securing cyberspace, and encouraging companies to engage in collaborative innovation.

Erik Stavnsager Rasmussen and **Stoyan Tanev**, Associate Professors at the University of Southern Denmark, identify the emergence of the "lean global startup" as a new type of firm. By examining the connections in the literature on lean startups and born-global firms, they identify areas of future research to better understand lean global startups from a theoretical perspective.

Next, **Sebastian Mohr** and **Omera Khan** from the Technical University of Denmark identify key questions about 3D printing that they predict will have disruptive impacts on future supply chains. Their analysis of potential impact areas includes mass customization, resource efficiency, decentralization of manufacturing, reduction of complexity, rationalization of inventory and logistics, product design and prototyping, and legal and security concerns.

Then, **Renaud Levesque**, **D'Arcy Walsh**, and **David Whyte** from the Communications Security Establishment (CSE) in Ottawa, Canada, examine the challenge of securing cyberspace. They share their experiences in contributing to the establishment of the VENUS Cybersecurity Corporation, a not-for-profit corporation that aims to make Canada a global leader in cybersecurity. They argue that a radical shift is required in terms of how cybersecurity research is conducted, how researchers are educated, how new defendable systems are developed, and how effective defensive countermeasures are deployed. After examining the key drivers and corresponding focus areas for securing cyberspace, they put forth a list of "big questions" that must be addressed first.

Katri Valkokari, Principle Scientist at VTT (Technical Research Centre of Finland) then asks "In the innovation game, why do so many companies stay on the sidelines?" Valkokari examines the benefits of collaborative innovation and the barriers that are holding some companies back (despite the benefits). She also describes potential strategies to encourage companies to overcome their reluctance and identifies several promising avenues for future research that will help companies know where to play, with whom to play, and how to play the innovation game.

Finally, this issue includes a summary of a recent TIM Lecture presented by **Firdaus Kharas**, a social innovator, director, and humanitarian who founded Chocolate Moose Media, a social enterprise with the mission to better the human condition through media. Kharas shared his experiences producing animations, documentaries, films, and television series designed to educate, entertain, and change societal and individual behaviour via a process he calls "Culture Shift". His goal is to positively influence the viewers' knowledge, attitude, and behaviour, especially in children and young adults.

In our December and January issues, we revisit a recurring and popular theme in the TIM Review: **Living Labs**. Our guest editors will be **Seppo Leminen** (Laurea University of Applied Sciences and Aalto University, Finland), **Dimitri Schuurman** (iMinds/Ghent University, Belgium), **Mika Westerlund** (Carleton University, Canada), and **Eelko Huizingh** (University of Groningen, Netherlands).

For future issues, we welcome your submissions of articles on technology entrepreneurship, innovation management, and other topics relevant to launching and growing technology companies and solving practical problems in emerging domains. Please contact us (timreview.ca/contact) with potential article topics and submissions.

We hope you enjoy this 100th issue of the TIM Review and will share your comments online.

Chris McPhee
Editor-in-Chief

Editorial: 100th Issue

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About the Editor

Chris McPhee is Editor-in-Chief of the *Technology Innovation Management Review*. He holds an MASc degree in Technology Innovation Management from Carleton University in Ottawa, Canada, and BScH and MSc degrees in Biology from Queen's University in Kingston, Canada. Chris has over 15 years of management, design, and content-development experience in Canada and Scotland, primarily in the science, health, and education sectors. As an advisor and editor, he helps entrepreneurs, executives, and researchers develop and express their ideas.

Reflecting on 100 Issues of the TIM Review

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> " *The past empowers the present, and the* "
> *sweeping footsteps leading to this present*
> *mark the pathways to the future.*

Mary Catherine Bateson
Writer and cultural anthropologist

First launched in 2007, the *Technology Innovation Management Review* has now reached the milestone of 100 issues. This article looks back over these first 100 issues, the themes they covered, trends in authorship and readership, and future opportunities and challenges for the journal.

Introduction

Since July 2007, this journal has been publishing monthly issues intended to bring together diverse viewpoints – from academics, entrepreneurs, companies of all sizes, the public sector, the community sector, and others – to bridge the gap between theory and practice. Originally called the *Open Source Business Resource,* the journal was relaunched in October 2011 as the *Technology Innovation Management Review* (TIM Review). With the publication of the current issue, the journal has now reached the 100-issue milestone.

This article follows on from the earlier article, "Reflecting on Fifty Issues of the OSBR", which marked and explained the transition from the OSBR to the TIM Review (McPhee, 2011). From its origins as a means to explore the business side of open source, the journal's core topics began to evolve as open source became "a better-understood, mainstream tool for technology businesses" (McPhee, 2011). With a relaunch, new name, and newly developed publication platform, the journal broadened its scope to the issues and emerging trends relevant to launching and growing technology businesses. The subsequent 50 issues of the TIM Review have focused on the theories, strategies, and tools that help small and large technology companies succeed, with a particular focus on the topics of technology and global entrepreneurship in small and large companies.

This article reflects upon the journal's 100 issues, with particular emphasis on the 50 most recent issues that were published since October 2011. First, an overview of the journal provides additional context to understand the journal's past and future. Next, the first 100 issues of the TIM Review are examined in terms of their themes and popularity. Finally, the article discusses the journal's future opportunities and challenges that will be faced in the next 100 issues.

About the TIM Review

The TIM Review is a monthly, peer-reviewed journal published in association with the Technology Innovation Management (TIM) program (Box 1), an international graduate program at Carleton University in Ottawa, Canada. The journal seeks to cover globally relevant topics of interest to authors and readers from a variety of roles and backgrounds, including academics and practitioners. In particular, the TIM Review seeks to provide opportunities to explore and legitimize new ideas for solving practical problems in emerging domains relevant to technology companies and innovation management professionals.

To maximize real-world value, remove barriers to diversity, encourage widespread dissemination, and assure quality content, the journal has been designed with the following distinctive features:

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1. *Lessons from theory and practice:* Whether the contributed insights come from academia or industry, authors are encouraged to emphasize the managerial implications of their work. The intention is to help authors develop, define, and share principles based on lessons from theory and practice, so that they can contribute solutions to real-world technology innovation problems.

2. *Open access with no author fees:* The journal does not charge its readers or its authors. Although the journal faces an ongoing challenge with sustainable funding and sponsorship, this approach is designed to remove any barriers to contribution and dissemination.

3. *Editorial support:* The TIM Review offers a high level of editorial support in addition to feedback through the peer-review process to improve the contributions from authors. This support is provided to all authors, but it particularly intended to encourage contributions from practitioners (who may not write regularly in the style and format required by a journal) and authors from around the world (who may need additional help in expressing their insights in English).

Since 2011, the TIM Review website (timreview.ca) has welcomed more than half a million unique visitors, and it now receives over 27,000 unique visitors per month from around the world. The authors have predominantly come from the Americas (especially Canada, where the TIM Review is based) and Europe, but the readers have been more evenly distributed (Figure 1). These trends are also reflected in the lists of the top 10 countries by authorship and readership (Table 1). However, the most recent data shows a trend toward even greater international representation. With regards to authorship, 2015 is the first year in which Canada did not have the highest percentage: more than half of the authors who have published in the TIM Review so far in 2015 are from Europe. Similarly, in 2015, readers from Asia (32%) have so far overtaken readers from the journal's "home continent", the Americas (30%).

In the 100 issues, the journal has published contributions from more than 650 authors in the form of 507 articles, 35 shorter and less formal "Q&As" that provide answers to specific questions, and 39 summaries of lectures from the TIM Lecture Series at Carleton University. Each of these formats is open to both academic and practitioner contributions: the intention is to encourage a common platform for readers and authors, regardless of their role.

Box 1. About the TIM Program

The Technology Innovation Management program (TIM; timprogram.ca) is a Master's level program at Carleton University in Ottawa, Canada. It leads to either a Master of Applied Science (MASc) or a Master of Engineering (MEng) degree. All classes are offered in a traditional, face-to-face university setting; however, a distinctive feature of the TIM program is that all courses are also delivered concurrently over the Internet.

The objective of this program is to train aspiring entrepreneurs on creating wealth at the early stages of company or opportunity lifecycles. The program benefits are targeted at the following people:

• Founders of new companies

• People seeking more senior leadership roles within established companies

• Talented professionals building credentials and expertise for their next career move

• People who wish to work for or supply specialized services to founders of new companies or new lines of business of existing companies

• People who wish to improve the health of ecosystems that support technology entrepreneurship

The TIM program ecosystem includes Lead To Win (leadtowin.ca): an award-winning entrepreneurship community that provides coaching, early-buyer support, IT support, funding for students and young entrepreneurs, and development events. In 2015, Lead To Win was ranked by Stockholm-based UBI Global as one of the top 10 university business incubators in North America (Murray, 2015).

However, the shift in scope from the OSBR to the TIM Review was accompanied by a more academic article format and more rigorous peer review process, and there has been a corresponding shift toward more academic authors in the TIM Review, with PhD-level academics and students together accounting for 58% of TIM Review authors compared to 36% of OSBR authors (Figure 2). Nonetheless, the relative volume of practitioner contributions (i.e., articles by authors from the

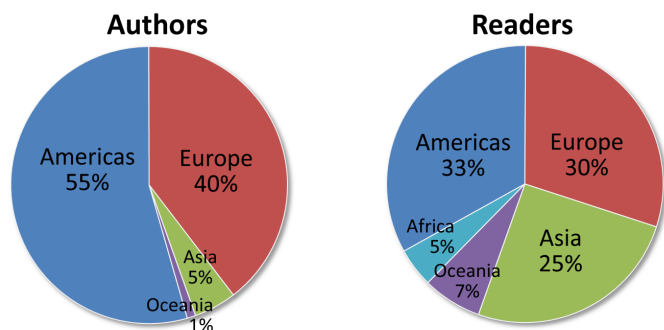# Reflecting on 100 Issues of the TIM Review

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Figure 1. Geographical distribution of TIM Review authors and readers (2011 to 2015)
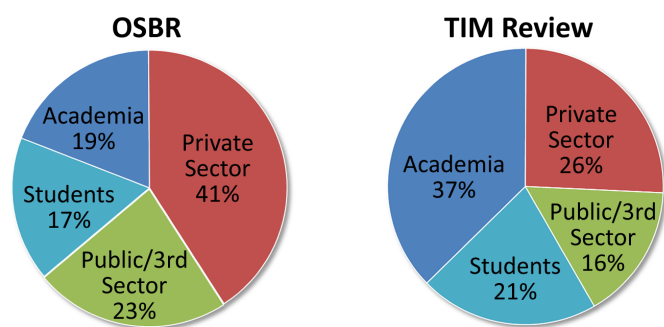

Figure 2. The diversity of author roles in the OSBR (2007–2011) and TIM Review (2011–2015)

Table 1. Top 10 countries by TIM Review authorship and readership (2011 to 2015)

Authors	Readers
1. Canada	1. United States
2. Finland	2. India
3. United States	3. Canada
4. Spain	4. United Kingdom
5. Denmark	5. Malaysia
6. India	6. Australia
7. United Kingdom	7. Germany
8. Germany	8. Philippines
9. Belgium	9. Netherlands
10. Netherlands	10. Kenya

private, public, and third/community sectors) has still accounted for 42% of TIM Review authors, suggesting that the journal remains an attractive publication to practitioner authors.

