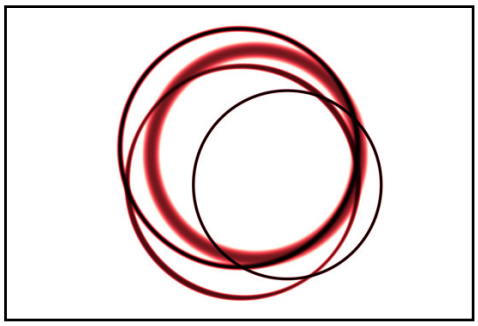
Technology Innovation Management Review

May 2012



Technology Entrepreneurship

Welcome to the May 2012 issue of the *Technology Innovation Management Review*. The editorial theme of this issue is Technology Entrepreneurship. We invite your comments on the articles in this issue as well as suggestions for future article topics and issue themes.

Carleton UNIVERSITY

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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 third sector, and others – to bridge the gap between theory and practice. In particular, we focus on the topics of technology entrepreneurship, economic development, open source business, and innovation management.

Upcoming Issues

- *June:* Global Business Creation
  Guest Editors: Marko Seppä and Stoyan Tanev
- *July:* Social Innovation
  Guest Editor: Stephen Huddart

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 past articles and blog posts.
- 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

Editorial: Technology Entrepreneurship

Chris McPhee, Editor-in-Chief

Tony Bailetti, Guest Editor

From the Editor-in-Chief

It is my pleasure to welcome back **Tony Bailetti**, Director of Carleton University's Technology Innovation Management program (TIM; carleton.ca/tim), as the guest editor for four issues on the theme of Technology Entrepreneurship: February, March, April, and May. Dr. Bailetti has done a tremendous job of assembling a wonderful line-up of authors for these four issues and I hope you will take advantage of the insights they have provided in their articles.

In his editorial, Dr. Bailetti proposes that the TIM Review should take a leadership position in technology entrepreneurship and global entrepreneurship. Further details about this call to action will be presented in the upcoming TIM Lecture on May 31st at Carleton University. The lecture will focus on the assets and initiatives developed by the TIM program over the past five years (including the TIM Review) and audience members will be encouraged to contribute to the real-time development of an action plan to attain this goal. For more information about this upcoming lecture, see the announcement at the end of the PDF version of this issue.

In June, we will examine the theme of Global Business Creation with **Marko Seppä**, founder of Global Faculty Partners for Problems Worth Solving LP, and **Stoyan Tanev**, Associate Professor at the University of Southern Denmark.

In July, we will be joined by **Stephen Huddart**, President and CEO of the J.W. McConnell Family Foundation, as guest editor for the theme of Social Innovation.

As always, we welcome your feedback, suggestions for future themes, and contributions of articles. We hope you enjoy this issue of the TIM Review and will share your comments on articles online. Please also feel free to contact us (timreview.ca/contact) directly with feedback or article submissions.

Chris McPhee
Editor-in-Chief

From the Guest Editor

Welcome to the May issue of the TIM Review, the last of four issues focused on technology entrepreneurship.

This is a call to entrepreneurs in small and large firms as well as to academics, educators, service providers, and policy makers who serve entrepreneurs all over the world to make the TIM Review the leading journal in technology entrepreneurship and global entrepreneurship over the next three years. While becoming a leading journal in three years seems beyond normal achievements in the "journal business", I have no doubt that the TIM Review can attain this goal.

A leadership position for the TIM Review charted to benefit technology and global entrepreneurs as well as those who support them is most desirable because it will bring clarity to: i) the salient and distinguishing aspects of technology and global entrepreneurship; ii) cost effective solutions to the problems faced by entrepreneurs operating in new and established firms; and iii) the relevance of theoretical advances. A leadership position of the TIM Review will also stretch our thinking, help entrepreneurs make hard decisions, expand our view of the world of entrepreneurship, and develop entrepreneurial skills.

In addition to classic metrics for academic journals (e.g., impact factors, citation rates, number of readers), I offer the following four proof points to track the progress that the TIM Review will make towards a worldwide leadership position:

1. Minimum of 1/3 of total unique visitors originate from outside of North America

2. Minimum of 1/4 of professors who teach technology and global entrepreneurship assign TIM Review content as required readings for their courses

3. Minimum of 20 well-known academics from at least five countries actively engaged as journal article reviewers and guest editors

4. Income generated to cover the costs of first growing the TIM Review to a global leadership position and then maintaining it

Editorial: Technology Entrepreneurship

Chris McPhee and Tony Bailetti

The May issue of the TIM Review includes five articles and a report on the third TIM Lecture of 2012. The five articles provide: i) a categorization of firms' growth strategies; ii) a tool that entrepreneurs can use to design their organizations so that they deliver desired outcomes; iii) a model to examine deal-making during the investment stage of a new technology firm; iv) insights on how entrepreneurs profit from the exploitation of opportunities that disrupt the status quo; and v) an overview of the 20 articles published in the February, March, April and May issues of the TIM Review. The report summarizes the third lecture of the 2012 TIM Lecture Series titled "Next-Generation Technology Challenges and Business Opportunities", presented by David Thomas, founder of Bedarra Research Labs on April 19, 2012.

Seppo Leminen, Principal Lecturer at the Laurea University of Applied Sciences, Finland, and **Mika Westerlund**, Assistant Professor at Carleton University's Sprott School of Business, investigate the link between a small firm's investment in R&D and its growth strategy, and they provide a categorization of firms' growth strategies.

Chris McPhee, Editor-in-Chief of the *Technology Innovation Management Review*, describes results-based organization design and provides a tool that entrepreneurs can use to design their organizations so that they deliver desired outcomes.

Arthur Low, founder and CEO of Crack Semiconductor, describes the effect that John Sanguinetti's two companies had on the market for integrated circuit design languages and identifies lessons for entrepreneurs on how to profit from the exploitation of Schumpeterian opportunities.

Michael Ayukawa, founder of Cornerportal, applies a revised version of the model proposed by Oliver Hart and Bengt Holmstrom to examine deal-making during the investment stage of a new technology firm.

Tony Bailetti, Sonia Bot, Tom Duxbury, David Hudson, Chris McPhee, Steven Muegge, Stoyan Tanev, Michael Weiss, Jonathan Wells, and Mika Westerlund provide an overview of the 20 articles on technology entrepreneurship published in the last four issues of the TIM Review.

Twenty-one authors contributed 20 articles to the last four issues. Of the 21 authors, 16 are full-time faculty, staff, or graduate students of Carleton University's Technology Innovation Management (TIM) program and the Sprott School of Business doctoral program; two are faculty members of universities in Nordic countries who have strong ties with TIM faculty; and three are experienced professionals who contribute immensely to the delivery of entrepreneurial programs in Canada's Capital Region.

We thank you for your support of the TIM Review and urge you to engage in its quest to produce a first-class journal for technology entrepreneurs and global entrepreneurs. This worldwide effort offers significant benefits to entrepreneurs and many opportunities for scholarly inquiry and innovative industrial initiatives.

We hope that you, your colleagues, and your organizations benefit from reading the February, March, April and May issues of the TIM Review.

Tony Bailetti
Guest Editor

About the Authors

Chris McPhee is Editor-in-Chief of the *Technology Innovation Management Review* and is in the Technology Innovation Management program at Carleton University in Ottawa. Chris received his BScH and MSc degrees in Biology from Queen's University in Kingston, following which he worked in a variety of management, design, and content-development roles on science-education software projects in Canada and Scotland.

Tony Bailetti is an Associate Professor in the Sprott School of Business and the Department of Systems and Computer Engineering at Carleton University, Ottawa, Canada. Professor Bailetti is the Director of Carleton University's Technology Innovation Management program. His research, teaching, and community contributions support technology entrepreneurship, regional economic development, and international co-innovation.

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Categorizing the Growth Strategies of Small Firms

Seppo Leminen and Mika Westerlund

> *"Innovation has nothing to do with how many R&D dollars you have. When Apple came up with the Mac, IBM was spending at least 100 times more on R&D. It's not about money."*
>
> Steve Jobs
> Designer, inventor, and co-founder of Apple Inc.

This study investigates the link between a small firm's investment in R&D and its growth strategy. A firm's growth strategy refers to the means by which the organization plans to achieve its objective to grow in volume and turnover. We categorize firm growth strategies into eight distinctive clusters: opportunity explorers, radical innovators, business developers, business expanders, profit makers, business rebuilders, stagnators, and downsizers. We argue that understanding a firm's growth orientation provides a way to assess the returns of its R&D investments, because an organization's intangible growth strategies and tangible inputs are connected.

Introduction

Understanding small-business growth strategies is today more topical than ever before. Small firms are vital contributors to economic growth and the perfect incubators of innovation (Morrison et al., 2003; tinyurl.com/cda8rzu). Achieving rapid growth is crucial to small firms (Churchill and Lewis, 1983: tinyurl.com/79uq2wx; Greiner, 1993: tinyurl.com/cnjrkhx). In order to compete, managing organizational growth has become a priority for top management teams of small firms.

Our understanding of growth strategies in the small-business context is quite limited. Porter's (1996; tinyurl.com/d5rnnbg) typology for discussing corporate strategies focuses on large firms and does not properly highlight growth strategies. Therefore, some authors have suggested frameworks to identify specific growth strategies (Kirchhoff, 1994; tinyurl.com/6uwd56q), while others investigate diverse growth phases (Stremersch and Tellis, 2004; tinyurl.com/6sfgn7n). Our objective is to understand the link between a firm's R&D investment and its growth strategy.

The remainder of this article is organized into four sections. After this brief introduction, we discuss a firm's growth and its underlying strategic orientations in the context of small firms. We proceed by presenting our proposed framework, which links a small firm's R&D investments and its growth strategy. Finally, we conclude by discussing our findings and their implications.

Background on the Growth of Small Firms

The literature on small-firm growth can be organized into three streams: i) tangible and intangible growth drivers; ii) growth stages; and iii) Schumpeterian growth models.

The first literature stream aims to understand the tangible and intangible drivers of growth. Many authors identify internal resources that firms need to systematically organize for growth (Robson and Bennett, 2000; tinyurl.com/7hzanud), whereas others focus on strategic relationships as a way to grow (Lechner and Dowling, 2003; tinyurl.com/3zxcqfl). The internationalization perspective emphasizes processes that should be adapted to shift the firm's focus from local to global operations

Categorizing the Growth Strategies of Small Firms

Seppo Leminen and Mika Westerlund

(Coviello and McAuley, 1999; tinyurl.com/7urgaws). According to the cognitive approach, organizational intention and ability (Morrison et. al., 2003; tinyurl.com/cda8rzu), leadership and talent (Gandossy, 2005; tinyurl.com/c7rfbnn), and growth aspiration (Glancey, 1998; tinyurl.com/8x7ax9k) are necessary conditions for growth. In addition, intangible resources are just as important determinants of firm success than tangible resources (Galbreath, 2004; tinyurl.com/8y7klr2).

The second literature stream on firm growth examines the various *stages of growth*. Conceptualizing the growth of organizations by describing their transitions through a series of stages, from birth to maturity, has considerable intuitive appeal (Phelps et al., 2007; tinyurl.com/6mjq3vb). For example, the development of relationships with partners provides the needed resources for the rapid scaling-up of production, but utilizing a growth opportunity may later require a new set of allies (Hite and Hesterly, 2001; tinyurl.com/6w5x4zl). The stage approach also asserts that there are several growth challenges due to design flaws in each stage. However, the life-cycle hypothesis that underlies this perspective (i.e., the assumption that growth is linear, sequential, deterministic, and invariant) has recently been argued not to pertain (Phelps et al., 2007; tinyurl.com/6mjq3vb). Although the critical argument may not completely hold, growth does seem to be a more complex phenomenon.

The third literature stream comprises *Schumpeterian growth models*. It is a particular type of economic growth that is generated by the endogenous introduction of product or process innovations (Dinopoulos, 2009; tinyurl.com/77earot). Schumpeterian growth apprehends the benefits that result from the destruction of old products and processes by new ones. This perspective explains growth by innovation and entrepreneurial spirit and suggests R&D investments as antecedents to organizational growth and performance (Wolff and Pett, 2006; tinyurl.com/72d62l3). The relationship between financial R&D investments and returns is based on the selected strategy and type of operations, because increasing or decreasing R&D investments are strategic inputs that affect the magnitude and timing of future revenue (Lantz and Sahut, 2005; tinyurl.com/6wvywe2). Innovation-based growth is crucial for small firms.