Issue Themes and Popularity

The majority of issues have covered particular editorial themes, such as technology entrepreneurship, open source business, and cybersecurity, which each have been covered in at least seven issues. Themes that have been covered in at least three issues include business ecosystems, living labs, service innovation, open innovation, and co-creation. A full list of themes from the 100 issues is presented in Appendix 1 and is available online in the issue archive (timreview.ca/issue-archive/).

Table 1 lists the 10 most popular TIM Review issues published since October 2011. In some cases, popularity reflects general interest across the articles in an issue; however, in other cases, there can be one or two highly popular articles that drive the popularity of the issue overall, as reflected in Table 1. Note that this list is

based on absolute web traffic and does not take into account the amount of time each article has been available online: newer issues may ultimately prove more popular once they have had more time to attract visits. Indeed, several issues published under the OSBR banner (i.e., before October 2011) have remained popular, including Co-Creation (December 2009 and March 2011), Economic Development (November 2010), Sales Strategy (October 2010), Growing Business (June 2010), and Technology Entrepreneurship (June 2011).

Conclusion: Looking Ahead

With the first 100 issues now published, the journal has reached a state of maturity where the challenges and opportunities are particularly exciting. In particular, we aim to grow the journal's reputation among the academic community. The journal is currently listed in the Directory of Open Access Journals (DOAJ), EBSCOhost, the Finnish Publication Forum (Julkaisufoorumi), Google Scholar, ProQuest, and Ulrich's, and we intend for this list to grow as the journal matures further. A key sign of progress will be for the journal to achieve recog-

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Table 1. Top 10 most popular* issues of the TIM Review published since October 2011

	Issue	Theme	Guest Editor(s)	Driving Article(s)**
1	Feb 2012	Technology Entrepreneurship	Tony Bailetti	• Q&A. What Is Customer Value and How Do You Deliver It? (Shanker, 2012a)
2	Mar 2012	Technology Entrepreneurship	Tony Bailetti	• Global from the Start: The Characteristics of Born-Global Firms in the Technology Sector (Tanev, 2012) • A Customer Value Creation Framework for Businesses That Generate Revenue with Open Source Software. (Shanker, 2012b)
3	Jun 2012	Global Business Creation	Marko Seppä & Stoyan Tanev	• Building Trust in High-Performing Teams (Hakanen & Soudunsaari, 2012)
4	Oct 2011	Introducing the TIM Review	--	• Acquisition Integration Models: How Large Companies Successfully Integrate Startups (Carbone, 2011) • A Sales Execution Strategy Guide for Technology Startups (Gilbert & Davies, 2011)
5	Sep 2012	Living Labs	Mika Westerlund & Seppo Leminen	--
6	Aug 2012	Entrepreneurship in the 21st Century	--	• Creativity: Linking Theory and Practice for Entrepreneurs (Duxbury, 2012)
7	Aug 2014	Innovation and Entrepreneurship in India	Kalyan Kumar Guin	• The Government of India's Role in Promoting Innovation through Policy Initiatives for Entrepreneurship Development (Abhyankar, 2014)
8	Dec 2012	Recent Research	--	• Neuromarketing: Understanding Customers' Subconscious Responses to Marketing (Suomala et al., 2012)
9	Feb 2013	Platforms, Communities, and Business Ecosystems	Steven Muegge	• Key Factors Affecting a Technology Entrepreneur's Choice of Incubator or Accelerator (Isabelle, 2013)
10	Aug 2013	Cybersecurity	Tony Bailetti	--

*Based on pageviews at timreview.ca from October 1, 2011 to October 31, 2015.

**Driving articles are articles that account for more than 1/3 of an issue's pageviews.

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nition in lists of quality journals. The challenge will be to further increase the academic quality of the articles while maintaining the journal's status as a desirable publication for practitioner authors and readers.

While we seek to further solidify the TIM Review's increasing popularity and worldwide reputation, we must also work hard to ensure financial sustainability, which remains an ever-present challenge for any open-access journal, especially one that does not charge author fees. In addition to future experiments with business models that support the journal's global presence, an ongoing strategy to financially support the operations of the journal comes through "Best of TIM Review" book series, which has four published titles that are currently available through Amazon:

1. *For Technology Entrepreneurs* (Bailetti & Hurley, 2013)

2. *Business Models for Entrepreneurs and Startups* (Muegge & Haw, 2013)

3. *Value Co-Creation* (Tanev & Seppä, 2013)

4. *Cybersecurity* (Craigen & Gedeon, 2015)

Soon, additional "Best of TIM Review" books will be published on Living Labs and Open Source Business, in addition to a book that includes the most popular articles published in the TIM Review.

In terms of the next wave of articles that will hopefully become the "best of" the next 100 issues, our near-term editorial calendar includes familiar topics such as technology entrepreneurship, living labs, cybersecurity, and innovation management. However, we will continue to look ahead to domains where theory and practice may be limited, as evidenced by the authors in this 100th issue looking ahead and identifying the key unanswered questions in emerging domains. Our guest editors, authors, readers, and board members have played critical roles in identifying real-world problems that need research-based solutions, and we invite you to propose issue themes and article topics that will be developed, disseminated, and debated in future issues of the TIM Review.

Acknowledgements

About the Author

Chris McPhee is Editor-in-Chief of the *Technology Innovation Management Review*. Chris holds an MASc degree in Technology Innovation Management from Carleton University in Ottawa, Canada, and BScH and MSc degrees in Biology from Queen's University in Kingston, Canada. He has over 15 years of management, design, and content-development experience in Canada and Scotland, primarily in the science, health, and education sectors. As an advisor and editor, he helps entrepreneurs, executives, and researchers develop and express their ideas.

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Appendix 1. 100 Issues of the TIM Review and OSBR (Available at timreview.ca/issue-archive/)

| | **Technology Innovation Management Review** | | | |
	2011	2012	2013	2014	2015
January		Open Source Business	Open Source Sustainability	Open Source Business	Cybersecurity
February		Technology Entrepreneurship	Platforms, Communities, and Business Ecosystems	Seeking Solutions	Technology in Service Innovation
March		Technology Entrepreneurship	Local Open Innovation	Emerging Technologies	Innovation Tools and Techniques
April		Technology Entrepreneurship	Open Innovation and Entrepreneurship	Service and Innovation	Cyber-Resilience in Supply Chains
May		Technology Entrepreneurship	Technology Evolution	Service and Innovation	Insights
June		Global Business Creation	Insights	Opportunities and Capabilities	Critical Infrastructures and Cybersecurity
July		Social Innovation	Cybersecurity	Insights	Creativity in Innovation
August		Entrepreneurship in the 21st Century	Cybersecurity	Innovation and Entrepreneurship in India	Insights
September		Living Labs	Managing Innovation for Tangible Performance	Insights	Insights
October	Introducing the TIM Review	Born Global	Managing Innovation for Tangible Performance	Cybersecurity	Smart Cities and Regions
November	Recent Research	Insights	Living Labs	Cybersecurity	100th Issue
December	Intellectual Property Rights	Recent Research	Living Labs and Crowdsourcing	Innovation and Entrepreneurship	

| | **Open Source Business Resource** | | | |
	2007	2008	2009	2010	2011
January		Interoperability	Enterprise Participation	Success Factors	The Business of Open Source
February		Open Data	Commercialization	Startups	Recent Research
March		Procurement	Geospatial	Mobile	Co-Creation
April		Communications	Open APIs	Cloud Services	Collectives
May		Enterprise Readiness	Open Source in Government	Communications Enabled Applications	Technology Entrepreneurship
June		Security	Women in Open Source	Growing Business	Technology Entrepreneurship
July	Introducing the OSBR	Accessibility	Collaboration	Go To Market	Women Entrepreneurs
August	Business Models	Education	Tech Entrepreneurship	Interdisciplinary Lessons	Miscellany
September	Defining Open Source	Social Innovation	Business Intelligence	Keystone Companies	
October	Licensing	Building Community	Arts & Media	Sales Strategy	
November	Support	Health and Life Sciences	Value Co-creation	Economic Development	
December	Clean Intellectual Property	Enabling Innovation	Value Co-Creation	Humanitarian Open Source	

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The Emergence of the Lean Global Startup as a New Type of Firm

Erik Stavnsager Rasmussen and Stoyan Tanev

> “*A scalable startup typically requires a local population >100 million people. If your country doesn't have that, you need to be born global. Your country/industry needs a 'go global' playbook.*”
>
> Steve Blank
> Author and entrepreneur

This article contributes to the interplay between international entrepreneurship, innovation networks, and early internationalization research by emphasizing the need to conceptualize and introduce a new type of firm: the lean global startup. It discussed two different paths in linking the lean startup and born-global internationalization strategies. The first path refers to generic lean startups that have undertaken a rapid internationalization strategy (i.e., lean-to-global startups). The second path refers to startups that have started operating on global scale since their inception and adopted the lean startup approach by seamlessly synergizing their global and lean product development activities. The article emphasizes several aspects that could be used as part of the theoretical foundation for conceptualizing lean global startups as a special new type of firm: i) the emergent nature of their business models, including the challenges of partnership development on a global scale; ii) the inherently relational nature of the global resource allocation processes; iii) the integration of the entrepreneurial, effectuation, and global marketing perspectives; iv) the need to deal with a high degree of uncertainty, including the uncertainty associated with cross-border business operations; and v) linking the ex-ante characteristics of lean startups with the ex-post characteristics of born-global firms in order to develop a technology adoption marketing perspective that considers the "crossing the chasm" process as a successful entry into a global market niche.

Introduction

"Born Global or Die Local", as Steve Blank (2014) states, can be seen as the maxim for many new technology-based firms all over the world. At their start, a large number of these companies face the challenge of being both innovative and global at the same time. This challenge calls for the integration of two different research streams, which have until now been separate. The first stream is well established and focuses on international new ventures (Oviatt & McDougall, 1994) or born-global firms (Knight & Cavusgil, 1996; Rennie, 1993). The second stream is in the process of emerging and deals with the specifics of lean startups (Blank, 2013; Ries, 2011). The problems faced by lean startups and born-global firms during the early stages of their existence are to a large extent identical and could, from a theoret-

ical point of view, be analyzed in a unified way. Many of these problems are rooted in the challenge of dealing simultaneously with early internationalization (starting or going global), business modelling, partnership relationship management, resource allocation and innovation management under conditions of multiple uncertainties right from or near their founding. Integrating the two research streams offers the opportunity to look at the empirical evidence related to new technology startups in a way that could help the emergence of a more rigorous lean startup research field as well as contribute to the articulation of business design principles that would help the conceptualization of the "lean global startup" as a new type of firm. Combining the two perspectives above gives rise to a number of interesting issues that will be discussed in this article, which starts with a summary of insights from the literat-

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ure on lean startups and born-global firms, continues with a discussion focusing on the integration of the two streams, and concludes by providing a more detailed justification for the conceptualization of the lean global startup as a new type of firm.

Conceptual Insights Based on a Literature Review

The lean startup research stream and the born global/international new venture research stream arise from different traditions. Research on lean startups has been emerging from the technology-driven world with a focus on innovation, agile, and rapid product development, whereas the born-global research stems from the international business research with a focus on international operations, partnership development, marketing, and export. But, the two streams tend to share several key overlapping themes. First of all, they both seem to focus on the early stages of the business lifecycle and thus on small and medium-sized firms, and not on established multi-national corporations. Furthermore, they both focus on the entrepreneur and the founding or management team of the firm. And, from a more theoretical point view, both research streams have been inspired by both the effectuation research paradigm (Dew, Read, Sarasvathy, & Wiltbank, 2009; Dew, Sarasathy, Read, & Wiltbank, 2009; Sarasvathy et al. , 2014; Sarasvathy, 2001, 2008) and entrepreneurship research in general. In the next part of the article, the foundations of the two research streams will be outlined to illustrate the commonality of their theoretical backgrounds and especially of their empirical contexts.

Characteristics of born-global firms and the entrepreneurial challenges of early internationalization

The distinctive characteristics of born-global firms can be summarized as follows (Tanev, 2012):

1. The decision of a born-global firm to engage in a systematic internationalization process is usually determined by its nature – the type of technology that is being developed or the firm's specialization within the specific industry sector, value chain, or market (Jones et al., 2011).

2. Born-global firms tend to be relatively small and have far fewer financial, human, and tangible resources as compared to large multinational enterprises that have been considered as dominant in global trade and investment.

3. Many born-global firms are technology firms, although the born-global phenomenon has been widely spread beyond the technology sector (Moen, 2002).

4. Born-global firms have managers possessing a strong international outlook and international entrepreneurial orientation. The skills of top management teams have been found to be very important for the enablement of a more intense internationalization, particularly in the knowledge-based sectors (Andersson & Evangelista, 2006; Johnson, 2004; Loane et al., 2007).

5. Born-global firms tend to adopt differentiation strategies focusing on unique designs and highly distinctive products targeting niche markets, which may be too small for the tastes of larger firms (Cavusgil & Knight, 2009).

6. Many born-global firms leverage information and communication technologies to identify and segment customers into narrow global market niches and skillfully serve highly specialized buyer needs. Such technologies allow them to process information efficiently and communicate with partners and customers worldwide at practically zero cost (Maltby, 2012; Servais et al., 2006).

Many born-global firms expand internationally by engaging in international direct sales or by leveraging the resources of independent intermediaries located abroad. Very often, such firms cooperate with multi-national corporations by using their existing channels, networks, and Internet infrastructure to rapidly receive substantial revenues and cash flow (Vapola et al., 2008; Vapola, 2012). Multi-national corporations may act as systems integrators or distributors of products and services of born-global firms, providing opportunities for learning, technological infrastructure access, and evolutionary growth. Recent studies have thus emphasized that the early internationalization of such firms should be considered as an innovation process in itself and that innovation and internationalization have a positive effect on each other (Zijdemans & Tanev, 2014).

The lean startup approach

Steve Blank's introduction of the customer development process launched the lean startup movement (Blank, 2007). *The Startup Owner's Manual* (Blank & Dorf, 2012) describes a step-by-step process for man-

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aging the search for a new business model and provides entrepreneurs with a path from idea to a scalable business model. Blank's customer development process could be considered as a more comprehensive approach that enhances Moore's (1991) technology adoption lifecycle approach by describing the challenges of "crossing the chasm" between the early adopters and the first market niche, leading to the mainstream market. Eric Ries, a former student of Steve Blank, suggested a startup approach inspired by Blank's customer development framework (Ries, 2011). To describe his new approach he used the term "lean" from lean manufacturing to emphasize the core idea behind the methodology – the focus on eliminating waste, the non-value-creating efforts – that he saw in startups around him building products that nobody wanted. After refining and developing further the initial methodology in cooperation with startup owners, writers, and thinkers, Ries published his book *The Lean Startup* in 2011, thus contributing to the establishment of a lean startup terminology including the terms minimum viable product (MVP), pivoting, build-measure-learn, etc. Following the work of Ries (2011) and Blank, Eisenmann, Ries, and Dillard (2012) defined a lean startup as a firm that follows a hypothesis-driven approach to the evaluation of an entrepreneurial opportunity and the development of a new product for a specific market niche. The lean startup methodology focuses on translating a specific entrepreneurial vision into falsifiable hypotheses regarding a new product together with an associated emerging business model. The hypotheses are then tested using a series of well-thought prototypes and minimum viable products that are designed to rigorously validate specific product features or business model specifications. In this context, the entrepreneurial opportunity is based on shaping the new solution in a way that could solve a specific customer problem. The uniqueness of the methodology consists of its ability to explicitly take into account the numerous uncertainties regarding the suitability of a given solution towards a specific customer problem.

In recent years, a wide array of authors contributed to further developing the method by giving their take on the matter. Two other prominent contributors to the lean startup approach are Nathan Furr and Paul Ahlstrom (2011) with their book *Nail It then Scale It.* By observing both startup failures and successes, they started to see a pattern, which came to serve as the foundation of their approach. They suggested a three-step process where the entrepreneur starts with a hypothesis about the customer pain and then tests it. Once the customer pain has been identified and validated, a hypothesis about the minimum feature-set that is necessary to drive a customer purchase should be made. From there, a series of gradually more advanced prototypes should be built, while discussing and validating with customers each of the steps. Eventually, the customer solution will be "nailed", and the startup can focus on developing a go-to-market strategy and scaling the business. Other authors contributed to the original methodology by focusing on two different aspects. The first aspect is the operationalization of the lean startup approach with a focus on practical tools and frameworks. The most valuable example in this direction is the "running lean" approach by Ash Maurya (2012), which has received much attention. The second aspect is the extension of the lean startup methodology to a broader context including the management of new product design, development, and commercialization in established firms (Anthony, 2014; Arteaga & Hyland, 2014; Furr & Dyer, 2014).

Linking the Two Research Streams

If one takes a closer look at the two research streams, some common trends can be identified. The international new venture and born-global firm research field has its focus on how small and medium-sized enterprises can accelerate their entry into global markets, whereas lean startup research has its focus on how new entrepreneurial firms can develop new products and services and reach a large number of customers in a shorter period. Both research streams stress the complexity and the contingency of the process, the scarcity of resources, the innovation challenges, and the specific risks and uncertainties the firms have to deal with. The link between the two approaches can be found in their focus on entrepreneurship because, in both cases, the entrepreneurs have to learn to operate in complex and uncertain business ecosystems including suppliers, R&D partners, competitors, customers, etc. This is especially true in the case of high-tech firms, which have to be active on a global scale right from the beginning.

In several cases, technology entrepreneurship and innovation research studies have reached out to encompass themes that are typical of research focusing on born-global firms. For example, Bailetti (2012) examines how new growth-oriented technology firms can (or must) operate in a global market right from their founding. The entrepreneurs behind these technology startups must plan the internationalization of the firm in the right way from the very beginning. Moogk (2012)

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discusses the lean startup concept and how entrepreneurs can apply it to the process of new technology commercialization. This is done in a context of extreme uncertainty and technology startups have to learn to design and to use minimum viable products to be able to enter a market before potential competitors. Minimum viable products offer the possibility for the technology to be tested in a way that could help the evaluation and the facilitation of a firm's global growth opportunities.

Other authors, including Tanev and colleagues (Tanev, 2012; Tanev et al., 2014), have approached the technology startup and the lean approach from the born-global context. One of their recommendations is that researchers should focus on defining startup design principles that incorporate the key attributes of born-global firms and use these design principles to launch and grow new technology firms. Trimi and Berbegal-Mirabent (2012) have discussed the emerging trends in business model design by focusing on open innovation, customer development, agile development, and lean methodologies. According to them, all these approaches converge in the use of quick iterations and the adoption of a trial-and-error philosophy for validating the hypotheses of the business model and the appropriateness of specific product or services. The logic of the lean startup model could be substantiated by combining it with specific business model frameworks

that can integrate the entrepreneurial, innovation, and internationalization aspects of born-global startups (Onetti et al., 2012). The framework suggested by Onetti and colleagues (2012) defines the business model as the way a company structures its activities in determining the focus, locus, and modus of its business, where the "focus" of the business refers to the activities providing the basis of firm's value proposition (i.e., the set of activities on which the company's efforts are concentrated); the "locus" refers the location or locations across which the firms resources and value adding activities are spread (i.e., local vs. foreign based activities, inward-outward relationships, entry modes, etc.); and the "modus" refers to the specific business modes of operation with regards to the internal organization and the network design (i.e., insourcing and outsourcing of activities along social and inter-organizational ties, inward-outward relationships with other players, strategic alliances, etc.). The focus/locus/modus business model framework is one of the few that allows for accommodating the global dimension of resources, partnerships, and emerging technology markets.

There are also some distinctions between the characteristics of born-global firms and lean startups (Table 1). These distinctions offer additional opportunities for the exploration of potential synergies between the two research fields. For example, although there is a focus on

Table 1. Comparison of lean startups and born-global firms

Comparative Category	Lean Startups	Born-Global Firms
Type of firm	Technology startups	Small and medium-sized enterprises
Target market	New niche markets	Preexisting niche market
Product commercialization strategy	Technology adoption lifecycle model / Crossing the chasm to address first new market niche	Global marketing approach focusing on market entry strategies
Product development focus	New product development / Prototyping / Experimentation / Agile development	Innovative products / Technology excellence
Business model	Business model emergence	Business model development / Adoption
Entrepreneurship approach	Hypothesis-driven entrepreneurship	Exploring the value of effectual entrepreneurship but focusing on causal, goal-driven internationalization strategies
Overall temporal perspective of key business attributes	Ex ante	Ex post

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niche markets as the main target of firms' products and services, the emphasis is slightly different. Whereas the lean-startup approach focuses on the challenges associated with crossing the chasm between early enthusiasts and early adopters (i.e. on developing the first substantial market niche that would validate and economically fund the development of the whole product), the research on born-global firms seems to focus on market niche entry strategies (Burgel & Murray, 2000). The two perspectives could be integrated by considering the first market niche that would make a firm "cross the chasm" as a market niche in a global location with respect to firm's initial place of operation. In this sense, crossing the chasm for such a firm would in reality be equivalent to becoming global.

On the other hand, the lean startup approach takes a definitive new product development perspective and focuses on the challenges associated with moving across the stages of a specific technology adoption lifecycle, whereas research on born-global firms rarely discusses the challenges associated with the development of new offerings and focuses on the global marketing impact of competitive innovative products based on technological excellence or network effects. In other words, born-global firms seem to be considered in a context that is predominant about small and medium-sized enterprises, which is different from the context of a startup (Coviello, 2015). The reason for this difference is mainly historical given that the born-global concept emerged within the context of international business research focusing on retrospective studies of the process and antecedents of internationalization. Table 1 emphasizes the difference between the ex-ante and ex-post temporal perspectives of lean startups and born-global firms, respectively. It refers to the fact that lean startups operate in the anticipation of establishing a viable business model and a strong market position, whereas born-global firms are usually considered as having already established themselves in a global marketing context and benefiting from an established business model. In this sense, the challenges of linking the two research streams refer to the possibility of relating the ex-ante characteristics of lean startups to the ex-post characteristics of born-global firms.