Underlying Strategic Orientations

Strategic orientation refers to the formulation of strategies with long-term objectives. It consists of both strategic intent and actual behaviour (Siguaw et al., 2006; tinyurl.com/6nzfw5j). Entrepreneurs use it to guide the efforts in the organization, because it "reflects strategic directions implemented by a firm to create the proper behaviours for the continuous superior performance of the business" (Gatignon and Xuereb, 1997; tinyurl.com/6uomxlf). In this study, we focus on two types of complementary strategic orientations: innovation orientation and growth orientation.

Innovation orientation consists of market orientation and technology orientation. Market orientation describes a firm's posture towards creating an understanding of its customers and serving customer needs (Narver and Slater, 1990; tinyurl.com/ca6bvyf). Its positive impact on organizational performance is widely acknowledged, but it reflects a reactive posture given that it concentrates on the expressed needs of current customers. Technology orientation describes a firm's posture towards engaging in technological research and development, in analyzing technology potentials, and in forecasting technology trends (Gatignon and Xuereb, 1997; tinyurl.com/6uomxlf). It manifests in the acquisition of substantial technological expertise and in the investment in technological leadership (Talke et al., 2011; tinyurl.com/6nrcj4r). Markets and technology are alternative directions of innovation orientation; however, we use the term innovation instead of technology, because many firms develop services. Consequently, small businesses focus on either exploiting markets or exploring for innovation.

Growth orientation refers to the entrepreneur's desire to achieve growth. Most firms, of course, desire growth to prosper and survive. High-growth orientation means that rapid growth is the top priority, while low-growth orientation means safe, slow, and steady growth are priorities for management (Brown et al., 2001; tinyurl.com/6sv2mja). However, not all firms are targeting to grow and maximise their returns. Some entrepreneurs avoid risk and responsibility by limiting undesired growth. According to the results of a Norwegian survey, nearly 40 percent of the entrepreneurs did not want their firms to grow at all and nearly two-thirds did not want their firms to grow in terms of employment (Kolvereid, 1992; tinyurl.com/7a7q7tw). Firms are either growth- or control-oriented.

Growth-Strategy Framework

In this study, we establish a framework to describe four diverse growth strategies of small firms using innovation orientation and growth orientation as dimensions. These growth strategies are: i) explore, ii) expand, iii) ex-

Categorizing the Growth Strategies of Small Firms

Seppo Leminen and Mika Westerlund

ploit, and iv) restrain. They are supported by literature on small business growth (Davidsson et al., 2002: tinyurl.com/7c7plqk; Chan et al., 2006: tinyurl.com/7wjwc3d; Morrison et al., 2003: tinyurl.com/cda8rzu) and each strategy is a result of the underlying organizational orientations. In addition, we include two dimensions describing "investments" as tangible inputs and "returns" as outputs to complement the intangible growth strategies as suggested by Kirchhoff (1994; tinyurl.com/6uwd56q). They describe a firm's R&D expenses and the attained performance in terms of revenues.

We maintain that a firm's growth strategy not only defines its R&D investments, but also affects the expected returns. We further see that innovation matures typically following a counter-clockwise cycle; starting from an "Explore" strategy. However, a firm can opt for any strategy or even skip phases during the evolution. Consequently, the framework provides us with eight categories of small firm growth (Figure 1).

1. The "explore" strategy accentuates the firm's innovation development efforts

Firms that explore their path to growth need to be innovation oriented. In the long run, it is necessary for the firm to explore new possibilities and to develop new competencies. Exploration refers to a firm's capturing of competences through activities characterized by search, variation, risk taking, experimentation, play, flexibility, discovery, and innovation (Gupta et al., 2006; tinyurl.com/cuvnelj). Competitiveness can be guaranteed only through innovation activity, which allows survival in the market competition. However, innovation activity calls for heavy investments in research and development. Therefore, exploring firms stand on unstable grounds since they have high level of investments, but gain little or no profits from the new product introduction (Homburg et al., 2002; tinyurl.com/d3u79m2).

The relationship between the R&D investments and returns reveals whether the firm is an *opportunity ex-*

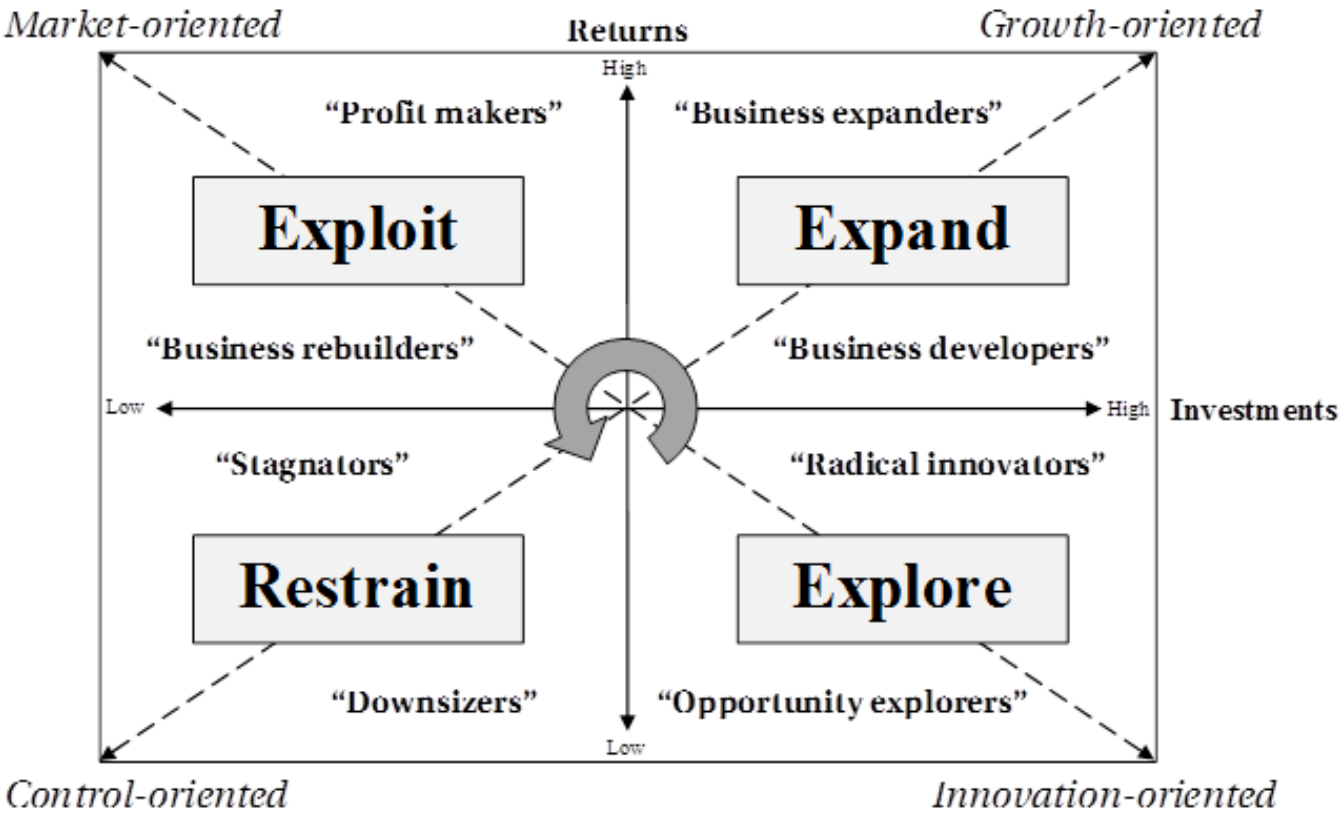

Figure 1. Framework of small-firm growth strategies and the counter-clockwise cycle of innovation maturity

Categorizing the Growth Strategies of Small Firms

Seppo Leminen and Mika Westerlund

plorer scanning potential technologies and market opportunities that could generate future innovations and revenues. It can, for example, search for new technological capabilities (Koza and Lewin, 1998; tinyurl.com/7wgc4rk). At this point, returns are at low levels because there is no concrete prospect to grab on or the development work is at an early stage. Alternatively, the firm may be *radical innovator* that challenges its competitors by proactively investing in the development of breakthrough technology. Innovation development has shifted from mere opportunity seeking into a product or service development plan and introduction.

2. The "expand" strategy reveals the firm's eagerness for growth

The expand strategy suggests that a firm is growth-oriented with a high level of investments and a high level of returns. It refers to a firm's expansion to new markets and customer domains. However, small businesses face numerous constraints to growth such as limited capital, time, experience, and information resources. Therefore, this strategy is challenging yet profitable. Growth aspiration is the most important discriminating characteristic between growth-oriented and non-growth oriented entrepreneurs (Delmar et al., 2003; tinyurl.com/6spud97). It promotes a path-dependent and self-reinforcing progression toward permanently faster growth (Eisenhardt and Schoonhoven, 1990; tinyurl.com/89c2lld) and is positively associated with sales growth (Delmar et al., 2003; tinyurl.com/6spud97).

A firm following the expand strategy may be a *business developer* targeting to develop its business processes into a better functioning entity. Alternatively, the firm may develop its commercialization methods and begin voluminous selling of the innovation. Investments in process development typically result in only moderate increases in returns, unless the staff's growth-oriented mentality enables the firm to fully utilize the inputs. Conversely, if the return on investments ratio is high, the firm may aim at rapid expansion of its business. For example, internationalization is fundamental to the rapid growth of firms in the contemporary business environment (Hadley and Wilson, 2003; tinyurl.com/83m4fhh). Such a small firm becomes a *business expander* with a high investment rate and a high level of returns.

3. The "exploit" strategy highlights the organization's profit-making objective

Firms utilizing the exploit strategy should be market oriented. Kohli and Jaworski (1990; tinyurl.com/82wqnrx) define market orientation as the generation of market intelligence pertaining to current customer needs and the firm's responsiveness to it. Market-oriented firms exploit the existing resources in an efficient way. Exploitation includes refinement, choice, production, efficiency, selection, implementation, and execution as approaches in resource capturing (March, 1991; tinyurl.com/8xqlyp5). It consists of only a petty refinement of existing technology, because the exploitative firm sustains a price competition with a high-level profit objective. Market orientation and business performance have a strong positive link, particularly in small firms (Golann, 2006; tinyurl.com/7cv2z6a).

An exploiting strategy means that small firms have a low rate of R&D investment and a high level of returns. It enables them to exploit the market and generate immense cash flows. Companies typically move from exploration to exploitation along with the maturation of innovation. Whereas explorers invest copiously to create novel offerings for future markets, exploiters cash in the current ones. Investments in the production technology and adaptation to customer's needs may yield excessive profits and the small firm becomes a *profit maker*. Conversely, *business rebuilders* cut off R&D investments and acquire profitability through marketing spending, but this approach is effective only in the short run. Many Internet businesses spent heavily on marketing, but after the bubble burst, most of this spending stopped. Firms need to rebuild their businesses to avoid disappearance due to fierce competition and decreasing price margins.

4. The "restrain" strategy means controlling unwelcome organizational growth

The restrain strategy pertains to the manager of a small business who is reluctant to grow the business. The growth of firm and the business is restrained by controlling the activities of the staff and the operations of the firm (Eisenhardt, 1985; tinyurl.com/87ye9xf). The behaviour with this strategy manifests in low levels of investment and low level of returns. Although it can be just a responsive action to a firm's financial predicament, many entrepreneurs refuse to enlarge their firms beyond a specific number of employees. In fact, they try to reduce the undesired growth. There are several motives for restraining strategy, such as self-employment instead of profit maximisation. Firms following the restrain strategy have generally low rates of growth (Glancey, 1998; tinyurl.com/8x7ax9k).

Labour costs are common incentives for decreasing R&D investments (Cordis, 2006; tinyurl.com/c47at2m). However, they are not a major problem when either re-

Categorizing the Growth Strategies of Small Firms

Seppo Leminen and Mika Westerlund

turn on investments or operating margins are high. Considering that the restrain strategy suggests low returns and low margins, *stagnators* try to keep their businesses above the surface as long as they can. They either avoid the growth or have exceeded the time limit of exploiting market as a business rebuilder. Their trivial investments do not allow the growth of profits; rather they keep them at the current level or with a downward trend. Similarly, the restrain strategy is preferred by *downsizers*, who intentionally avoid risks of growth or who consider ending their business, for example due to the entrepreneur's retirement. Even this reaction to unsolicited growth can be profitable for a while.

Our framework also has limitations. Similar to other studies on firm growth, we accept that an endogenous growth strategy is not exclusive, because: i) growth may be affected by changes in the industry, ii) the effective size of businesses may vary by the sector, and iii) some industries are more capital-intensive than others. Furthermore, there are low-cost ways to invest in R&D, such as participating in the open innovation development. These aspects should be considered when applying the framework.