For example, Bailetti and Zijdemans (2014) suggested a global value generation framework based on a dynamic resource perspective according to which the distinction between the ex-ante and ex-post value of resources. Schmidt and Keil (2012) complement the effectual entrepreneurial approach, which is typical of most technology startups, including those that global-

ize rapidly under conditions of high operational, competitive, and market uncertainties (Sarasvathy et al., 2014). The global value generation framework is based on the findings of Schmidt and Keil (2012), who identified four factors or drivers that make a resource valuable to a firm ex ante: i) the firm's ex-ante market position; ii) its ex-ante resource base, which allows for complementarities; iii) its position in inter-organizational networks, which allows them to access privileged competitive information; and iv) the prior knowledge and experience of managers, which allows them to make decisions that would lead to competitive differentiation. The key contribution of Bailetti and Zijdemans (2014) was to position these four drivers in relation to the ex-post characteristics of born-global firms and offer an analytical background for future research that could further substantiate the logic of born-global technology startup success. The global value generation framework was later adopted by Zijdemans, Azimi, Tanev, and Bailetti (2015), who focused on two of the drivers that appear to be most relevant for lean startups: i) the ex-ante resource base, which allows for complementarities, and ii) the firm's position in inter-organizational networks, which allows them to access privileged competitive information. One of the key findings was that the chances of successful access to a global market niche are much higher if a startup gets hold of resources with multiple complementary effects contributing to their global market position. The findings suggest a close interrelation between intellectual property strategy, lean startup development, and global growth, which could additionally enhance the effects of resource complementarity and the access to networks resources leading to global growth. Also, it was found critical to make a distinction between upstream and downstream resources on early internationalization. This distinction provides an opportunity to discuss the complementary downstream impact of ex-ante upstream resource allocation on a global scale. Last but not least, the multiple effects of resource complementarity could be further enhanced through the upstream and horizontal affiliations of executive managers with respected scientific, technological, and professional organizations. This is an important message for science and technology-based startups interested in pursuing a global growth strategy.

Conclusion

The reflections in this article suggest several different aspects that could be used as part of the theoretical foundation for conceptualizing a lean global startup as a special new type of firm:

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1. The emergent nature of their business models, where every specific business model framework is becoming just a template for the development of a viable business model.

2. The inherently relational nature of the (global) resource allocation processes.

3. The integration of the hypothesis-driven and effectual entrepreneurial perspectives.

4. The integration of the entrepreneurial, effectual, and technology marketing perspectives

5. The need to deal with the high degree of uncertainties associated with the overall business, marketing, technology innovation, and operational environment, including the uncertainty associated with cross-border business operations.

6. Linking the ex-ante characteristics of lean startups with the ex-post characteristics of born-global firms in order to develop a technology adoption marketing perspective considering the "crossing the chasm" process as a successful entry into a global market niche.

The distinction between ex-ante and ex-post perspectives (Schmidt & Keil, 2012) is an important aspect, which offers the opportunity to discuss two different paths in linking the lean-startup and born-global strategies in new technology firms and thus helping the conceptualization of the lean global startup as a new type of firm (Tanev et al., 2015). The first path is associated with the opportunity for generic lean startups to go global by undertaking a rapid internationalization strategy. Such lean-to-global startups (L2GS) establish themselves by using a generic lean startup approach on a local or national level and then engaging in a more traditional born-global journey by exploring internationalization opportunities short after inception. The second path is associated with the opportunity for global startups – in the terminology of Oviatt and McDougall (1994) – to adopt the lean startup approach since their very inception by seamlessly synergizing their global and lean activities. It might be appropriate for such new firms to be qualified as being both lean and global from the start (Tanev, 2012) or as lean and global startups (L&GS). One could define then the lean global startup (LGS) by using the following symbolic equation: LGS = L2GS + L&GS.

On a more fundamental level, the conceptualization of the lean global startup is inherently related to the relational and global business aspects of new technology firms. It includes firm's ability to: i) choose the operational focus, activities, internal resources, capabilities, and assets that it is best at maximizing, and ii) look for complementary external resources and partnerships (including global resources and partners) in order to complement their specific business and operational priorities. It is exactly their specific business and operational focus that predetermines the necessity and the relational nature of their global resource allocation process.

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3D Printing and Its Disruptive Impacts on Supply Chains of the Future

Sebastian Mohr and Omera Khan

“ One has to passionately believe it is possible to ” change the industry, to turn it on its head, to make sure that it will never be the same again.

Richard Branson
Entrepreneur, investor, and philanthropist

3D printing technology has emerged as one of the most disruptive innovations to impact the global supply chain and logistics industry. The technology is impacting our personal and professional lives, with some claiming that the technology will revolutionize and replace existing manufacturing technologies, while others argue that the technology merely enhances some aspects of the production process. Whether evolutionary or revolutionary, 3D printing technology is recognized as a striking trend that will significantly impact supply chains. Although the expansion of 3D printing in the private consumer market is an interesting development in its own right, the biggest potential for disruption lies in industrial applications and how 3D printing will influence supply chains of the future. In this article, we examine the areas of the supply chain most likely to be disrupted by 3D printing technology and we identify the key questions that must be answered in a roadmap for future research and practice. While we seek answers to these questions, we suggest that managers should develop a flexible change management strategy to mitigate the effects of disruption to their future supply chains and take advantage of the resulting opportunities. Those that do nothing will be left wanting, because the influence of 3D printing technology on supply chains is expected to grow.

Introduction

The concept of disrupting established systems and paradigms with innovative ideas and technologies has been prevalent throughout the history of mankind and is far older than any research documented about this topic. One of the earliest examples of this concept is the shift from hunter–gatherer groups to agricultural communes, which occurred approximately 12,000 years ago (Alday Ruiz, 2005), and well documented cases from more recent eras include the development of the Gutenberg printing press in the middle ages (Samuelson, 2000) as well as the invention of steamboats and the automobile (Mowery & Rosenberg, 1999) in the 19th century. Industrialization has been a strong enabler of innovation and technology disruption (Mowery & Rosenberg, 1999), with prominent examples being Henry Ford's factory and assembly line concept, which revolutionized industrial manufacturing (Batchelor,

1994) and the Microsoft operating system, which accelerated the adoption of personal computing (Chesbrough, 2003), thereby changing established paradigms and the status quo.

In modern times, cases of innovation disruption have become more frequent (Watson, 2012) with novel technologies such as the Internet of Things, autonomous machines, and high-end sensor technology being developed at a fast pace and applied in a wide range of different areas. 3D printing is one of these new, innovative technologies and it has made its mark on the industrial sector as well as the commercial market. The core principle of this method is that materials are added rather than subtracted from a larger raw material object during the manufacturing process, as is the case with conventional manufacturing; hence, 3D printing is synonymous with the term "additive manufacturing" (Campbell et al., 2011). It has successfully disrupted the

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prototyping industry and given birth to new fields in the areas of design and manufacturing. With the ongoing improvement of 3D printers in terms of accuracy, speed, and quality, the potential for future impact is immense (Mohr, 2015).

It is of paramount importance that we explore what aspects of the supply chain have the potential to be disruptive so that managers can be adequately prepared and agile to adapt to a changed environment. In this article, we share our views on the impact of 3D printing technology as a potentially disruptive innovation, which have been created through an extensive examination of the literature, research outcomes of a Master's thesis on the topic, and our discussions with experts in the field. Through a synthesis of the relevant literature, we identify seven key areas likely to be impacted by 3D printing technology:

1. Mass customization

2. Resource efficiency

3. Decentralization of manufacturing

4. Complexity reduction

5. Rationalization of inventory and logistics

6. Product design and prototyping

7. Legal and security concerns

For each impact area, we list and discuss a number of trends that we can expect to see driving these impacts. Then, we conclude by presenting a roadmap of key questions concerning the aspects of the supply chain that have the biggest potential of disruption.

Impact Area 1: Mass Customization

3D printing can have remarkable impacts on downstream sections of the supply chain, such as production and distribution. Tailoring individualized offers to each customer and the involvement of clients in design and production activities hold potential for a shift in priorities of cost and profit management, and late-stage postponement can make the supply chain more agile and flexible to react to changes in the marketplace (Petrick & Simpson, 2013).

Trends driving the impact
• The value proposition of this customization principle

is the inclusion of the customer into the design process, or in other words, the initiation of *customer co-creation* (Beyer, 2014).

• Customer involvement could potentially change underlying assumptions of supply chain strategies, redefining the "how, where, and who" of an established supply chain structure; thus, it may also change management priorities (Nyman & Sarlin, 2014).

• 3D printing could blur the line between purchase and creation, or in supply chain terms, it could merge design, manufacturing, and distribution (Tien, 2012).

Impact Area 2: Resource Efficiency

As an additive manufacturing technology, 3D printing has greater resource efficiency compared to most conventional, subtractive production methods (Campbell et al., 2011). This has led some authors to propose that the rapid success of 3D printing will initiate a change of view on natural resources with respect to material savings during production, smart redesign of components, and the ability to utilize recycled materials for the printing process (Reeves, 2009; Wigan, 2014).

Trends driving the impact
• 3D printing could enhance the development of the concept of the circular economy and promote the utilization of recycled materials.

• 3D printing produces less waste during manufacturing compared with conventional machines, thereby contributing to a greener, more environmentally sustainable technology (Janssen et al., 2014).

• Better use of postponement and late-stage customization through 3D printing could significantly reduce overproduction and excess inventory.

• 3D printing as a portable manufacturing technology will take production closer to the market, thus reducing global footprint of the supply chain and a reduction in carbon emissions (Petrick & Simpson, 2013).

Impact Area 3: Decentralization of Manufacturing

The relocation of manufacturing through 3D printing can bring considerable benefits in the form of on-location production and consumption as well as quicker responses to changes in demand. Reshoring manufacturing with 3D printing can improve time-to-market,

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responsiveness, and the degree of agility in the supply chain for small volumes of products, particularly those that require high technological specifications (Garrett, 2014).

Trends driving the impact
- The high ratio of output volume to space occupied makes the technology an enabler of distributed manufacturing (Birtchnell et al., 2013).

- 3D printing is useful for manufacturing in difficult-to-reach locations or in humanitarian logistics after a natural disaster (Tatham et al., 2014).

- 3D printing technology does not require the same skills as conventional manufacturing; manufacturing could be re-shored and take place closer to customers in their home markets, mitigating the risks of obsolescence.

Impact Area 4:　Complexity Reduction

3D printing is a powerful tool to reduce complexity in the supply chain, from the consolidation of components into a single product: by replacing previously assembled parts with a single component, the manufacturing process can be simplified significantly (Gao et al., 2015). Consequently, there is great potential for savings on internal cost and time through reduced supply chain complexity.

Trends driving the impact
- Component consolidation lowers not only the number of components in the manufacturing flow, it can also permanently reduce the number of stock keeping units (SKUs) in the system.

- 3D printing replaces many of the assembly steps required during the production phase in the supply chain with a single task; therefore, process complexity is reduced, making the flow of the material more transparent and easier to control (Janssen et al., 2014).

Impact Area 5: Rationalization of Inventory and Logistics

3D printing allows for production to happen on demand and at the point of consumption; therefore, the need to transport physical goods can be replaced by placing manufacturing close to the customer, which would lead to the rationalization of warehousing and logistics (Manners-Bell & Lyon, 2012). Furthermore, the movement of physical goods across the globe can be substituted by sending electronic files for the printers (Nyman & Sarlin, 2014). Digital inventory in the form of 3D model files for the entire product portfolio could replace physical inventory for technically complex products, further reducing the number of SKUs and the total number of stored parts.

Trends driving the impact
- The combined effects of 3D printing on various sections of the supply chain could potentially initiate a decrease in demand for global transportation of physical goods and inventory activities.

- 3D printing will have an impact on the volume of the inventory and on the inventory mix, including a shift to inventory in the form of raw materials (e.g., powders or filament coils) rather than semi-finished parts and components. The handling of these raw materials is cheaper, safer, and requires lesser skilled workers than the handling of semi-finished goods and final products.

Impact Area 6: Product Design and Prototyping

Because 3D printing technology is so versatile, it can produce a vast range of fundamentally different outputs cheaply, easily, and quickly. Therefore, 3D printers can play a key role in creating innovative processes for manufacturing and testing prototypes as well as new or updated product designs (Berman, 2012; Lee, 2013). 3D printing can also be used in direct manufacturing of products or product components (General Electric, 2015). This is primarily the case for product modules with a high need for customizability and a high degree of complexity, but comparatively low production volumes.

Trends driving the impact
- Due to its additive nature and direct digital-to-physical concept, product designers are no longer tied to traditional constraints imposed by production such as "design for manufacturing"(Mohr, 2015). Instead, many products can be redesigned almost entirely with a focus on other critical aspects such as enhanced functionality and material savings without compromising any of the attributes.

- Customer involvement in the design process will create "prosumers": individuals who are actively involved in the creation of a product while at the same being its main consumers.

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Impact Area 7: Legal and Security Concerns

Legal concerns have been and will continue to be an important topic of discussion in relation to 3D printing (Dante, 2014; Schildhorn, 2014). Some researchers argue that anything that can happen, will happen, including the printing of harmful objects such as guns or the bypassing of legal checks built into a traditional supply chain (Schildhorn, 2014). Furthermore, due to the fact that the current underlying legal framework does not consider the copying of physical objects, it is ill-equipped to define clear rules for the use of 3D printers. For example, who is held responsible for the printing of harmful objects such as knives and guns? Or, who is to blame if a 3D printed product fails: the designer, the printing machine manufacturer, the material supplier, or the company printing and selling the product? Thus, there is great uncertainty regarding the future impacts in areas such as personal injury, intellectual property theft, and product liability.

Trends driving the impact
• The technology is becoming more and more mainstream with the spread of open source modelling software and sharing platforms for 3D files, enhancing the risk of legal misconduct (Dante, 2014).

• Scanning technology that is used to transform physical objects into digital 3D printing files with ease is experiencing rapid development (Nyman & Sarlin, 2014).

Conclusion

The impacts described above illustrate why 3D printing has enormous potential to disrupt the status quo. This disruptive innovation threatens not only the established paradigms in the manufacturing industry, but also applies to legal and security concerns. With 3D printing technology being well established in many industrial production companies looking for new, innovative ways to expand the purpose of this technology and with 3D printing making a strong move into the commercial consumer market, this disruption could unfold sooner rather than later. It is likely that we will see a variety of disruptive, innovative ideas originating from new applications surrounding this technology, and although the future developments are highly uncertain, they are certainly worth investigating and discussing. In Table 1, we identify the key questions that must be answered in a roadmap for future research and practice so that researchers and managers can mitigate the negative impact of disruption or take advantage of its resulting opportunities. Although this disruptive innovation could be devastating for some elements of the supply chain, it can be the start of a revolution for others. Thus, supply chain managers must be aware of the potential impacts that this technology could have on their organization and accordingly, be prepared to react in a flexible and adaptive manner.

Table 1. Key unanswered questions about the disruptive impacts of 3D printing on future supply chains

Aspect	Questions
Manufacturing	• How will the emergence of 3D printing enable other innovations in this sector? • What knock-on effects will the disruption of manufacturing have in other areas?
Dispersed manufacturing	• How will the local-for-local business model affect global logistics activities? • Will there be a shift in transported goods towards more raw materials?
Design	• How will 3D printing continue to drive innovation in product design? • Which industries/product groups will be most affected by new designs?
Shift in skill requirements	• What skillsets will supply chain managers require in the future? • What will happen to the majority of the workforce in low-cost countries?
Sustainability	• Could 3D printing technology initiate a new era of sustainable businesses? • How will material savings and smart designs affect production in the long run?
Legal/security concerns	• Who owns the design/product risk? • How are the total costs of ownership defined?

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Towards an Agenda for Research and Practice

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> " *Cybersecurity is perhaps the most difficult* "
> *intellectual profession on the planet.*

Dan Geer
Computer security and
risk management specialist

In this article, we seek to identify the important challenges preventing security in cyberspace and to identify the key questions that nations should set out to answer to play a leading role in securing cyberspace. An important assertion is that the challenge of securing cyberspace transcends the abilities of any single entity and requires a radical shift in our approach in how: i) research is conducted, ii) cybersecurity researchers are educated, iii) new defendable systems are developed, and iv) effective defensive countermeasures are deployed. Our response draws upon extensive source material and our personal experiences as cybersecurity professionals contributing to the establishment of the VENUS Cybersecurity Corporation, a not-for-profit corporation that aims to make Canada a global leader in cybersecurity. We view the challenge to be global and transdisciplinary in nature and this article to be of relevance world-wide to senior decision makers, policy makers, managers, educators, strategists, futurists, scientists, technologists, and others interested in shaping the online world of the future.

Introduction

The explosive growth of the Internet has radically transformed the way we interact as a society. It underpins all facets of our critical infrastructure, enables global commerce, and affords us unparalleled near-real time access to information. It has also made us information-dependant in both our professional and personal lives. With the advent of the Internet of Things (IoT), we now live in a digital era that has rapidly transitioned society from a state best described by the term "always connected" to a new reality of "everything connected".

An unintended consequence of this connectivity is that it has introduced new vulnerabilities, adversarial threats, and challenges to our society. Network boundaries are becoming both blurred and porous. In fact, the overall "attack surface" of modern networks is increasing at an exponential rate. Cisco estimates that 15 billion devices will be connected to the Internet this year, increasing to 50 billion devices by 2020 (Macaulay et al., 2015). Each new device represents a new connection into the network and yet another potentially exploitable entry vector for an adversary. Perhaps most worrisome is that studies have shown that approximately 70% of these devices contain serious vulnerabilities (HP, 2014). Here, the asymmetric nature of cybersecurity comes into focus, namely the work factor for an attacker is the "cost" of finding a new attack vector while the defender bears a cumulative cost of all known attacks. Put more plainly, a defender has to stop all entry vectors into a network whereas an attacker only has to find one way in (Geer, 2015).

Although we can argue that the IoT represents a revolution of connectivity, the Industrial Internet of Things (IIoT) – the use of IoT technology in manufacturing – represents a steady evolution of structured connectivity. Anxious to reduce operational costs and increase industrial automation, the very "system of systems" that composes our critical infrastructure (e.g., the smart

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grid, water treatment, transportation, financial services) are all moving away from communicating over air-gapped enclaves to leverage the connectivity provided from information technology (IT) networks. Operational technology (OT) and IT networks have converged and, as a result, systems and architectures everywhere are at risk because they are being tasked to perform in unintended ways. In fact, recent high profile cyber-attacks against cyber-physical networks all highlight the fact that digital attacks are bridging from the virtual world to cause major damage in the physical world:

1. The Stuxnet computer worm was designed to infect and replicate using Windows operating systems in order to overwrite Siemens Step 7 software. It targeted the Iranian nuclear program and, once installed, Stuxnet, allowed for both surveillance of enrichment activities and sabotage by causing centrifuges to spin out of control (Langer, 2011).

2. The self-replicating virus dubbed "Shamoon" operated in three distinct phases to attack Saudi Aramco, a national petroleum and natural gas company in Saudi Arabia. The first phase was used to infect a system in order to steal data. In the second phase, the virus attempted to infect connected systems within the local network in order to maintain persistence in the target network. Finally, in the last phase, the virus attempted to hide its "tracks" using destructive techniques that include overwriting accessed files and the system's master boot record (Bronk, 2013).

3. In 2008, intruders exploited the software running on surveillance cameras along the Baku–Tbilisi–Ceyhan (BTC) crude oil pipeline in Azerbaijan, Georgia, and Turkey. The exploit allowed them to gain access to software that provided operational control of the pipeline so they could increase pipeline pressure without raising alarms, ultimately causing an explosion that shut down the pipeline (Robertson, 2014).

4. Germany's Federal Office for Information Security (BSI) reported massive damage to an unnamed steel mill in Germany. The mill suffered an intrusion through malicious software attached to an email that allowed for unauthorized access to critical plant components. The threat actor showed knowledge of industrial control systems and caused cascading system failures that resulted in a massive explosion (Zetter, 2015).

However, there are also many examples of success stories in the quest to secure cyberspace:

1. Operation Tovar was an international collaborative effort among law enforcement agencies to counter the Gameover Zeus botnet used by cybercriminals to perpetrate bank fraud and distribute the malware referred to as CryptoLocker ransomware (Dawda, 2014). CryptoLocker was a Trojan horse program that would encrypt files on a hard drive and would display a message stating that a ransom or payment would have to be made in order to decrypt them. After the botnet's command and control infrastructure was taken down, the decryption keys were recovered and made available to victims free of charge.

2. The Australian Signals Directorate has released a list of the top 35 mitigation strategies to against targeted intrusions. Those organizations that followed the mitigation strategies have shown a dramatic improvement in terms of lowering the number of successful intrusions (Stilgherrian, 2015).

3. Level 3 Communications and Cisco teamed up to shut down a major malicious network that targeted approximately 90,000 systems with the Angler Exploit Kit malware. Command and control servers were identified and shutdown, thereby denying the botnet operators $30 to $60 million a year in criminal proceeds from bank fraud and ransomware (Avery, 2015).

Nonetheless, the security of cyberspace is a problem domain where there are more questions than answers. As implied by the opening quotation, it is a challenge that is incredibly intellectually demanding. According to Geer (2015), a key reason is that "there is no real ability to perform controlled experiments, yet uncontrolled natural experiments are all round us all the time even though data quality from those natural experiments is constantly confounding the issue". These "uncontrolled natural experiments" are a reference to real-world impacts on an increasingly online interconnected global society of man and machines.

As this article will show, the threat environment is rife with challenges. However, with these challenges comes opportunity. In aiming for a goal of cybersafety, there is the possibility of profoundly increased productivity and creativity (Bailetti et al., 2014; Nagger, 2015). This perspective emphasizes cybersafety as an important ena-

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bler of a globally connected future society that functions at a different level and pace than today's world.

Within this broad domain, our perspective emphasizes the opportunities for Canada and similarly positioned countries to thrive in the future if they can earn leadership positions in securing cyberspace. In this journal, Bailetti and co-authors (2013) proposed a not-for-profit corporation – what became the VENUS Cybersecurity Corporation (venuscyber.com) – as an innovation engine to make Canada a global leader in cybersecurity. The overall system-level intent of this effort is to convert innovation into the following results: i) new knowledge jobs; ii) addressed gaps in cybersecurity R&D and in operational limitations; iii) new highly qualified people operating in the cybersecurity space; and iv) sustainable income for the operator of the innovation engine (Bailetti et al., 2013). The resulting effort expended to launch and operate the VENUS Cybersecurity Corporation has further informed our view on the nature of the problem and how to address the challenge in Canada, but there remain many issues to be resolved and many open problems to be addressed. In particular, through our contributions to the establishment of the VENUS Cybersecurity Corporation, we have learned that:

1. Industry leadership is lacking. Canada's Cyber Security Strategy (Government of Canada, 2010) has the stated goal "to protect critical infrastructure". This simply cannot be accomplished without the direct involvement of critical infrastructure industries. Sadly, although these industries must deal with cybersecurity issues, given that the potential negative impact on their bottom line is enormous, they have still not found a way to monetize these efforts, which are seen only as an expense as opposed to an investment opportunity, a market differentiator, or simply a de-risking investment to protect their brand.

2. Critical mass is lacking across all sectors. Because cybersecurity is a systemic problem, it can only be efficiently addressed through concerted efforts that involve the supply chain of this same critical infrastructure industry. It is a "weakest link in the chain" issue and individual vendors are not willing to invest unless they are explicitly compelled by mandatory standards, which do not exist. Compounding the issue, the government sector has not effectively facilitated an appropriate level of engagement from all sectors in a unified and coordinated way.