Conclusion

Our objective was to understand the role of tangible and intangible resources in small business growth. To grow, a small firm requires investment and the desire to grow. In small firms, investment decisions and outcomes are connected via the firm's growth strategy. Because small businesses have diverse strategic orientations regarding innovation and growth, this connection allows us to identify different clusters of firm growth. These clusters are not stagnant but evolutionary. Typically, business innovation matures in a counter-clockwise cycle, starting from exploration and shifting towards exploitation as the offering or business matures. However, the firm can skip phases or opt for any specific cluster at any time regardless of the cycle. Nonetheless, companies need to start the cycle again to avoid the survival trap.

About the Authors

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Results-Based Organization Design for Technology Entrepreneurs

Chris McPhee

> *"Failure comes only when we forget our ideals and objectives and principles."*
>
> Jawaharlal Nehru (1889–1964)
> 1st Prime Minister of India

Faced with considerable uncertainty, entrepreneurs would benefit from clearly defined objectives, a plan to achieve these objectives (including a reasonable expectation that this plan will work), as well as a means to measure progress and make requisite course corrections. In this article, the author combines the benefits of results-based management with the benefits of organization design to describe a practical approach that technology entrepreneurs can use to design their organizations so that they deliver desired outcomes. This approach links insights from theory and practice, builds logical connections between entrepreneurial activities and desired outcomes, and measures progress toward those outcomes. This approach also provides a mechanism for entrepreneurs to make continual adjustments and improvements to their design and direction in response to data, customer and stakeholder feedback, and changes in their business environment.

Introduction

Technology entrepreneurs face many challenges when trying to turn ideas into profitable businesses. Aside from the challenge of creating products or services that customers will want to pay for, entrepreneurs also face the challenge of creating an organization that functions efficiently and delivers the outcomes that founders and investors desire. As an organization, a technology firm may grow organically in response to internal or external demands, but that does not necessarily mean it is finely tuned to achieve particular outcomes, assuming these outcomes have been defined. Even when organizations have well-defined objectives, there may not be a logical connection between the organization's structures, processes, and activities or any theoretical or practical understanding about the mechanisms by which the desired outcomes may be achieved. Organizations may be a result of happenstance as much as intention.

In this article, the author introduces an approach that can help technology entrepreneurs design and continually refine their organizations to increase the likelihood that they will deliver the desired immediate, intermediate, and ultimate outcomes. First, the author describes a cyclical organization design process that integrates lessons from theory and practice into the design of an organization. Next, a results-based management approach is described to show how it links activities to outcomes and provides a mechanism for measuring progress toward those outcomes. Next, the author combines these two approaches to create a new approach called "results-based organization design". Then, the article provides a hypothetical example of how this approach can be applied to the design of a technology startup. Finally, several implementation tips are provided and conclusions are offered.

Organization Design

Researchers in the field of organization design seek to better understand the functions and processes of organizations and how they can be improved. A design perspective implies that organizations can be deliberately constructed (or changed) through research and are not simply the subjects of passive observation or theoretic-

Results-Based Organization Design for Technology Entrepreneurs

Chris McPhee

al models. In practice, organizations do not emerge fully formed from the ether, and while they may change in response to internal and external demands, their creators often engage in a some form of design process before and after their construction. What separates the practical activity of "designing organizations" from the research activity of "organization design" is that the latter is grounded in theory, which should improve the chances that the resulting organization will deliver the outcomes desired by its designer.

The importance of linking theory and practice in organization design was recognized by Georges Romme (tinyurl.com/8yyakyt) and colleagues, who developed a cyclical approach to designing and improving organizations based on a set of design principles. Design principles are sets of propositions that are grounded in theory and practice, that is, they draw upon lessons learned from both practical experience and from academic literature (Romme and Endenburg, 2006: tinyurl.com/6aowwdz; van Burg et al., 2008: tinyurl.com/3v3787c). Design principles inform subsequent design and implementation steps in the process originally proposed by Romme and Endenburg (2006), which they called "science-based organization design". The steps in this design process are:

1. Gather lessons from theory and practice. This step captures what is known about subjects relevant to the design task, including both practical experience and academic literature.

2. Formulate design principles. This step synthesizes the lessons from theory and practice into a set of propositions that provide a guiding light in the design process. Design principles are sufficiently general that they could be used by others faced with similar design challenges.

3. Formulate design rules. This step develops guidelines that are grounded in one or more design principles and are specific to the design context. Design rules are solution-oriented and make a logical connection between the focus of a given design rule and its expected outcome. A good design rule will "contain information on what to do, in which situations, to produce what effect and offer some understanding of why this happens" (Denyer et al., 2008; tinyurl.com/7xvkmh5).

4. Design the organization. This step applies the design rules into the development of a specification for the intended organization.

5. Implement the design. This step applies the design to the actual construction of the new organization.

6. Observing the new organization. This step assesses how well the organization works. Based on observations (and possibly experiments as well), new ideas for improving the design may be generated. These ideas should be used to alter any or all of the previous steps through a redesign process. Thus, these steps do not describe a linear process, but rather form a closed-loop feedback system through which continuous improvements can be made.

The organization design process described above includes three important elements: i) grounding in both theory and practice; ii) logical connections between design elements and desired outcomes; and iii) a mechanism for ongoing improvement to the design. However, this overall process does not include specific guidance on how to relate design elements to outcomes on different timescales. It also does not provide practical guidance on how the feedback loop should be closed (i.e., what data should be collected and how it should be used). In the section that follows, another approach is described; when combined with an organization design approach, it offers solutions that fill these two gaps.

Results-Based Management

Managers often face the challenge of connecting what their organization is doing "on the ground" today with the broad-scale outcomes they ultimately hope to achieve. In some cases, the desired outcomes may be vague, poorly articulated, or disconnected from the actual activities the organization undertakes; in other cases, the outcomes may be undefined or not shared by all stakeholders. Furthermore, the ultimate outcome desired by an organization may require long-term commitment, and it may be difficult to know whether immediate-term activities are producing results that will lead the organization efficiently toward those outcomes. An approach that is suited to such situations is "results-based management", which provides a set of working tools that allow managers to evaluate the performance of initiatives against defined outcomes.

Although results-based management can be applied in many different situations, it is common in the public sector and the non-profit/community sector. It is especially common in international development contexts, where long-term development objectives, such as improving

Results-Based Organization Design for Technology Entrepreneurs

Chris McPhee

health in a particular region, are difficult to connect with the actual activities undertaken, such as providing health education services to individual communities within that region. As an example, the Canadian International Development Agency (CIDA; acdi-cida.gc.ca) has over 30 years of experience refining its results-based management approach, which it uses to manage its international development projects and investments. In this context, the approach improves decision making, transparency, and accountability (CIDA, 2008; tinyurl.com/3jy985q).

At the core of CIDA's approach is the logic model, which is a common feature of results-based management. The logic model is "a depiction of the causal or logical relationships between inputs, activities, outputs, and the outcomes of a given policy, program or investment" (CIDA, 2008; tinyurl.com/3jy985q). CIDA's descriptions of these components are summarized below:

1. Ultimate outcome: the long-term objective or the top-level, measureable change that the initiative is designed to effect. This component answers the question: "Why are we doing this?"

2. Intermediate outcomes: medium-term objectives that are expected to logically follow on from the achievement of the immediate outcomes. Intermediate outcomes are usually associated with changes in behaviour or practices, and they must be measurable.

3. Immediate outcomes: short-term objectives that are the direct result of the outputs of activities. Immediate outcomes are usually associated with increased awareness, skills, or access, and they must be measurable.

4. Outputs: the measurable products of activities.

5. Activities: the actual items of work undertaken to produce outputs.

6. Inputs: the financial, human, material, and information resources available to undertake activities. In CIDA's framework, including this component in the logic model is optional, although they obviously are still required to carry out the specified activities.

The format of the logic model is a table that lists the activities and outputs and the immediate, intermediate, and ultimate outcomes of an initiative (see Table 1). Cells near the top of the table may be merged with adjacent cells in the same row to indicate outcomes that are a product of multiple activities and outputs. Ideally, managers complete the logic model with input from stakeholders, which helps develop a complete and shared view of an initiative and its direction. The table may be completed from the top-down or the bottom-up, depending on the situation, but the essential aspect is the logical connection between each related component, which creates a vertical chain of results.

Table 1. A logic model template*

Ultimate Outcome				
Intermediate Outcomes				
Immediate Outcomes				
Outputs				
Activities				

* For a more detailed template with instructions, see the CIDA website: tinyurl.com/3lnnde6

Results-Based Organization Design for Technology Entrepreneurs

Chris McPhee

The logic model is intrinsically linked to a second working tool: the performance measurement framework. The performance management framework uses the outcomes defined in the logic model to establish "a structured plan for the collection and analysis of performance information" (CIDA, 2008; tinyurl.com/3jy985q). This framework documents the major elements of the monitoring system, including performance indicators, baseline data, specified targets, and data sources. It also specifies whose responsibility it is to collect the data, how frequently it is to be collected, and how it will be collected (Table 2).

The logic model and performance management framework are used together to: i) define the logical relationships between what the initiative is meant to achieve and what activities are actually being done to work towards those outcomes and ii) monitor progress toward those outcomes, ensuring that the initiative will actually deliver what it was designed to achieve. While commonly used to facilitate international development initiatives, the results-based management approach and templates are readily adapted to organization design efforts, as will be demonstrated in the sections that follow.

A Combined Framework

The organization design approach can be combined with the results-based management approach to yield a new approach for designing organizations: results-based organization design. This new approach maintains the benefits of organization design, particularly the practical and theoretical grounding of design principles and the closed-loop feedback loop, which provides a mechanism for ongoing improvement. By replacing design rules with a logic model that is guided by design principles, more explicit connections between design activities and their

Table 2. A performance management framework template*

Expected Results	Indicators	Baseline Data	Targets	Data Sources	Collection Methods	Frequency	Responsibility
Ultimate Outcome							
Intermediate Outcomes							
Immediate Outcomes							
Outputs							

Results-Based Organization Design for Technology Entrepreneurs

Chris McPhee

outcomes across different timescales can be developed. Further, the performance management framework is intrinsically linked to the logic model and provides a practical solution to the challenge of closing the feedback loop and triggering changes "upstream" in the re-design process. Figure 1 illustrates the components of the results-based organization design approach. The shaded boxes highlight the components integrated from results-based management.

Results-based organization design follows a cycle of steps designed to answer the following questions:

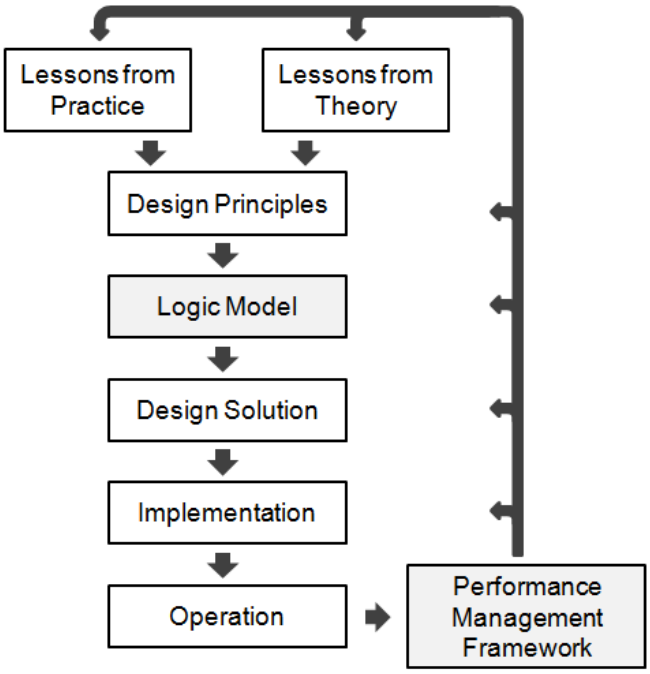
1. **Lessons from practice:** *What does our experience tell us?*
2. **Lessons from theory:** *What does theory tell us?*
3. **Design principles:** *What grounds our thinking? What tells us which solutions are likely to work?*
4. **Logic model:** *What is the link between what we intend to do and what we expect it will achieve, both right away and in the future?*
5. **Design solution:** *What do we intend to build?*
6. **Implementation:** *What did we actually build?*
7. **Performance management framework:** *Is it working?*
8. **Feedback loop:** *Where do we need to make changes?*

The author has developed and applied this results-based organization design approach during the design and construction of the organization that produces and disseminates this journal, the *Technology Innovation Management Review* (TIM Review). However, this approach can be generalized to other design contexts. In the section that follows, the results-based organization design approach will be applied to a hypothetical example to illustrate how it can be used by technology entrepreneurs.