3. Securing cyberspace is a societal concern that has no easy or obvious solution. Like health, cybersecurity cannot be addressed and resolved once and for all. Unlike the health domain however society has simply not yet reached a level of consciousness where it decides to generate the policies required to create a global response that has a chance to potentially match the global risk.

There are other jurisdictions that have solved some of these concerns or at least are more advanced than Canada. For example, the United States has been able to leverage its vast research and development capacity, including a network of national labs, not-for-profits, and high-end academic research programs, to better address the breadth and depth of the challenge. The United Kingdom has just announced a national cybersecurity plan, which includes the establishment of a National Cyber Centre to provide "economic security, national security and the opportunity that comes to a country that provides that security" (Osborne, 2015), which builds upon their more mature research and innovation programs.

Based on these lessons, this article proposes to identify the key questions that can be answered by building intellectual and industrial capacity in a coordinated fashion and by better leveraging existing talent to secure cyberspace for the greater prosperity of all. We present our analysis within the Canadian context, although much of the discussion can apply to other countries.

First, we provide necessary background information about the challenges of the threat environment. Next, we describe the key drivers to securing cyberspace. Finally, we identify the key questions that will form the basis of an agenda for research and practice. Finally, we offer conclusions.

Background: Challenges in the Threat Environment

Keeping pace with the constantly evolving cyber-threat landscape is a daunting task. This is coupled with the fact that IT security systems and architectures, everywhere, are being tasked to perform in ways they were never intended to operate. Specifically, the Internet is a complex globally distributed system that was initially designed for maximizing connectivity with very little thought about security. Geer (2015) highlights that "the security of cyberspace means responding to sentient opponents", while Wechsler (2015) argues that securing cyberspace is first and foremost about all-encompassing recognition to detect cyberspace intrusions that are adversarial in nature. The key point is that, in

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the face of sophisticated adversarial threats, the world simply does not know how to secure cyberspace.

With this context in mind, we identify a set of seven observations based on practical knowledge of both the threat environment and state-of-the art cyber-defence countermeasures, gained during our professional work and contributions to the establishment of the VENUS Cybersecurity Corporation:

1. Tractable network defence postures focus on understanding the interaction/correlation of both internal and external network behaviours: modelling the Internet at an enterprise network edge is not a tractable security approach. Recent cyber-threats have shown that even state-of-the-art commercial security products are not sufficient to block intrusion attempts from sophisticated threat actors referred to colloquially as advanced persistent threats (APT). Well-financed criminal enterprises and nation states with modest budgets can purchase, configure, and automate malware detection test suites comprised of the latest ant-virus software, personal security products (PSPs), firewalls, etc. To rise to the challenge, we must expect that the adversary has a copy of the commercial product(s) we employ to defend our networks for their own in-house malware testing and adapt our defensive tactics accordingly.

2. Detection techniques must have the necessary fidelity to enable non-human-in-the-loop automated defences. Current intrusion detection approaches are flawed because they focus on incoming network traffic looking for malicious behaviour. The issue with this approach is that the volume, velocity, and variety of Internet traffic are increasing at an exponential rate – the current coping strategy is bound to fail. Couple this with the fact that novel intrusions can exploit publically unknown vulnerabilities (i.e., zero-day exploits) and thus have no observable a priori pattern. More effort is needed to exploit the temporal advantage enjoyed by the network defender (e.g., observation of subtle changes in the network using network/host baselines over time) to develop techniques to observe abnormal lateral networks movements and command and control (C&C) patterns within the network.

3. The threat landscape has outpaced our quantification of the threat – sophisticated exploits are becoming democratized while sophisticated threat actors are interested in low value information and compute

resources. We must address the negative causal link between false positives and false negatives (i.e., the fidelity of detection has to improve to a point where sophisticated automated defensive actions are the norm). Generating an "incident report" or requiring an analyst to investigate a suspected intrusion is akin to "admiring the problem". Although the initial suspected infected system may be identified and remediated, other systems inside the network may now also be compromised (e.g., lateral adversarial movements in the network to establish persistence). "Time to action" must be minimized by identifying and eliminating (where possible) human-in-the-loop decisions/bottlenecks/transforms. The work force is finite; acceleration of the analytic workflow needs to be leveraged by using systems/processes that are scalable and repeatable.

4. A state-of-the-art network defence posture must borrow from an attacker's playbook and invoke a "weird machine" paradigm, for example, a heterogeneous deployment of commercial products or non-standard deployments to enable a non-standard and thus "best of breed" detection approach. Traditional threat risk assessments (TRAs) are broken. Standard TRA methodologies typically underestimate the threat and, although the process serves to indicate some measure of due diligence has been taken to assess the network security posture, it can amount to a form of "security theatre". Recent high-profile attacks have shown us that: i) sophisticated adversaries are interested in "low value information"; ii) sophisticated exploit tools/frameworks are widely promulgated at no or low cost, thus removing the requirement of high technical skill as a barrier to entry; and iii) outsourcing of vulnerabilities research means that zero-day exploits are commoditized and available for sale.

5. Convergence of IT and OT networks has exposed critical components to a wide range of cyber-threats that are not traditionally monitored by IT staff and existing cybersecurity technologies. With increased Internet connectivity and the advent of the industrial Internet, physical systems are increasingly being targeted by cyber-attacks. The critical infrastructure that underpins our society, such as electric and water utilities, manufacturers, and oil and gas operators all use industrial control systems (ICSs) to support these industrial processes. Perhaps the most prevalent ICS is SCADA (i.e., supervisory control and data acquisition). ICS/SCADA systems are part of the OT networks comprised of electromagnetic systems (i.e., physical

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systems) that were designed to operate in an environment largely separate from conventional IT networks (i.e., cyberspace). These converged IT/OT networks are now being connected to the Internet (directly or indirectly through corporate networks), thereby increasing their exposure to a wide range of cyber-threats. This is coupled with the fact that OT networks are not traditionally monitored by IT security staff and existing cybersecurity technologies. As a result, the merging of the cyber-physical networks has been done in an ad hoc manner with very little thought about inherent vulnerabilities, secure network topologies, and state-of-the-art protection mechanisms.

6. Access to highly qualified personnel (HQP) is limited and significant training and experience is required to transform new recruits into cybersecurity professionals. In fact, the need for seasoned, well-trained cybersecurity researchers and professionals has outpaced supply: over the last five years, the demand for cybersecurity professionals has grown approximately 3.5 times faster than demand for other IT positions (Burning Glass, 2015). One might argue that this skills gap could be addressed by using a transdisciplinary approach to hiring by targeting individuals with a high degree of technical aptitude and "trainability" versus the requirement for a STEM background. However, this approach would not obviate the time delay caused by the significant amount of training and practical experience required to transform a new recruit into a cybersecurity professional.

7. The profound lack of shared meaningful data sets limits the repeatability and reproducibility of experimental results for new cybersecurity tools and techniques. Cybersecurity researchers are often relegated to using data sets obtained from lab or synthetically manufactured datasets that skew the experimental outcomes as a result of having a lack of naturally occurring abnormal network behaviour, or *crud,* that is regularly seen in real networks (Paxson, 1999). Conversely, some researchers have the advantage of having access to large "real world" networks for testing but due to privacy and legal concerns cannot share the data with the broader community. A balance has to be struck between privacy concerns and the lack of available curated datasets.

Key Drivers to Securing Cyberspace

When assessing the need for anticipatory intelligence, O'Connell (2015) suggests that "analysis will deepen de-

cision-maker understanding of what is *driving* an issue so as to better and more deliberately prepare for it". When assessing the nature of the challenge of securing cyberspace, we identified three key drivers:

1. Complexity of the problem space

2. Accelerated pace of change

3. Finite internal capacity

Key driver 1: Complexity of the problem space

The first key driver to securing cyberspace is the complexity of the problem domain (Geer, 2015; Wechsler, 2015), which is illustrated by the nature of the challenges in the threat environment, as described in the previous section. Geer (2015) notes the possibility of introducing irreversible and unintended effects that are permanently incompatible with fundamental values when responding to sentient opponents. To accommodate these kinds of concerns, Douba and colleagues (2014) introduced a weak transdisciplinary framework that explicitly accommodates a value level (theology, ethics, and philosophy) along with normative (intent, risk-based decision making), capacity (technical disciplines), and empirical (real-time manifestation of phenomena) levels when contemplating the nature of "cybersafety of the online world of the future".

Key driver 2: Accelerated pace of change

The second key driver is the exponentially increasing rate of scientific and technological change. Using a retrospective analysis, Urban (2015) provides a convincing description of the Law of Accelerating Returns – the informal law that advances are becoming bigger and bigger and happening more and more quickly. Urban (2015) directly conveys how fast things will change in the future: "All in all, because of the Law of Accelerating Returns, [Ray] Kurzweil believes that the 21st century will achieve 1,000 times the progress of the 20th century." Assuming that a weak transdisciplinary framework is useful when representing and analyzing the problem domain, we argue that it is important to introduce the increasing rate of change to the framework. The value level may change more slowly than the capacity or empirical levels but a deeper understanding of securing cyberspace may mean a deeper understanding of how the different levels of the framework interact given that change happens faster at different levels.

Key driver 3: Finite internal capacity

The third key driver is a recognition that any individual, organizational, national, or even global initiative will

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have limited resources to make cyberspace secure, whether the resources are people, money, infrastructure, and so on. In terms of the transdisciplinary framework introduced by Douba and colleagues (2014), this driver primarily manifests itself at the capacity and empirical levels, but there would clearly be manifestations at the value and normative levels too. Society needs the higher levels of the model to provide guiding principles as opposed to constantly lagging behind and reacting to technological innovation. In general, there is also an important interplay with the second key driver, because one of the characteristics of the accelerated pace of change is the potentially exponential ability to do more with less or to accomplish previous, or new tasks, in completely new ways in response to limited resources.

Focus Areas and Key Questions

In our judgement, although each driver is distinct, these three drivers together represent the primary forces that drive an organizational, national, or global strategy that intends to address the challenge of making cyberspace safer. In contrast with the current state of affairs, which is comprised of many disconnected cybersecurity research and practice agendas, we advocate an approach that provides a unified response to these primary forces.

For Canada, we believe attention should be given to three focus areas, one per driver, to further secure cyberspace in a manner that is to Canada's advantage. For each focus area, we also identify the outstanding questions that, if answered, could allow a nation such as Canada to earn a global leadership position in securing cyberspace. Although the security of cyberspace is a problem domain where there are more questions than answers, this article presents "the big questions" that should be addressed first.

1. Focus on establishing a deep understanding of securing cyberspace by engaging the right brain on the right problem at the right time. This focus area should leverage Canada's existing cadre of highly qualified experts, important relationships, and a unique society that is attractive to external expertise. However, there is currently a lack of coherent long-term vision (which anticipates the evolution of the problem domain) and a lack of internal expertise to engage external experts (due to the breadth and complexity of the domain or an inability to establish local expertise in a timely fashion). Thus, our key "big questions" in this focus area are:

- *What is an appropriate knowledge and learning framework to address the challenge of securing cyberspace?*

- *What is the best way to make systematic breakthroughs?*

- *How can Canada best leverage its limited human capital and also improve the productivity of this limited resource?*

2. Focus on "surfing the wave of change" by understanding what kind of change must happen and adapting constantly to secure cyberspace. Currently, Canada is not recognized as a global centre of innovation nor is it considered to be at the forefront of science and technology. Because of a poor strategic position, there is a danger Canada will be overwhelmed by the force of accelerating global change. However, given the opportunity to ride the wave of change to gain competitive advantage, Canada's relatively sophisticated but small-scale society means it has the structural make-up to support agility – there is the real possibility that Canada has the acumen to understand what kind of change must happen and to enact change. The implication is Canada will become more and more prosperous by harnessing specific scientific and technological breakthroughs in a timely fashion. Thus, our key "big questions" in this focus area are:

- *What is the best way to understand what kind of change must happen?*

- *What is the best way to keep pace?*

- *What is the best way to adapt to change that must happen?*

3. Focus on leading global initiatives that are significant to enhancing Canadian expertise and capacity to secure cyberspace. In our view, Canada is currently too constrained by rigid management processes, organizational boundaries, and budgets to coordinate public, private, academic, and non-governmental sectors. However, Canada does have world-class practical cyber-expertise that could evolve to lead global initiatives that are significant to securing cyberspace to Canada's advantage. If Canada can lead or leverage external initiatives while augmenting its internal expertise and capability, it can make a greater impact within the globally connected world of the future and effectively address the challenge of securing cyberspace to its advantage. Thus, our key "big questions" in this focus area are:

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• *What is the best way to indirectly scale Canada's limited resources?*

• *What is the best way to directly extend or augment Canada's finite capacity?*

• *What is the best way for Canada to establish credibility and have influence on a global scale?*

The challenge of securing cyberspace is perhaps never-ending and it is certainly daunting. However, we believe that progress can be made using an approach that features sustained vigilance and adaptable tools, which are as important as the tactical fixes that currently dominate the domain. Our intention here is for these focus areas and questions to become a starting point in developing an agenda for research and practice to secure cyberspace.

Through our involvement with the VENUS Cybersecurity Corporation, we are taking some early steps in this direction. As an ecosystem-based initiative, VENUS has to date established a network of core expertise that will incrementally grow to address the transdisciplinary nature of the challenge as understanding deepens. To this end, groundwork is being done to establish an open source foundry to enable the deployment of state-of-the-art capability for securing cyberspace. Interworking arrangements are being established with critical infrastructure providers to address the hardest cybersecurity concerns. Finally, initial partnerships are established or being established with important research and innovation organizations in the United States and the United Kingdom to collaborate with the right brains at the right time on the right problems.

Conclusion

The security, robustness, and stability of our access to electronic information and services are keystone requirements for sovereign economies. Without this assurance, nations are unable to effectively conduct business, deliver goods and services, and ensure uninterrupted operations in the global marketplace. An important assertion is that the challenge of securing cyberspace transcends the abilities of any single entity and requires a radical shift in our approach in how: i) research is conducted, ii) cybersecurity researchers are educated, iii) new defendable systems are developed, and iv) effective defensive countermeasures are deployed.

Accordingly, this article shared and built upon lessons learned from attempting to establish a not-for-profit corporation as an innovation engine to make Canada a global leader in cybersecurity: the VENUS Cybersecurity Corporation. We learned that industry leadership is lacking, critical mass is lacking across all sectors, and securing cyberspace is a societal concern that has no easy or obvious solution. With this context in mind, we identified a set of seven observations based on practical knowledge of both the threat environment and state-of-the-art cyber-defence countermeasures. We determined, at the heart of the problem, there are three key drivers: the complexity of the problem space, an accelerated pace of change and finite internal capacity. Three focus areas and associated questions were then identified to form the foundation of an agenda for research and practice to secure cyberspace.

In Canada, our view is that the status quo is represented by an overly insular Canadian society that attempts to independently "solve" the challenge of securing cyberspace on its own. However, there is an opportunity for Canada to play a leading role in securing cyberspace by engaging with external expertise and capacity using a transdisciplinary, ecosystem approach. By playing a leading role in securing cyberspace, we believe that Canada would benefit by attracting investment, creating high-value jobs, ensuring economic growth, encouraging companies to establish and grow, strengthening supply chains, developing industrial capabilities, fostering innovation and fostering success in export markets as cyberspace is better secured for the benefit of society as a whole. Through building intellectual and industrial capacity in a coordinated fashion, existing talent will be better leveraged and new talent will grow in a manner that enables Canada to gain a leadership position in securing cyberspace. Beyond the Canadian context, there is a need for global contributions to address the key questions identified here so we can better secure and shape the online world of the future.

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Q&A

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Q. *In the Innovation Game, Why Do So Many Companies Stay on the Sidelines?*

A. In today's global business environment, innovation is an extreme sport, where teammates, opponents, the playing field, and the rules of the game change all the time. In order to succeed, companies have to be highly skilled and react quickly to these changes – but more importantly – success depends on actually playing the game, not watching from the sidelines.

As research during the past several decades has shown, the innovation game increasingly depends on collaboration between players, for example with innovation driven by lead users (von Hippel, 1986), open innovation (Chesbrough, 2003), and co-innovation with several players (von Hippel et al., 2011, Lee et al., 2012). Still, although there are greater opportunities to develop new successful innovations by means of collaboration, such approaches also bring new risks (Pisano & Teece, 1989), which undermine a company's intention to collaborate. Such risks include loss of knowledge, higher coordination costs, as well as loss of control and higher complexity. The "not invented here" syndrome is another typical reason for staying on the sidelines of the innovation game (Chesbrough & Crowther, 2006). Furthermore, especially in small and medium-sized enterprises (SMEs) quite practical reasons such as challenges in finding the right partner, identifying relevant external knowledge sources, imbalance between innovation activities and daily business, or insufficient time and financial resources, hinder their participation.

Among both academics and practitioners, the collaborative innovation models are increasingly better understood, and companies are increasingly aware that they can benefit from such collaborations, whether it is among fore-runner companies such as Procter & Gamble or LEGO or among agile startup firms (Muegge, 2013) or open source communities within software industry (West & Callagher, 2006). Thus, regarding more traditional industries, it is also important to notice that an innovation model of co-creation of immaterial products, such as software, cannot be directly adapted to innovation in physical production (Bauwens, 2009).

But, given that around one third of innovating companies drew upon external development or knowledge sources from 2010 to 2012 (OECD, 2015), there are still many, many companies sitting on the bench and just watching the innovation game. There is also significant effect of firm size when collaborating on innovation: large firms are usually two to three times more likely to engage in collaboration than SMEs (OECD, 2015). These firms, still sitting on the sidelines, are either doubting that it would work for them or stalling because they just do not know how to actually start playing the game or cannot figure out with whom they should play. And so, a key future challenge is to help companies make the leap from sidelines to playing field so that they may reap the rewards of collaborative innovation.

In business, success rarely comes in the form of winning the game – success means you are able to keep playing. But, losses are common. In many cases, companies lose when they fail to adapt. Traditional players may enjoy great success for some time and then fail to adapt to changes, for example, because their playing style stagnates; they become locked in to key personnel, strategies, information flows, norms, and mental models. Then, new players may come from unexpected directions and with new playbooks. They are not creating entirely new games, but rapidly attacking to the gameplan of traditional players by using, for instance, new combinations of superior technology and compelling customer experience. There are several examples of how established corporations, for example Nokia, Blackberry, and Kodak, have quite suddenly found themselves unable to adapt. When this happens, the innovation game can be unforgiving.

Companies must be prepared for setbacks, but the risks are greater if they choose not to innovate. They must accept that the innovation game comes with risk, and they must be prepared to change their way of thinking, and not only among the coaching staff, because innovation is a team sport. Innovation should be a part of every employee's work, not only of those working in an R&D department or on the front lines of business development (Lafley & Charan, 2008).

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But, even if a company is aware of the benefits, accepts the risks, and is ready to take on the challenge of moving from the sidelines to the playing field, several key questions remain:

1. Where should they play?

2. With whom should they play?

3. How should they play?

Where to play
The answer to the question of where to play often depends on the nature of the business. One option is to seek out innovation centres or platforms that facilitate collaboration between different players, such startups, venture capitalists, accelerators, vendors, and academic institutions. Global technology hubs are the preferred destinations for setting up innovation centers. For instance, 60% of companies that have set up these centres have a presence in Silicon Valley (Capgemini, 2015). In many sectors, the locus of the innovation game is changing from local or regional places to virtual spaces and platforms (Muegge, 2013). When operating on large geographical scales, for instance, when exclusively using Internet platforms, the levels of interaction and collaboration between the players in the innovation game may remain low. Therefore new ways to integrate global and local playgrounds – physical and virtual meeting places – is required.

The global playing field creates powerful opportunities for players to access far-away markets and scale quickly, right from a company's inception, as evidenced by "born global" firms (Rasmussen & Tanev, 2015; Tanev, 2013). However, companies may find that their local playing field contains valuable opportunities and relationships. In the special issue of the TIM Review on "local open innovation" (timreview.ca/issue/2013/march), the focus was on the local game – meeting nearby players and learning how their skills can complement your own game. With local open innovation, Deutsch and Dancause (2013) stress the importance of fostering: i) input from "unobvious" sources; ii) informal relationships and interactions; and iii) serendipity. Similarly, living labs provide ready-made real-life environments for companies to interact with users and other stakeholders to create unforeseeable innovations (Leminen, 2015). Ultimately, the challenge focuses on how quickly ideas can be tried out and changes can be made, therefore the emphasis has been on rapid experiments, simulations, and pilots. These approaches make it easier for companies to step off the sidelines and get into the game so that they may benefit from new models of innovation.

With whom to play
Market sources, including other companies (e.g., suppliers), customers, or competitors, are the traditional sources of external knowledge and the most typical even today (OECD, 2015). Especially in R&D gate models and processes, early involvement of suppliers (ESI) models are an actively discussed phenomenon (Bidault et al., 1998; Johnsen, 2009). On the other hand, the service literature emphasizes service co-creation with customers (Hakanen & Jaakkola, 2012; Vargo & Lusch, 2008). Ever since von Hippel (1986) introduced the concept of a "lead user", there has been much discussion about the benefits of empowering consumers and end users to participate in innovation processes. Subsequently, innovation researchers have distinguished different collaboration models such as customer-focused innovation, customer-centred innovation, and customer-driven innovation (Desouza et al., 2008).Thus, larger companies are two or three times more likely to collaborate with research institutes or higher-education institutions than SMEs (OECD, 2015), meaning that larger companies have more experience in with different playing fields as well as with different players.

In today's networked economy, the boundary between a customer and a supplier is "fuzzy" or unclear – especially regarding the innovation and exploration of new knowledge (Paasi et al., 2010) and the importance of including other stakeholders is now recognized (Pedrosa, 2009). In the innovation game, these relationships with other players are dynamic: when the game suddenly changes, it may also mean that the customers or suppliers change. Still, the literature on inter-organizational relationships often highlights how relationship building and network management are longitudinal tasks, although these arrangements should be distinguished from companies by their temporality (Halinen et al., 2012).

In this fast-changing game, companies must consider how they are perceived by other players. One way to survive and succeed in the innovation game is to be an attractive team member. Companies need to continually strengthen their network positions and keeps themselves and their employees sharp. The key is to develop specific capabilities and clearly communicate your needs to other players who may become collaborators.