An Example of Results-Based Organization Design

In the March issue of the TIM Review, Stoyan Tanev described firms that are "born global", which means they are new ventures that "act to satisfy a global niche from day one" (Tanev, 2012; timreview.ca/article/532). Tanev described the characteristics of born-global firms, listed the conditions that are favourable for new technology companies considering early globalization, and underscored the importance of business ecosystems for the international performance of born-global firms. Tanev concluded his article with a call to identify the design principles that can be used to design technology startups that will be born global. In this section, the results-based organization design approach will be applied as a first step toward answering this call, but also to provide an example of how an entrepreneur might use this approach when designing a new technology venture. The example is not fully developed – it will just focus on a narrow slice of the approach – but it provides a starting point simply to illustrate how the approach can be applied to a technology entrepreneurship setting.

Figure 1. Results-based organization design



Design principles

As described above, design principles are synthesized from lessons from theory and practice. Tanev's (2012) article provides a starting point for research-based lessons, including the characteristics of born-global companies. For example, one characteristic is that managers of born-global companies "have a strong international outlook and international entrepreneurial orientation". The article also reports on a research study that examined the conditions for newly created technology firms considering early, rapid globalization; one of these conditions is the presence of key managers

Results-Based Organization Design for Technology Entrepreneurs

Chris McPhee

with experience in international business (Kudina et al., 2008; tinyurl.com/83c2qdz). To develop a design principle, this lesson from research would be combined with knowledge from practical experience. A hypothetical lesson from practice might be, for instance, an observation that managers with international business experience with more than one country appear to be more successful in expanding into new geographic markets than specialists that have only conducted business with only one other country. The implied mechanism underlying this hypothetical observation might be that a breadth of experience allows managers to generalize solutions to internationalization challenges. Taken together, these lessons from research and practice might be synthesized into the following design principle: *Ensure that the top management team has significant international business experience.*

Logic model

All of the design principles (i.e., not just the one example above) would guide the development of the logic model. For example, an activity relating to recruitment might be guided by the design principle that relates to international business experience. In this case, the activity might be to recruit a management team, which would yield the output of the appointment of one or more managers, which in turn would contribute to the immediate outcome of a management team with broad international business experience. Based on the causal mechanisms identified in the research studies that underlie the design principles, there is a reasonable expectation that this immediate outcome can contribute to intermediate outcomes relating the success of a born-global company.

Performance management framework

In the performance management framework, each of the outputs and outcomes in the logic model will have measureable indicators. Following the narrow slice in the example above, an indicator for the activity to recruit a management team might relate to the average number of years of international business experience among candidates. Another indicator might relate to the breadth of international experience among candidates. If the data relating to these indicators fall below the predefined targets, action may be taken to reach a more appropriate pool of candidates. Similar indicators could be used for the output and outcome, thereby tracking the breadth and depth of experience among newly hired managers and across the entire management team. These metrics provides managers with an indication of the performance of the company against predefined targets and outcomes.

The hypothetical example developed in this section focused on a narrow slice – the full approach would include several more design principles and a full logic model and performance management framework. Nonetheless, this incomplete example hopefully shows how this approach does more than just measure progress; it provides a method for managers to act to improve the organization's performance over time. On the surface, it may seem obvious that a company interested in succeeded in international markets should seek staff with international experience, but this approach adds value by ensuring that such relationships are based on research and practice, not just assumptions about causal mechanisms. Further, this approach goes beyond "process and documentation"; it makes these principles an explicit part of the organization's culture. By making its key activities, outputs, and desired outcomes explicit and agreed among stakeholders, the company can proceed more efficiently toward the achievement of those outcomes.

Benefits for Technology Entrepreneurs

The results-based organization design approach can be applied to the design and creation of a new technology venture. This approach provides the following benefits for technology entrepreneurs:

1. A focus on the pathway to the desired outcomes for the organization. Depending on their motivation, it is easy for many entrepreneurs to envision an ultimate outcome for their organization; however, it can be difficult to plot the intermediate steps between their initial idea and achievement of the ultimate outcome. This approach defines outcomes across different timescales, with a logical connection between the outcomes and the activities undertaken. It can also expose any misguided faith the entrepreneur may have in an idea, market attribute, or technology feature if there is no reasonable connection to the desired outcomes; such roadblocks may helpfully encourage the entrepreneur to rethink their current approach.

2. Even within a small team, it can be difficult to build consensus around the organization's outcomes. The logic model provides a framework to develop a shared view of the organization's direction. This can be particularly helpful when the logic model is developed with input from stakeholders (e.g., co-founders, the wider team, investors, advisors, lead customers); it can also become a helpful way to summarize the essential features of an organization for others, such as potential investors.

Results-Based Organization Design for Technology Entrepreneurs

Chris McPhee

3. It is natural to draw upon past experience and knowledge when making design decisions; however, an explicit process to capture and synthesize lessons from both theory and practice formalizes this process and forces the designer to justify why they think particular actions will have particular impacts. Gaps in thinking become readily apparent and stakeholders can work together to strengthen the "soft spots".

4. Technology entrepreneurs are often faced with new opportunities that threaten to shift the organization's focus. If results-based organization design has been implemented, it provides a means to evaluate whether new opportunities fit with the overall direction of the company. New opportunities may rejected if they do not fit into the agreed direction or are deemed a less efficient means of achieving the desired outcomes. Alternatively, the approach may help the entrepreneur weigh their options and decide to pursue the new opportunity.

5. It can be difficult for technology entrepreneurs to know whether their organization's various activities are having the desired effects. The results-based organization design approach provides a mechanism to capture and act upon performance data.

6. Technology entrepreneurs need to be able to quickly respond to changes in customer feedback, market demands, technological capabilities, and the business environment. The closed-feedback loop provides a mechanism to refine any aspect of the design on an ongoing basis.

7. The approach allows the company to develop intellectual property on how to grow the business. This intellectual property increases and becomes more valuable over time as the design is refined.

Implementation Advice

Despite the benefits of this approach, it does not guarantee success, particularly if careful consideration is not given to how it should be applied to a given situation. The following tips should help entrepreneurs apply this approach to the design of their own organizations:

1. Focus on a small number of important indicators in the performance management framework. If too many indicators are included or some of them are not actually measuring progress towards outcomes, then the effectiveness of the approach will diminish.

2. Resist the urge to capture everything. Focus on the elements that add incremental value. If including three extra design principles will not move the organization any closer to its ultimate outcome, then they are not worth adding.

3. Refine the approach over time. The goal is not to develop the perfect process on day one, nor is it to simply fill in the tables. Pay attention to the discussions around design principles, activities, and outcomes, as well as the logical connections between each of these elements. The learning and consensus-building that results from this process can be as valuable as the completed framework. As a cyclical approach, the design will naturally undergo iteration and refinement.

4. Apply the approach only to sufficiently stable situations. While logic models are expected to evolve over time, they are "implicitly linear" (Gamble, 2008; tinyurl.com/4xh6g39), which suggests they may not be suitable when innovation through rapid iteration and nonlinearity is an objective. This approach has broad applicability, but in the context of technology entrepreneurship, it may be more suitable for designing a technology startup (i.e., the organization) than for designing that startup's highly innovative product, which may involve rapid iteration on timescales that make this type of performance management inefficient.

5. Involve stakeholders in the process. In some cases, it may be most efficient to create drafts of the design principles and logic model and present them to stakeholders for feedback.

Conclusion

This article introduces results-based organization design, a practical approach that combines the benefits of organization design with the benefits of results-based management. It provides a means of integrating lessons from practice and theory into a design process that creates logical connections between an organization's activities and its desired outcomes while also providing a mechanism for ongoing refinement. While this approach is applicable to a variety of organization design challenges, this article makes a case that it may be particularly useful for technology entrepreneurs, who need to define clear outcomes and plan activities that can be expected to deliver those outcomes with little margin for error.

Results-Based Organization Design for Technology Entrepreneurs

Chris McPhee

Recommended Reading

- "Construction Principles and Design Rules in the Case of Circular Design" by Georges Romme and Gerard Endenburg (2006; tinyurl.com/6aowwdz)
- "Results-Based Management" (CIDA, 2009; tinyurl.com/8xfdayn)
- "Logic Model Development Guide" (W.K. Kellogg Foundation, 2004; tinyurl.com/2bd6538)
- "Logic Model Workbook" (Innovation Network: tinyurl.com/6s5qyjh)

About the Author

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Making Money from Exploiting Schumpeterian Opportunities: John Sanguinetti and the Electronic Design Automation Industry

Arthur Low

> *"I was reading EE Times one day in September of 1990, and saw a 2-paragraph article that said ...that Verilog might be made public....Within 5 seconds of reading that article, I knew that this was the opportunity I'd been looking for."*
>
> John Sanguinetti
> Entrepreneur and computer scientist

Accounts of the effect that John Sanguinetti's two companies had on the market for integrated circuit design languages were used to gain insights on how to profit from the exploitation of Schumpeterian opportunities. This article will be of interest to entrepreneurs who expect to profit from exploiting opportunities that disrupt the status quo. To write this article, the author reviewed the literature on Schumpeterian and Kirznerian opportunities and examined the writings of and about Sanguinetti and his companies, blogs written by industry insiders, and articles in industry trade journals. Sanguinetti's first company introduced a new technology and his second company introduced a new business strategy and a new technology. Both of Sanguinetti's companies undermined the capital investments of the established incumbents and created new value for customers. The article provides three main insights. First, deep knowledge and experience in the customer domain enable an entrepreneur to recognize and act to profit from a Schumpeterian opportunity. Second, to profit from a Schumpeterian opportunity the entrepreneur needs to combine technology and business model components in a way that adds significant value to customers. Third, large amounts of venture capital may or may not be required to exploit Schumpeterian opportunities.

Introduction

An entrepreneur is a person who recognizes an opportunity and acts to capture economic rewards derived from exploiting it. There are two types of entrepreneurial opportunities, one that is linked to Joseph Schumpeter's work (1942; tinyurl.com/7tzrbsk) and the other to Israel Kirzner's work (1973; tinyurl.com/6t87n3w).

John Sanguinetti launched two companies that had significant effects on the electronic design automation (EDA; tinyurl.com/bw5zf) industry. The innovation of the first company was a new technology, while the innovation of the second company was a new business model. Both opportunities will be shown to be of the Schumpeterian type.

This article first distinguishes a Schumpeterian from a Kirznerian opportunity and describes the EDA industry. Then, the two companies founded by John Sanguinetti are described. Three lessons learned from examining Sanguinetti's innovations are discussed. Finally, the article provides the conclusions.

Making Money from Exploiting Schumpeterian Opportunities

Arthur Low

Schumpterian Opportunities

De Jong and Marsili (2011; tinyurl.com/cz5cxgn) distinguish between Schumpeterian and Kirznerian opportunities. A Schumpeterian opportunity disrupts the existing market. It offers to destroy the capital of incumbent firms. In contrast, a Kirznerian opportunity fills gaps in the existing system. It does not disrupt the capital of incumbent firms.

To illustrate the difference between Schumpeterian and Kirznerian opportunities, take the case of a rare snowstorm descending on a mountain pass. An entrepreneur arrives with their truck filled with snow tires to a strategic point on the mountain highway where they can sell tires at inflated prices to worried travelers. An "arbitrage" situation (i.e., taking advantage of a price difference between two or more markets) is a classic Kirznerian opportunity. The entrepreneur who exploits a Kirznerian opportunity capitalizes on their asymmetrical knowledge to fill a gap in the existing system. A Kirzernian opportunity is one where the market balance can be restored with a price adjustment. The entrepreneur who transports snow tires to a location where a much higher price can be negotiated does not destroy the capital invested in a tire store or tire manufacturing facilities. Thus, the way an entrepreneur profits when acting on a Schumpeterian opportunity is quite different from the way an entrepreneur profits when acting on a Kirznerian opportunity.

The Verilog and VHDL Languages Used in Integrated Circuit Design

Verilog (verilog.com) is a hardware description language (HDL; tinyurl.com/76tcfdo). Verilog was developed in the 1980s as a proprietary language that engineers could use to describe hardware – specifically the digital logic functions of integrated circuits (ICs). By the end of the 1980s, Verilog had become the de facto industry standard for HDLs.