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And, as shown in the previous section, the choice of where to play affects who is available to play, whether it finding a global partner through an international innovation platform or getting out and meeting a helpful "neighbour" with complementary skills and needs. New types of players and coaches, such as open innovation service provider and other intermediators, can also help to play the game. It is important to look beyond the usual suspects and find new collaborators (Deutsch & Dancause, (2013). Both researchers and practitioners can also find new ways to involve all players in the innovation game: everyone will benefit if we can encourage the ones who are now sitting on the bench.

How to play
The innovation game is changing all the time. When players make decisions and calculate future alternatives, they are looking forwards. However, the future is always uncertain, and the game can really only be understood when looking backwards and reflecting on the moves made by each player and the consequences. Instead of aiming to avoid uncertainty, players must be flexible and prepared to make adjustments; the connectivity with other players implies that a decision or action by one influences all others, but not in any uniform manner. The results of the game appear from the dynamics of strategic manoeuvring amongst players, and therefore the key success factor is the player's ability to manage dynamic strategic interactions related to innovation (Aveni, 1997). This ability can be enhanced by studying the game and the behaviours of other players, and continually learning how to be a better player.

Innovative and future-focused players seek opportunities to maximize communication and interaction among actors in order to create knowledge synergies and new business opportunities. The practical challenge is to master a strategy of "plug, play, and repeat":

1. *Plug:* quickly find new unknown collaboration parties and evaluate them.

2. *Play:* configure collaborative settings that encourage players to work towards shared purposes, with enthusiasm.

3. *Repeat:* the game can change at any minute, so players must be prepared to repeat the "plug" and "play" steps with new partners working towards new goals.

This new approach encourages preparation and flexibility, but is not easy and it may take some companies far out of their traditional comfort zone. The new maps for searching business opportunities may be based on the connections rather than locations and their distances. The connections are built on different exchanges of, for example, information, money, resources, or social relationships.

Future research
To help more companies step onto the playing field, there are several areas that should be researched to complement our current understanding on how to play the innovation game.

First, given that knowledge is highly dispersed and complexity grows all the time, new sources of innovation are required. New players are needed and companies must search hard both locally and globally for problem solvers, and they must be prepared to collaborate with previously unknown partners.

Second, in addition to formal intellectual property rights, tacit knowledge will play a key role as the need to share (or protect) different knowledge sources increases. Furthermore, players should also be able to find the dark side of their knowledge base: knowing what questions that they are not able to answer.

Third, companies require several playbooks, or innovation models, to be used concurrently as they fit their strategies to different games and goals. For instance, companies are simultaneously connected to the global economy and its specific rules as well as social networks and communities, which operate by different sets of rules. Further research and insights from practice are needed to help companies develop their own style of "plug, play, and repeat" strategies.

Finally, to help companies feel confident enough to join the game, there needs to be further research about how exactly to change mindsets, meet potential collaborators (who may be unknown), figure out quickly if they are a good fit and can be trusted, and then lead the enthusiasm. A promising research approach to future-oriented innovation games follows system theory thinking (e.g., Ashby, 1958; Luhmann, 1995) and is based on systemic and practice-based approaches (Valkokari et al., 2011). According to this approach, the continuous change can be seen as ongoing improvisation: the innovation players' readiness to constantly disrupt themselves through strategizing and organizing within the innovation game. Thus, making game-specific decisions requires local and experiential knowledge, which can be gained only by playing the game. And the game cannot be played from the sidelines.

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TIM Lecture Series

Creating Life-Saving Media as a Social Entrepreneur
Firdaus Kharas

> " *I stay focused on the person whose behaviour* "
> *we are trying to change.*

Firdaus Kharas
Social innovator, director, and humanitarian

Overview

The TIM Lecture Series is offered by the Technology Innovation Management (TIM; timprogram.ca) program at Carleton University in Ottawa, Canada. The lectures provide a forum to promote the transfer of knowledge between university research to technology company executives and entrepreneurs as well as research and development personnel. Readers are encouraged to share related insights or provide feedback on the presentation or the TIM Lecture Series, including recommendations of future speakers.

The sixth TIM lecture of 2015 was held at Carleton University on September 23rd. The event was hosted by Carleton University's Canadian Health Adaptations, Innovations, & Mobilization Centre (CHAIM; carleton.ca/chaimcentre) and was sponsored in partnership with the TIM program; the Communication, Risk, and Public Health Research Group; Global and International Studies; and the Institute of African Studies.

Summary

The lecture was presented by social innovator, director, and humanitarian Firdaus Kharas. Kharas produces animations, documentaries, films, and television series designed to educate, entertain, and change societal and individual behaviour via a process he calls "Culture Shift". His goal is to positively influence the viewers' knowledge, attitude, and behaviour, especially in children and young adults.

In 1995, in Ottawa, Canada, Firdaus Kharas founded Chocolate Moose Media (chocmoose.com), a social enter-

prise with the mission to better the human condition through media. The company employs only one full-time person and follows a production process that brings together international collaborators to form ephemeral project teams. The following statistics demonstrate the global reach of the company's productions:

• Over 1 billion views

• Used in over 150 countries

• Animations are available in over 90 languages

• Over 80% of the world's population can assess at least one online animation in their language

• Recognized through 79 awards

Kharas began the lecture by describing the criteria he uses when choosing topics. The criteria are specific and strict, because Kharas is targeting issues where media can make a difference and that require a change in individual behaviour. To be chosen, a topic must be oriented toward saving or improving lives, it must address a global or regional issue, it must be difficult to tackle, whether through animation or other means, and there must be a need for cross-cultural media. The emphasis is on behaviour change, not education (although education can be a component); and the message is targeted at the individuals exhibiting the behaviour. Kharas seeks out areas where there is a great need that is not being addressed by others. A characteristic of his projects is that the resulting media are made freely available for wide distribution around the world.

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Firdaus Kharas

To change behaviour, Kharas favours persuasion over coercion. Where possible, humour is used to bring the viewer to a serious point, particularly when the audience is youth. The projects have carefully defined objectives, and when considering the audience, Kharas emphasized that he focuses on a "target of one". Whereas an educational campaign might contain broad information about a particular issue of general interest, a behaviour change communication must be aimed at the specific person whose behaviour they are trying to change, such as, a perpetrator of violence.

Animations can be particularly effective when trying to persuade individual behaviour change. In particular, animations can include universal characters that do not represent any one culture and therefore can reach any audience (Figure 1). Compared to live action, animations are also easy to provide in multiple languages, they can be readily remixed, and they create opportunities for innovation. The non-realism provides flexibility in production and in delivering the messages, and makes it possible to create media that can be funny or acceptable to all cultures. However, the animations are not translated; they are re-written into multiple languages using a common storyline that can be localized, particular when it comes to humour.
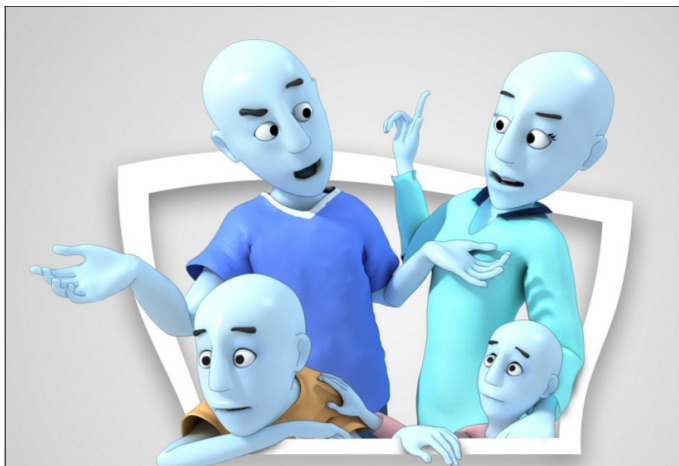

Figure 1. Screenshot from *No Excuses,* a series of 11 animated spots designed to prevent domestic violence

Kharas emphasized that the technology is not a solution by itself: compelling content is the key driver. But, there are key challenges for content creators, such as a lack of financing, the cost of creation (and a lack of understanding of those costs outside the media profession), creating and maintaining a focus on innovation, gaining acceptance from the end user, versioning into multiple languages, distribution, evaluation, and overcoming barriers to creating the content and having its messages be received as intended.

To illustrate and contextualize the messages from his lecture, Kharas showed several examples of his animations, most of which are available to view and download for free from his Vimeo channel (vimeo.com/firdauskharas):

• *No Excuses* (campaign against domestic violence)

• *The Three Amigos* (HIV/AIDS prevention program)

• *Buzz and Bite* (malaria prevention campaign)

• *Hind and Hamza* (campaign in Arabic on values such as gender equality, girl's empowerment, and racism)

• *Rashid: Living with Type 1 Diabetes*

• *Solar Campaign* (promotion of clean solar lights)

• *Ebola* (three videos on containment and prevention)

• *Cartoons for Children's Rights*

• *Biggie and Smallie* (values for young children)

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Firdaus Kharas

About the Speaker

Firdaus Kharas is a social entrepreneur and humanitarian. Through his company, Chocolate Moose Media, Kharas produces animation, documentaries, films, and television series designed to educate, entertain, and change societal and individual behaviour, particularly in relation to transmittable diseases, via a process he calls "Culture Shift". His goal is to positively influence people's knowledge, attitudes and behaviours, especially those of children and youth, in order to improve human health conditions globally. In June, 2015, Kharas received an honorary doctorate from Carleton University in Ottawa, Canada, in recognition of his "innovative work as a social entrepreneur and for the advancement of public health and children's rights in a global context".

This report was written by Chris McPhee.

Author Guidelines

These guidelines should assist in the process of translating your expertise into a focused article that adds to the knowledge resources available through the *Technology Innovation Management Review*. Prior to writing an article, we recommend that you contact the Editor to discuss your article topic, the author guidelines, upcoming editorial themes, and the submission process: timreview.ca/contact

Topic

Start by asking yourself:

- Does my research or experience provide any new insights or perspectives?

- Do I often find myself having to explain this topic when I meet people as they are unaware of its relevance?

- Do I believe that I could have saved myself time, money, and frustration if someone had explained to me the issues surrounding this topic?

- Am I constantly correcting misconceptions regarding this topic?

- Am I considered to be an expert in this field? For example, do I present my research or experience at conferences?

If your answer is "yes" to any of these questions, your topic is likely of interest to readers of the TIM Review.

When writing your article, keep the following points in mind:

- Emphasize the practical application of your insights or research.

- Thoroughly examine the topic; don't leave the reader wishing for more.

- Know your central theme and stick to it.

- Demonstrate your depth of understanding for the topic, and that you have considered its benefits, possible outcomes, and applicability.

- Write in a formal, analytical style. Third-person voice is recommended; first-person voice may also be acceptable depending on the perspective of your article.

Format

1. Use an article template: .doc .odt

2. Indicate if your submission has been previously published elsewhere. This is to ensure that we don't infringe upon another publisher's copyright policy.

3. Do not send articles shorter than 1500 words or longer than 3000 words.

4. Begin with a thought-provoking quotation that matches the spirit of the article. Research the source of your quotation in order to provide proper attribution.

5. Include a 2-3 paragraph abstract that provides the key messages you will be presenting in the article.

6. Provide a 2-3 paragraph conclusion that summarizes the article's main points and leaves the reader with the most important messages.

7. Include a 75-150 word biography.

8. List the references at the end of the article.

9. If there are any texts that would be of particular interest to readers, include their full title and URL in a "Recommended Reading" section.

10. Include 5 keywords for the article's metadata to assist search engines in finding your article.

11. Include any figures at the appropriate locations in the article, but also send separate graphic files at maximum resolution available for each figure.

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