Also in the 1980s, another HDL known as VHDL (tinyurl.com/d8r55fd) was developed for the United States military and was donated to the Institute of Electrical and Electronics Engineers (IEEE; ieee.org). In 1987, VHDL became an IEEE standard. In 1989, Cadence Design Systems (cadence.com) acquired a simulator of logic designs coded in Verilog from Gateway Design Automation. For Cadence, this simulator was a strategic technology that effectively gave the company a monopoly in the IC design simulator market for at least five years. VHDL standardization efforts worked to close the functional lead that Verilog had over VHDL in the simulation of IC designs.

In response to the threat posed to its dominant market position by an open VHDL, Cadence decided to release the Verilog language as an open standard. In 1995, Verilog also became an IEEE standard.

Sanguinetti's First Opportunity: A Verilog Compiled Simulator

An entrepreneur will understand, often in a flash of insight, what a bit of "news" means in terms of an opportunity. The news that Verilog would be publicly released presented John Sanguinetti with an opportunity for which he was uniquely positioned to exploit. He realized that his deep knowledge of Verilog and experience in the industry could enable him to introduce a technology that could undermine the market value of Cadence's Verilog simulator.

Sanguinetti was a computer scientist at NeXT (tinyurl.com/8med8), a company Steve Jobs started after he left Apple. Sanguinetti had completed his PhD dissertation on compiler design and was also an experienced user of Verilog. Like all other Verilog "bigots", Sanguinetti did not accept the widely-held belief that VHDL would kill off Verilog. Many who were in the business of designing ICs participated in the technical debate on whether VHDL or Verilog was the better language. In November of 1991, Open Verilog International published the Verilog Language Reference Manual. Soon afterwards, Sanguinetti started working intensely on an innovation that would later be recognized as one of the key technologies that revived Verilog and assured its future.

Verilog is a programming language with a similar grammar and syntax to the C programming language, which is widely used by software developers. A software programmer using C would develop a program in human-readable C then compile it into machine-readable code. Compiled programs run orders of magnitude faster than programs that are executed by a software interpreter, which interprets each chunk of code line-by-line. The VerilogXL simulator that Cadence acquired from Gateway Design Automation was an interpreter. As IC designs became larger, the simulation run time using VerilogXL became excessively long.

Making Money from Exploiting Schumpeterian Opportunities

Arthur Low

Sanguinetti developed a working prototype that could compile and simulate designs in Verilog in two months. He called it the Verilog Compiled Simulator, VCS. The VCS ran between 10 to 30 times faster than Cadence's VerilogXL interpreted simulator. At this time, NeXT was paying more than $100,000 for one VerilogXL simulation license and so was every other company that needed to simulate gate-level netlists.

A compiled Verilog simulator offered an incredible customer value proposition relative to the existing solution. Sanguinetti had no need for outside investment. He recruited close friends with IC design and sales experience to join him in launching a new company to develop and market VCS. He then quit his job at NeXT.

Sanguinetti's new company was called Chronologic Simulation. No one drew a salary for the first 15 months of the company's operations. Within two months of releasing VCS, the startup had sold five licenses to NeXT (Sanguinetti's former employer), Sun Microsystems, and three other companies. Initial sales were mostly achieved through personal contacts in Silicon Valley. One week in 1992, the startup had approximately $1,000 in a bank account; the next week, it had more than two million dollars in the same bank account. The startup had no external investors.

By 1994, Chronologic was on everyone's radar. Several companies, including Cadence, considered buying Chronologic. Since Cadence donated the Verilog language so that it could become an open standard, it may be that Cadence tolerated fair competition against its Cadence's VerilogXL simulator to further promote an open Verilog.

In early 1994, Sanguinetti and other Chronologic executives signed a letter of intent to merge with ViewLogic Systems, another provider of EDA tools. ViewLogic offered Chronologic stock worth $25 million. Shortly after Chronologic signed the letter of intent, Synopsys, a larger EDA company, offered to purchase Chronologic for $25 million in cash. According to the Chronologic team, ViewLogic had led them to believe they could stay in their own offices and keep operating as a separate division. Synopsys told them they would be absorbed. Moreover, had the Chronologic team accepted the Synopsys cash offer after signing the letter of intent with ViewLogic, the CEO of ViewLogic could sue each team member personally.

A year after the ViewLogic-Chronologic "merger", members of the Chronologic team felt aggrieved. Within a month of closing the deal, ViewLogic missed their numbers and the stock fell in response. ViewLogic controlled the Chronologic division and the other aspects of their EDA tool business were stagnant. Chronologic wanted changes, and brought their concerns to ViewLogic management. ViewLogic responded with a lawsuit. Most of the Chronologic staff quit within a week of the lawsuit. ViewLogic threatened Sanguinetti with legal action if he violated the non-compete clause in his contract. As a result, John Sanguinetti retired from the EDA business and pursued consulting work for several years.

Sanguinetti's Second Opportunity: Release of CynLib C++ Library as Open Source

John Sanguinetti's second startup made a strategic decision to release as open source an important EDA software technology: the innovative CynLib C++ library. The CynLib library extended the popular C++ software language to enable electronic system level (ESL) design. Thinking at the ESL level, logic designers model and verify their designs at a much higher level of abstraction than the logic described in Verilog. This advancement was important because the rapid growth in the size of IC designs required designers to describe more complex logic in shorter design cycles.

By 1998, new opportunities were emerging in the EDA industry and John Sanguinetti's non-compete clause had expired. He launched a new EDA company, CynApps, to develop an ESL design flow as a collection of software tools that together formed a complete end-to-end "methodology" for IC design. Venture capital was needed to fund the intensive capital requirements of this new business. In the booming technology sector of the late 1990s, it was not possible to expect top-quality engineers to join a speculative project without being well paid for their efforts. After talking to a few venture capital firms, he raised the money to start CynApps.

A year after raising funds, CynApps technology was being licensed to companies at over $100,000 per license. The core of the technology was the advanced C++ library, CynLib.

Synopsys, one of the largest companies in the EDA industry, had developed a similar ESL technology called SystemC. Users and smaller EDA startups were worried

Making Money from Exploiting Schumpeterian Opportunities

Arthur Low

that Synopsys would try to use its market power to ensure SystemC became an industry standard under its exclusive control. In 2001, Milton Lie, director of engineering of IC start-up Netrake, explained his concerns in an interview to EE Design (tinyurl.com/ch3hez5): "When I looked at these languages, I saw too many big companies with SystemC. My fear was that with so many big companies, with their own egos, it would be very hard to get off the ground. And I thought that Cynlib code, at that point, was a lot more mature."

CynApps, the startup, was not as powerful as Synopsys, the EDA giant. Sanguinetti informed Synopsys that he was considering releasing CynApps' CynLib C++ library as open source. By releasing CynLib as open source, the company hoped to stimulate engineers to adopt CynLib rapidly. Sanguinetti's observation of Linux and other open source projects led him to believe that many engineers would try CynLib and like it. He believed that CynLib users would be attracted to join the CynApps open source community and would work to preserve their experience. Some engineers might contribute to the code base for all sorts of reasons. In 1999, CynApps released CynLib as an open source C+++ library. The CynApps product offer was much more than a library; it was an entire system-level design methodology. The release of the library as open source was not expected to adversely impact CynApps' revenue.

Synopsys had another strategy for SystemC. Synopsys released SystemC as a quasi-open language under a "community source" license as the foundation of the new Open SystemC Initiative. The EDA industry reacted negatively to the "Open" SystemC Initiative. Many were concerned that Synopsys might benefit unfairly from the contributions of other collaborators. Cadence, Mentor Graphics, and other EDA companies did not immediately join the Open SystemC Initiative. The failure of Synopsys to attract Mentor and Cadence to support SystemC threw the EDA industry into chaos.

Many feared the development of two new ESL standards. The industry remembered the Verilog vs. VHDL "language wars" of the previous decade. "We are bringing clarity to the chaos that prevails in the system-level design language world today and simultaneously opening up a whole new realm of opportunities," the Synopsys CEO, Aert de Geus said (tinyurl.com/bw59hmm). "The initiative is championing interoperability at the beginning of this market, and SystemC is the right solution," he continued. But in the same EDN article in September, 1999, John Sanguinetti disagreed: "They are taking a very different approach to 'openness' than we are, making it very explicit that they will control any modifications to the library," Chaos, in the example cited, was the word used by the man whose capital was about to be destroyed by the Schumpterian entrepreneur.

The situation with Synopsys and the Open SystemC Initiative came to a head in 2001. One of the three co-chairs of the Open SystemC Initiative resigned and wrote a letter claiming that the open SystemC was a "Synopsys sham". The letter suggested that anti-trust laws might have been broken and SystemC's backroom deals might unfairly limit free-market competition. A law firm was asked to investigate the operation of the Open SystemC Initiative, and although the investigators reported no wrong-doing, Synopsys decided to release control of the organization it had started. This led to the release of SystemC as an open source C++ library, just like CynApps' CynLib.

The CynApps open source business model was an innovative concept in the EDA industry. The restrictive "community source" license for SystemC could not compete with CynApps' open source license for CynLib.

Lessons Learned

Three important lessons are learned from examining the effect that John Sanguinetti had on the EDA industry. First, deep knowledge and experience enable an entrepreneur to recognize and act on potential Schumpeterian opportunities. Dr. John Sanguinetti was a compiler design expert. His knowledge of Verilog and compilers as well as his experience in the EDA industry enabled him to recognize that the introduction of the Verilog Compiled Simulator, with an order of magnitude performance improvement over the existing Cadence VerilogXL system, could reshape his industry. He saw that his first company could make money by introducing a new technology that outperformed existing technology. Sanguinetti was very familiar with the effect that open source software had in the computer industry. His industry experience and knowledge about open source enabled him to recognize that his second company could make money by releasing the CynLib C++ library as open source and selling a methodology plus a suite of tools. Both companies disrupted the existing market rather than filling gaps in the existing system.

The second important lesson is that exploitation of Schumpeterian opportunities requires combinations of

Making Money from Exploiting Schumpeterian Opportunities

Arthur Low

technology assets and business models that significantly increase customer value. They are not just brought about by developing and introducing a novel technology. Schumpterian entrepreneurs bring chaos to the market as innovations create new opportunities. CynLib's release as open source destroyed Synopsys' business strategy to control modifications to SystemC. This required both technology and business model innovation. Synopsys planned to bring "clarity to chaos" by offering an "opportunity" via a community source license. However, CynApps rival technology combined with an open source license brought Synopsys' business conduct into conflict with its community, thus destroying its social capital.

The third lesson is that venture capital is not always required to exploit a Schumpeterian opportunity. For Sanguinetti's first company, an expert technologist working at home for a few months produced a technologically superior software innovation that delivered much higher value to customers than the available alternatives. The evidence was two million dollars in revenue from five initial customers in the first week of launch. Sanguinetti understood that loyal Verilog users would never change to VHDL unless there was no alternative. Sanguinetti's second company was financed with venture capital, providing the resources required to quickly bring to market a complex suite of software technology. More important, however, was the recognition that donating key IC design technology combined with a genuine commitment to support could enable an open community of users and contributors and create chaos in the EDA industry.

Conclusion

This article has highlighted making money from Schumpeterian opportunities rather than Kirznerian opportunities. John Sanguinetti's two companies, Chronologic Simulation and CynApps, are examples of an entrepreneur recognizing and acting upon opportunities that push an industry out of equilibrium. Sanguinetti's first company combined the publication of an open Verilog language standard with his compiler design expertise to introduce a faster Verilog simulator that undermined the value propositions and capital investments of the incumbent EDA companies. Sanguinetti's second company combined the technological innovation of an ESL design methodology with a novel business strategy of open source software and building a community of users and developers to destroy the social capital of a large EDA company that had tried to control the design libraries.

Three lessons were learned from this study of two Schumpterian opportunities introduced by the same man. First, deep knowledge and experience enable an entrepreneur to recognize and act on Schumpeterian opportunities. Second, exploitation of Schumpeterian opportunities requires combinations of technology assets and business models that significantly increase customer value; developing and introducing a novel technology is not enough. Third, venture capital may not be required. Aspiring entrepreneurs should pay close attention to the lessons learned from examining John Sanguinetti's two companies.

Recommended Reading

- John Sanguinetti's account of the start-up of Chronologic Simulation, the HDL wars, and the development of ESL technologies can be read in *Chip Design Magazine*: tinyurl.com/d7rv7yw
- John Cooley has for many years authored an industry blog called Deep Chip, which provides insider observations: deepchip.com
- *The EE Times* is a long-standing industry trade journal covering developments in the EDA industry: eetimes.com

About the Author

Arthur Low is the founder and Chief Executive Officer of Crack Semiconductor, a supplier of high-performance cryptographic silicon IP used in some of the most demanding security applications. Arthur has a number of patents in the field of hardware cryptography. He has worked for a number of IC startups as a Senior IC designer and Architect and gained much of his fundamental IC design experience with Bell-Northern Research in the early 1990s and with IBM Microelectronics in the late 1990s. Arthur has a BSc. degree in Electrical Engineering from the University of Alberta and is completing his MSc. degree in Technology Innovation Management in the Department of Systems and Computer Engineering at Carleton University.

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Applying the Theory of the Firm to Examine a Technology Startup at the Investment Stage

Michael Ayukawa

> *"There is nothing more practical than a good theory."*
> Kurt Lewin
> Psychologist and author

The investment stage of a new technology firm is when resources, opportunities, investors, and early customers first converge. Currently, technology entrepreneurs make many expensive mistakes. They invest in assets and develop capabilities that prove to have limited value. They take too long to discover and validate the product-market fit for their firms during the investment stage and run out of time and money. Understanding how theory can help entrepreneurs make decisions during the investment stage is important to accelerate new-firm formation and growth as well as to reduce the uncertainty of founders and stakeholders of technology firms.

This article introduces a model developed to examine deal making during the investment stage of a new technology firm. It is an extension of a model of lateral firm scope proposed by Oliver Hart and Bengt Holmstrom. The extensions come from considering a technology firm as being both a deal-making entity and a pool of resources during the investment stage. A deal is the result of a decision the entrepreneur and others make to coordinate (i.e., work together to achieve a common objective). Benefits from a deal include cash profits for the firm and private benefits for the entrepreneur.

This extended model is then applied to examine the author's firm which is still in the investment stage. Application of the extended model to a real-life situation generated two important insights: i) when private benefits include learning from experimentation, the number of deals increases and ii) at the start of the investment stage, private benefits drive deal-making, whereas at the end of the investment stage, cash profits derived from asset ownership drive deal-making.

Introduction

To avoid making costly mistakes, reduce the cost and time of engaging stakeholders, help overcome blind spots and biases, and focus attention, we need a much better understanding of what causes what – and why – during the investment stage of a technology firm. The investment stage is when a new technology firm must assemble and invest resources to execute on the prototypes of their value proposition to customers. This stage corresponds to the second of the three stages described by Cason and Wadeson (2007; tinyurl.com/869g49o).

Today, too many entrepreneurs are making important decisions based on guesswork, wrong data, unfounded opinions, poor analogies, and faulty logic. A theory that has predictive power and can help interpret what happens during the investment stage of a technology firm is needed.

This article makes three contributions. First, it links the theory of the firm, through the use of the Hart and Holmstrom model (2010; tinyurl.com/bver2xy), with the theory of entrepreneurship during the investment stage of a new technology firm. Second, the article uses deals, not assets or contracts, as reference points to better as-

Applying the Theory of the Firm to a Technology Startup at the Investment Stage

Michael Ayukawa

sess new technology firms. Third, it provides two interesting insights about new firm behaviour during the investment stage.

The following section of the article describes the model used to examine a technology firm at the investment stage. Next, the data on the deals closed by a new technology firm over a three-year period are provided and then the insights of using the model to examine the data are discussed. The last section provides conclusions.

The Model

To examine a technology firm during the investment stage, we use and extend the model that Hart and Holmstrom (2010; tinyurl.com/bver2xy) developed to examine the relationship between two units inside a firm. The original model examined the cases of coordination (i.e., working together on a common objective) under different circumstances of management control. It modeled the behaviour of two inside managers who lead two separate units in a lateral relationship. These two inside managers may have a boss who coordinates (integrated) or may not (non-integrated).

The Hart and Holmstrom model has two key ingredients. First, each unit generates two kinds of benefit: profit for the unit and private benefits for the people in the unit. The unit's profits are transferable with ownership. Private benefits represent job satisfaction and are not transferable. However, private benefits can be assigned a monetary value. Second, coordination between two units results when their managers agree on a decision that affects each other (e.g., decide to visit the same customer, share space, adopt a standard). If the managers disagree, there is no coordination. The benefits are modeled using the framework of incomplete contracts as reference points developed by Hart and Moore (2008; tinyurl.com/c56xtnb).

We have developed an extension to their model that focuses on the deals of a firm during the investment stage, instead of assets or contracts. We propose that a deal is the reference point based on the belief that the sequence of deals a new firm makes and executes during the investment stage provides a better view of the firm's capabilities than an inventory of its assets and contracts.

In our model, we examine firms in the investment stage; two players who agree to work together do so around a deal. Each interprets the deal in the way that is most favourable to the player. A player who does not derive the most-favoured outcome from a deal feels wronged, offended, or unhappy. The player then performs in a perfunctory way – the player completes their side of the deal merely as a routine duty, hastily executed and superficial. Perfunctory performance causes economic inefficiencies.

The Hart and Holmstrom model examines three cases of cooperation:

1. Non-integration without cooperation

2. Non-integration with cooperation

3. Integration with cooperation

Integration reflects whether the parties have a coordinating boss. Cooperation distinguishes between two relationship patterns among the players. A transient or transactional relationship is where performance in a perfunctory way due to non-coordination does not apply (i.e., it is just business). An ongoing relationship is where perfunctory performance due to non-coordination may apply. For example, there is a cost for non-coordination if a friend asks for your help and you say "no". For example, the cost affects the friend's motivation to respond to your request for help at a future date. Note that players within a firm are assumed to have an ongoing relationship and therefore always operate under case three.

Deals generate two kinds of benefits:

1. Monetary profits that are transferrable with ownership

2. Private benefits, which are non-transferable. For example, skills.

Monetary profits can be generated by the sale of products or services or by the sale of company equity. Compared to an established firm, the monetary profit that a startup generates through sales of products or services may be small or zero.

Private benefits capture the notion of skills and training: elements that correlate to some future value (e.g., billing rate, wages, and career prospects) but also relate to reputation (e.g., commitment, honesty, and fairness).

Applying the Theory of the Firm to a Technology Startup at the Investment Stage

Michael Ayukawa

In the Hart and Holmstrom model, coordination between managers was conceptualized as always reducing private benefits. The rationale for this was that "job satisfaction stems from the ability to pursue an independent course or agenda." Any coordination compromised this pursuit and therefore was seen as a negative.

In the case of a new technology firm in the investment stage, we observe something different than what is in the Hart and Holmstrom model. Coordination has the prospect of increasing the net private benefits for the players. There is a prospect for a high net value of private benefits in contributing to the foundational learning in a growth-oriented startup that is greater than that of any loss of pursuing an independent course or agenda.

What this means for a new firm is that the motivation for early coordination can be expected to be more heavily weighted towards private benefits, rather than immediate profit. It pays off to coordinate with others for the purpose of learning.

However, as the need to generate cash profits increases, the firm is compelled to shift its focus from private benefits to monetary profit benefits (i.e., revenues). The work of Hart and Holmstrom suggests that this coordination is more likely to occur through integrated resources (i.e., within the firm) since it effectively discounts the value of private benefits.

A Real-Life Technology Firm

The author examined the deals of the company he founded with his partner in early 2009. Presently, the company is in the investment stage. Table 1 provides information on the deals that required a commitment of at least 20% of the founder's company resources in time or money from March 2009 to May 2012. For each of the 18 deals, Table 1 provides the month and year when the deal was agreed to, the type of the deal, the ratio of profits to private benefits estimated by the author, and the number of players involved in the deal.

Of the 18 deals, six were profit centric (i.e., the value was in selling goods or services, two were training deals (i.e., the value was in education), five were community deals (i.e., the value was in building relationships), three were grants, and two were investments.

Table 1 illustrates that:

1. The number of deals and the number of players engaged in a deal increased with time.

2. Commercial activity increased with time.

3. Deals shifted with time from providing private benefits to providing profit benefits.

Many cooperative relationships were formed in the community projects and the training programs and this created a network of potential partners and opportunities. From this network of partners came many players in the later deals.

With the exception of one, all the community projects and training were deals without a formal contract. They were without compensation and driven by private benefits of learning and relationship building.

The one training program with a contract was a struggle at the end as the original proposal deliveries no longer fit the business direction but had to be completed. Somewhat similarly, a grant program with a fixed deliverable was eventually abandoned as the original objective no longer fit with the company direction. In both these cases, a longer-term contract (both were 6 to 9 months in length) with fixed deliverables became difficult to manage for the startup. This might signal that connecting grants and contracts to an emerging firm may have unintended consequences of handcuffing the startup to early thinking and restricting their ability to embrace new learning. Note that this startup did not generate significant services revenue.

In contrast to defined contracts, investment capital provided freedom to create prototypes strictly for learning and largely without regard to third parties. This began to change as the firm engaged with clients and projects that were public facing. Changes "on the fly" also became more difficult to negotiate when many players were involved. Now that the firm engages primarily with profit-centric deals, delivery is tied to a fixed specification and timeline.

Insights

There are two insights that emerge from the model used to examine a technology company at the invest-

Applying the Theory of the Firm to a Technology Startup at the Investment Stage

Michael Ayukawa

Table 1. Analysis of deals from March 2009 to May 2012

Year	Deal	Month	Deal Type	Profit/ Private	Players in Deal
2009	1	Mar	Profit	0.3	2
	2	Jun	Training	0	2
	3	Sep	Grant	0.7	2
2010	1	Jan	Training	0.5	2
	2	Mar	Profit	0.5	2
	3	Jun	Community	0.3	2
	4	Jun	Community	0	4
	5	Oct	Community	0.4	4
	6	Nov	Grant	0.5	2
2011	1	Jan	Investment	2.3	4
	2	Aug	Profit	0.4	6
	3	Oct	Community	0.3	4
	4	Oct	Grant	1.0	2
	5	Nov	Profit	2.5	2
2012 (up to May)	1	Mar	Community	0.2	7
	2	May	Profit	0.8	4
	3	May	Profit	1.5	5
	4	May	Investment	1.3	5

ment stage. First, when private benefits are positive (vs. negative) under coordination, the total number of deals increases. Hart and Holmstrom relate private benefits to job satisfaction. They conclude that coordination will decrease job satisfaction because individuals are no longer free to decide as they wish. While this conclusion makes sense in the context of an existing firm with employees and an operational history, it makes less sense when a technology firm is at the investment stage. Coordination results in increased learning for an entrepreneur. This increased learning is a private benefit for an entrepreneur.

The second insight is that at the start of the investment stage, private benefits drive deal-making while cash benefits derived from asset ownership drive deal-making towards the end of the investment stage.

The investment stage is where the entrepreneurial firm assembles the assets that will later become operationalized. At the beginning of this stage, the focus is on learning by experimenting. Profits are important but largely as a matter of validating support for the firm's emerging value proposition. In such an environment, investing too early in operational assets can effectively reduce

Applying the Theory of the Firm to a Technology Startup at the Investment Stage

Michael Ayukawa

the degrees of freedom to experiment because of the need to justify the investment. The flip side is that the investment shortens the time to operationalize and generate a meaningful revenue stream.

Conclusions

This work extends the model proposed by Hart and Holmstrom in two ways. First, the model used in this article focuses on deals, not on assets or contracts that the firm owns. Deals are different because they include both profit and private benefits. Second, private benefits in the model used in this article include benefits from learning by experimentation and cooperation and they increase with coordination. Hart and Holmstrom assume that private benefits refer to job satisfaction and that they decrease with coordination.

This extended model was examined in a single case and was consistent with the expected behavior. More work is obviously in order but there is some indication that this effort may help connect entrepreneurship to the formal theory of the firm and thus help create a theoretical foundation for the study of entrepreneurship.

About the Author

Michael Ayukawa is the co-founder of Cornerportal Inc., a company that is committed to bring economic opportunity to more individuals in more communities worldwide. He is also a master's student in the Technology Innovation Management program at Carleton University and plays an active in several emerging business ecosystem projects.

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An Overview of Four Issues on Technology Entrepreneurship in the TIM Review

Tony Bailetti, Sonia Bot, Tom Duxbury, David Hudson, Chris McPhee, Steven Muegge, Michael Weiss, Jonathan Wells, and Mika Westerlund

> *"Discovery consists of seeing what everybody has seen and thinking what nobody has thought."*
>
> Albert Szent-Györgyi
> Physiologist and Nobel Laureate (1937)

The field of technology entrepreneurship is in its infancy when compared to other fields such as economics and management. Articles on technology entrepreneurship have been published in at least 62 journals, of which only 18 contribute to technology innovation management or entrepreneurship. Less than a handful of these 62 journals are considered to be "good" journals and none can claim a leadership position in technology entrepreneurship. The purpose of this article is to provide an overview of the 20 journal articles published in the February, March, April, and May 2012 issues of the Technology Innovation Management Review (TIM Review).

Introduction

Technology entrepreneurship is an investment in a project that assembles and deploys specialized individuals and heterogeneous assets that are intricately related to advances in scientific and technological knowledge for the purpose of creating and capturing value for a firm (Bailetti, 2012; timreview.ca/article/520). Technology entrepreneurship applies equally well to newly formed or established firms as well as firms of any size.

The study of technology entrepreneurship serves an important function beyond satisfying intellectual curiosity. Technology entrepreneurship is necessary for growth, differentiation, and competitive advantage at the firm, regional, and national levels (Bailetti, 2012).

In early September 2011, a request for articles on technology entrepreneurship was issued to the faculty, staff, doctoral and master students, and professionals associated with Carleton University's Technology Innovation Management program (carleton.ca/tim) with the intent of producing a special issue of the TIM Review on the theme of technology entrepreneurship. Given the overwhelming response to this request and the perceived importance of the topic, four consecutive issues focusing on technology entrepreneurship were published in early 2012.

In this article, the 20 journal articles published in the February, March, April and May 2012 issues of the TIM Review – and listed in Table 1 – are classified based on the subject matter and main objective of the article. Next, four salient aspects of the set of 20 journal articles are discussed. Finally, the last section provides our conclusions.

Journal Articles by Themes

Table 2 organizes the 20 articles published in the February to May 2012 issues of the TIM Review into nine themes. The first eight themes in Table 2 were those used to organize the 93 articles on technology entrepreneurship published since 1970 reviewed by Bailetti (2012; timreview.ca/article/520). The ninth theme, Theory advancement, is new. The new theme was added because three articles in the TIM Review dealt with building theory more than with the topics included in the other themes.

An Overview of Four Issues on Technology Entrepreneurship in the TIM Review

Bailetti, Bot, Duxbury, Hudson, McPhee, Muegge, Weiss, Wells, and Westerlund

Table 1. The 20 articles published in the TIM Review from February to May 2012

Issue	Article Title	Author(s) and Link to Article
February	1. Technology Entrepreneurship: Overview, Definition, and Distinctive Aspects	Bailetti (2012; timreview.ca/article/520)
	2. Entrepreneurial Effort in the Theory of the Firm	Hudson (2012; 521)
	3. Organizational Ambidexterity: How Small Technology Firms Balance Innovation and Support	Schreuders and Legesse (2012; 522)
	4. Social Entrepreneurship: Definition and Boundaries	Abu-Saifan (2012; 523)
	5. Chinese Entrepreneurs Go Global	Zhou (2012; 524)
March	6. Global from the Start: The Characteristics of Born-Global Firms in the Technology Sector	Tanev (2012; 532)
	7. Towards More Case Study Research in Entrepreneurship	Duxbury (2012; 533)
	8. A Customer Value Creation Framework for Businesses That Generate Revenue with Open Source Software	Shanker (2012; 534)
	9. Minimum Viable Product and the Importance of Experimentation in Technology Startups	Rancic Moogk (2012; 535)
	10. A Guide for Entrepreneurs Who Lead and Manage Change	Plante (2012; 536)
April	11. Business Model Discovery by Technology Entrepreneurs	Muegge (2012; 545)
	12. User Frustrations as Opportunities	Weiss (2012; 546)
	13. Process Ambidexterity for Entrepreneurial Firms	Bot (2012; 547)
	14. How Do Large Companies Manage Their Investments Across the Three Horizons?	Carbone (2012; 548)
	15. The Role of Universities in Technology Entrepreneurship	Wells (2012; 549)
May	16. Categorizing the Growth Strategies of Small Firms	Leminen and Westerlund (2012; 553)
	17. Results-Based Organization Design for Technology Entrepreneurs	McPhee (2012; 554)
	18. Making Money from Exploiting Schumpeterian Opportunities: John Sanguinetti and the Electronic Design Automation Industry	Low (2012; 555)
	19. Applying the Theory of the Firm to Examine a Technology Startup at the Investment Stage	Ayukawa (2012; 556)
	20. An Overview of Four Issues on Technology Entrepreneurship in the TIM Review	Bailetti et al. (2012; 557)

An Overview of Four Issues on Technology Entrepreneurship in the TIM Review

Bailetti, Bot, Duxbury, Hudson, McPhee, Muegge, Weiss, Wells, and Westerlund

Table 2. Themes contained in TIM Review articles from February to May 2012

	Themes	References	# of Journal Articles	% of Total
1	External factors that influence formation of technology firms	• Wells (2012)	1	5%
2	How, why, and when technology entrepreneurship affects the socio-economic development of a region	• n/a	0	0%
3	Approaches used by small technology firms to generate revenue and reduce costs	• Muegge (2012) • Rancic Moogk (2012) • Shanker (2012) • Weiss (2012)	4	20%
4	Internal practices used to operate and transform small technology firms	• McPhee (2012) • Plante (2012) • Schreuders & Legesse (2012)	3	15%
5	Interdependence between technology path and small technology firm formation and growth	• Leminen & Westerlund (2012) • Low (2012)	2	10%
6	Overview of technology and social entrepreneurship	• Abu-Saifan, 2012) • Bailetti (2012) • Bailetti et al. (2012)	3	15%
7	Corporate entrepreneurship function in mid-sized and large firms	• Bot (2012) • Carbone (2012)	2	10%
8	Contributions to closely related fields	• Tanev (2012) • Zhou (2012)	2	10%
9	Theory advancement	• Ayukawa (2012) • Duxbury (2012) • Hudson (2012)	3	15%
		Total	**20**	**100%**

An Overview of Four Issues on Technology Entrepreneurship in the TIM Review

Bailetti, Bot, Duxbury, Hudson, McPhee, Muegge, Weiss, Wells, and Westerlund

Journal Articles by Main Objective

Table 3 identifies the main objectives of the 20 articles on technology entrepreneurship published in the February to May issues of the TIM Review. The following subsections more closely examine each objective.

1. Provide solutions to problems faced by technology entrepreneurs
Ten articles described approaches, frameworks, guides, mechanisms, models, or tools that technology entrepreneurs can use to solve eight of the problems they face. Table 4 identifies the eight distinct problems and matched them against the 10 articles that propose solutions in the context of technology entrepreneurship.

These articles cover the complement of articles in the following three themes from Table 2: Approaches used by small technology firms to generate revenue and reduce costs, Internal practices used to operate and transform small technology firms, and Corporate entrepreneurship function in mid-sized and large firms.

2. Advance theory to help technology entrepreneurship
Three articles focused on advancing theory of entrepreneurship. The process of building theory can be conceptualized as comprised of four components: i) theory

Table 3. Main objectives of 20 TIM Review articles

	Main Objective	# of Articles	%
1	Provide solutions to problems faced by technology entrepreneurs	10	50%
2	Advance theory to help technology entrepreneurs	3	15%
3	Scope and define the fields of technology and social entrepreneurship	3	15%
4	Leverage salient features of international entrepreneurship	2	10%
5	Provide lessons from experience	2	10%
	Total	**20**	**100%**

Table 4. Articles that address solutions to problems faced by technology entrepreneurs

	Problem	Articles with Solutions
1	Developing a successful business model	• Muegge (2012)
2	Discovering business opportunities	• Weiss (2012)
3	Testing a new product's fit to a market and its growth projections	• Rancic Moogk (2012)
4	Balancing initiatives to exploit vs. initiatives to explore	• Bot (2012) • Carbone (2012) • Schreuders & Legesse (2012)
5	Designing firms to deliver desired outcomes	• McPhee (2012)
6	Leading and managing change to grow a firm	• Plante (2012)
7	Attaining a firm's goals for revenue and volume	• Leminen & Westerlund (2012)
8	Generating revenue from the use of open source assets	• Shanker (2012)

An Overview of Four Issues on Technology Entrepreneurship in the TIM Review

Bailetti, Bot, Duxbury, Hudson, McPhee, Muegge, Weiss, Wells, and Westerlund

formation, ii) categorization, iii) observation and description, and iv) research tools. Table 5 shows the articles on theory building by component.

Table 5. Articles on theory building

	Component	Articles
1	Theory formation	Hudson (2012)
2	Categorization	n/a
3	Observation and description	Ayukawa (2012)
4	Research tools	Duxbury (2012)

Of these three articles, two describe the link between the theory of the firm and entrepreneurship (Ayukawa, 2012; timreview.ca/article/556; Hudson, 2012; timreview.ca/article/521); one argues for greater use of case research to develop theory of entrepreneurship (Duxbury, 2012; timreview.ca/article/533).

Of the two articles that describe the link between the theory of the firm and entrepreneurship, one is focused on entrepreneurial employees of large companies (Hudson, 2012; timreview.ca/article/521), while the other one examines the investment stage of new technology companies (Ayukawa, 2012; timreview.ca/article/556).

3. Scope and define the field
The first article in the four-issue series on technology entrepreneurship reviewed the articles published over the last 40 years, proposed a definition of technology entrepreneurship, and described its distinguishing aspects (Bailetti, 2012; timreview.ca/article/520). In this last article, we examine what was published in the past four issues of the TIM Review (Bailetti et al., 2012; timreview.ca/article/557).

One article defines social entrepreneurship, examines the boundaries of socially-oriented entrepreneurial activities, and positions the social entrepreneur in the spectrum of entrepreneurship (Abu-Saifan, 2012; timreview.ca/article/523).

4. Leverage salient features of international entrepreneurship
Two articles focus on international aspects of entrepreneurship. Tanev (2012, timreview.ca/article/532) describes the characteristics of technology firms designed to be global upfront. Zhou (2012; timreview.ca/article/524) uses the Kirznerian and Schumpeterian perspectives of entrepreneurship to examine the "go global" initiatives of Chinese entrepreneurs and describes the unique characteristics of the business environment and culture in China, which are likely to motivate Chinese entrepreneurs to go global.

5. Lessons from experience
Two articles describe lessons gained from industry experience. Low (2012; timreview.ca/article/555) identifies the lessons learned from examining the effect that two companies had on the market for integrated circuit design languages. Wells (2012; timreview.ca/article/549) examines the role universities play helping entrepreneurs launch and grow their businesses.

Salient Aspects

Four factors distinguished the set of 20 articles published in the TIM Review from the 93 articles published from 1970 to 2011.

1. Oriented to solving real problems
Over the last 40 years, the technology entrepreneurship literature has been dominated by a theme that focuses on identifying the antecedents and consequences of technology firm formation. Of the 93 earlier papers reviewed, 42 (45%) were classified under this theme (Bailetti, 2012; timreview.ca/article/520); in contrast, only one of the 20 papers (5%) published in the TIM Review focused on this theme (Table 2).

The articles published in the TIM Review are dedicated to solving a diverse set of real problems encountered by entrepreneurs in small and large companies. Table 3 shows that 50% of the TIM Review articles proposed solutions to problems faced by entrepreneurs. Table 4 indicates that these articles addressed solutions to diverse problems.

It is interesting to note that none of the TIM Review articles fall within the second theme in Table 2, How, why and when technology entrepreneurship affects the socio-economic development of a region, despite the fact that the TIM Review articles are from people associated with a particular geographic region in Canada that has a history of technology firms and a base of government-sponsored research laboratories. This suggests that while the TIM Review articles are oriented to solving real problems, the interest is in problems that are not idiosyncratic to a specific company, technology sector,

An Overview of Four Issues on Technology Entrepreneurship in the TIM Review

Bailetti, Bot, Duxbury, Hudson, McPhee, Muegge, Weiss, Wells, and Westerlund

governmental policy, or metropolitan area despite ready access to potential case study material in that geographic region.

2. Contributed to theory building
While there is nothing more practical than a good theory (Lewin, 1952; tinyurl.com/brzkmvl), not one of the 93 articles reviewed by Bailetti (2012; timreview.ca/article/520) stated that the advancement of the theory of technology entrepreneurship was its main objective. In contrast, three of the 20 articles published in the TIM Review contributed to the advancement of theory of entrepreneurship.

Two articles provided new ideas for understanding, conceptualizing, and dealing with problematic situations (Ayukawa, 2012: timreview.ca/article/556; Hudson, 2012: timreview.ca/article/521). One article provided researchers with key information and facts relevant to carrying out research in technology entrepreneurship (Duxbury, 2012; timreview.ca/article/533).

3. Greater focus on profiting from filling gaps in existing systems rather than on profiting from creative destruction
The technology entrepreneurship literature published from 1970 to 2010 as well as the 20 articles published in the TIM Review deal with problems associated with the production and adoption of radical innovations. Only one of the 20 articles published in the TIM Review focused on influencing or causing creative destruction.

This suggests that the articles published in the TIM Review take a view of entrepreneurship that encompasses a wider range of potential actions than would be associated with rare disruptions of economy-wide equilibrium (Schumpeter, 1950; tinyurl.com/cka78wt). Entrepreneurship applies to a broad group of individuals in a variety of roles (Shane, 2012; tinyurl.com/bn3vp9g) including those engaged in "occupational entrepreneuring" (Courpasson, Dany & Marti, 2011; tinyurl.com/dx9z9y4) addressing more everyday opportunities in existing systems.

The TIM Review content has taken a view of entrepreneurship that is broad however most of what has been published to date focuses on profiting from opportunities to fill gaps in existing economic systems and even in existing firms. Consequently profiting from the rare but immensely valuable "big bangs" (Perez, 2009; tinyurl.com/cun7j4n) has largely been ignored.

4. Existence of critical mass
A total of 21 authors contributed 20 articles to the four issues on technology entrepreneurship and Tables 1 through 5 are evidence that sufficient quantity and diversity of contributors of journal articles with innovative ideas exists. If this continues, it is expected that the rate of innovative contributions can become self sustaining and create further growth in knowledge.

Conclusions

Faculty, students, staff and professionals associated with Carleton University's TIM program contributed 19 articles on technology entrepreneurship and one article on social entrepreneurship to the TIM Review. The 20 articles published in the February, March, April and May 2012 issues were classified based on themes and the article's main objective. The set of 20 articles published in the TIM Review were oriented more towards contributing solutions to real problems faced by technology entrepreneurs and advancing theory than those reviewed by Bailetti (2012; timreview.ca/article/520).

Two aspects require particular attention. A major effort must be dedicated to producing TIM Review content that helps technology entrepreneurs profit from creative destruction opportunities (Schumpeter, 1950; tinyurl.com/cka78wt). Most of what has been published on technology entrepreneurship to date has focused on profiting from opportunities to fill gaps in the existing economic system. A second major effort needs to focus on global entrepreneurship, particularly what can be done to decrease the time to cash from sales to foreign customers. How can we design technology companies so they can operate globally shortly after they are launched?

About the Authors

Tony Bailetti is an Associate Professor in the Sprott School of Business and the Department of Systems and Computer Engineering at Carleton University, Ottawa, Canada. Professor Bailetti is the Director of Carleton University's Technology Innovation Management program. His research, teaching, and community contributions support technology entrepreneurship, regional economic development, and international co-innovation.

An Overview of Four Issues on Technology Entrepreneurship in the TIM Review

Bailetti, Bot, Duxbury, Hudson, McPhee, Muegge, Weiss, Wells, and Westerlund

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Tom Duxbury is Entrepreneur in Residence at Wesley Clover Technologies, a private equity incubator. He is currently completing his PhD in Management at the Sprott School of Business at Carleton University in Ottawa, where he teaches courses in entrepreneurship and innovation.

David Hudson is pursuing doctoral studies and is a lecturer in the MBA program at Carleton University's Sprott School of Business in Ottawa Canada. His research focus considers entrepreneurial effort by employees and changes arising from consumer technology use in industry. Previously, David was the Vice President for Advanced Research and Technology at a large technology firm and has had an extensive career in technology development and product line management. He received Bachelor's and Master's degrees in Systems Design Engineering from the University of Waterloo.

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Michael Weiss holds a faculty appointment in the Department of Systems and Computer Engineering at Carleton University, and he is a member of the Technology Innovation Management program. His research interests include open source business models, collective innovation, mashups and end-user development, product line engineering, and business patterns. Michael has published over 100 papers in conferences and journals.

Jonathan Wells is Executive Director, Research Centre in Technology Innovation, at Carleton University in Ottawa, Canada. Jonathan comes from a background of software engineering, with experience in all sizes of high-tech business, from very small startups upwards to large multinationals. He founded and ran a small software development and consultancy business for several years and subsequently worked as a project manager for HP software development teams in New Zealand, later holding the position of CIO for the Meat Inspection Branch of the NZ Canadian Food Inspection Agency. Jonathan has an undergraduate degree in Physics and Computer Science and holds an MBA from the University of Canterbury, Christchurch, NZ.

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TIM Lecture Series: Next-Generation Technology Challenges and Business Opportunities

Dave Thomas

> *"Seeing the future of technology is pretty easy. Seeing the future of the world is another thing."*
>
> Dave Thomas
> Founder and Chairman of Bederra Research Labs

The third TIM lecture of 2012 was presented by David Thomas, Founder and Chairman of Bederra Research Labs, who shared his visions for the future of technology as well as the challenges and business opportunities it will bring. The event was held at Carleton University in Ottawa, Canada, on April 19, 2012.

The TIM Lecture Series is hosted by the Technology Innovation Management program (TIM; carleton.ca/tim) at Carleton University. The lectures provide a forum to promote the transfer of knowledge from 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.

This report summarizes the presentation and its key messages, including the lessons learned and actions identified by audience members. The slides from his presentation are available here: tinyurl.com/d36vnxa.

Part 1: Future Technology

In the first part of his presentation, Dave Thomas examined current technology trends and the future direction of technologies such as mobility, cloud computing, "Big Data", NoSQL databases (tinyurl.com/yes8tem), computer languages and development processes, and outsourcing to cyborgs and robots. Particular emphasis was placed on the explosive growth in new technologies that take advantage of the availability of massive computational power, which is a key driver for future technology.

The presentation also focused on the complexity of current and future technology, which is creating both educational and management challenges. We now have many options available to us, but they come with costs, including: complex integration, multiple languages, legacy support, etc. Fortunately, a layer of entrepreneurs are building platforms and tools that make it easier for others to build upon this complexity without needing to become entangled within it. These new tools simplify the creation process to the point that even domain experts can use them, which reduces their dependency on developers. Even so, we will require a new set of skills (e.g., social intelligence, new media literacy, trans-disciplinarity, a design mindset, cross-cultural competency) to succeed with the future landscape of technology.

Part 2: Business Implications

In the second part of his presentation, Dave Thomas discussed the business side of future technology. As a speculator on the "lunatic fringe" of technology, he de-

TIM Lecture Series: Next-Generation Technology Challenges and Business Opportunities

Dave Thomas

scribes himself as a "wildly optimistic downside planner". This means he reaches for the most optimistic outcomes, but plans ahead for how he might fail: "When it happens, I can recognize it as an event to manage and I already know what to do." This approach highlights the speculative nature of next-generation technology; the chances of failure are high, the landscape is unpredictable, but the potential reward is substantial.

Future technology will require new business models, even though the long-established business models will still be relevant in some areas. Dave Thomas predicts that we will see more companies creating short-lived virtual corporations with partners and increasing segregation of highly innovative business units that can be spun off and re-acquired if future options are sufficiently valuable. He also discussed the implications of lower start-up costs, crowdsourcing, and virtual accelerators, which are creating an increasing number of opportunities for entrepreneurs. However, he noted that there is a difference between using existing technology to develop an opportunity and actually innovating by developing new technology through entrepreneurship. Thus, many of today's "technology startups" are really business ventures that just use IT. For the latter companies, it is the business knowledge that is critical, not the technology.

Dave Thomas encouraged the audience to find a problem that someone cares about, develop domain expertise in that area, and listen carefully to customers to fully understand the pain caused by this problem. As an example, he discussed the pain computer users still feel when communicating with machines. With this simple example, he examined several future technologies that could lead to business opportunities on both the input and output sides of human-computer interaction.

In closing, Dave Thomas emphasized that, to make money in next-generation technology, entrepreneurs need to be inventing the technology or at least leading the technology. This can be a demanding and time-consuming process, which takes a minimum of three years just to acquire the necessary knowledge and potentially takes many more years to perfect the technology. However, it is not enough to be in a leadership position with respect to creating value with new technology; constant dialogue with potential customers is also essential to extract value from the technology.

Lessons Learned

In the discussions that followed the first and second parts of the presentation, audience members shared the lessons learned they learned from the presentation and injected their own knowledge and experience into the conversation.

The audience also identified the following key takeaways from the presentation:

1. Prognosticators are unable to see 20 to 40 years into the future in the way they used to (e.g., science fiction writers). It is becoming harder to anticipate new technologies.

2. The future will require more generalized knowledge than specialized knowledge.

3. Nowadays, all computation is really a query.

4. Develop solutions that are "fit to task" – they do not need to be perfect.

5. Many technologies are really just different embodiments of past technologies.

6. You need to fail fast to learn and improve. There is great value in learning early on that a customer does not see the value in your product.

7. If you never leave your discipline, you can never solve the big problems.

8. Learn to live in "problem space" and "customer space".

9. Hide the complexity – just give the end user a simple tool that lets them solve their problem.

10. Pain is a source of opportunity.

11. Domain expertise is a valuable form of intellectual property.

12. What is the difference between an entrepreneur and a founder? The entrepreneur can sell!

13. If you cannot convince anyone that your idea has value, you should not bother building it.

TIM Lecture Series: Next-Generation Technology Challenges and Business Opportunities

Dave Thomas

14. Ideas are plentiful, but the real value comes from execution. Only in very rare cases can ideas be sold.

15. You need to do more than think outside the box; you need to think beyond the box.

16. Choose something that is not obvious. Many will think you are wrong. You should ignore them if you can validate your idea with a few important customers.

Suggested Next Steps

To conclude the evening, the host – Dr. Tony Bailetti, Director of the TIM program – challenged the audience to identify community actions that could be taken to establish a leadership position in entrepreneurship and next-generation technology:

1. Increase the emphasis on sales and marketing among entrepreneurs in our community, including the need to "sell ideas" in terms of testing concepts with customers.

2. Renew the branding of our region. The old brand was "Silicon North" – the time for renewal is now.

3. Encourage engineers to understand the value of "business people". This is often a weakness in a technical community.

4. Encourage interdisciplinary collaboration. This is essential if we are to exploit future technologies and business opportunities.

5. Create focused, high-value networking groups, not just groups for job seekers or service providers.

6. Hold more events with top speakers: ones that are widely recognized as experts, who know what they are talking about, and communicate effectively.

About the Author

Dave Thomas has a wide spectrum of experience in the software industry as an engineer, consultant, architect, executive and investor (davethomas.net). He is the Founder and Chairman of Bedarra Research Labs (bedarra.com), a company specializing in emerging software technologies and applications. Bedarra provides virtual CTO and CEO, as well as directors, advisers, and business mentors to support new initiatives. He is also the Managing Director of Object Mentor (objectmentor.com), a company specializing in the training and deployment of agile and object-oriented software development methodologies. Dave is best known as the founder and past CEO of Object Technology International Inc. (formerly OTI, now IBM OTI Labs), where he led the commercial introduction of object and component technology. The company is often cited as the ideal model of a software technology company and was a pioneer in agile product development with a process called "just-in-time software".

Citation: Thomas, D. 2012. TIM Lecture Series: Next-Generation Technology Challenges and Business Opportunities. *Technology Innovation Management Review*. May 2012: 35-37.

Upcoming TIM Lecture: May 31, 2012

TIM Lecture Series:

Leadership Position in Technology Entrepreneurship and Commercialization: Status, Challenges and Opportunities

In the fourth TIM Lecture of 2012, you will engage with the faculty, students and professionals working to establish a worldwide leadership position in technology entrepreneurship and commercialization for Canada's Capital Region. The lecture will emphasize the many opportunities for you to contribute to this leadership position.

An update on the assets developed over the last five years will be provided. TIM students will deliver 5 minute presentations on their companies, theses and projects. TIM Council members will provide an overview of the initiatives designed to attain the eight proof points identified to establish a leadership position in technology entrepreneurship and commercialization.

After the status reports, we will discuss the challenges and opportunities of establishing a leadership position in technology entrepreneurship and commercialization worldwide and the key points of an action plan will be identified real-time with input from attendees. This is an opportunity for you to help shape Ottawa's leadership position in technology entrepreneurship worldwide.

Details

When: Thursday, May 31, 2012
6:00pm to 9:00pm (ET)

Where: Room ME 3275
Mackenzie Building
Carleton University
1125 Colonel By Dr
Ottawa, Canada

Cost: Free

About the Speakers

This lecture will feature a number of speakers associated with the Technology Innovation Management (TIM) program at Carleton University.

For more information on the TIM program, visit: carleton.ca/tim

Register Now at the Eventbrite website

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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. Only the essential references should be included. The URL to an online reference is preferred; where no online reference exists, include the name of the person and the full title of the article or book containing the referenced text. If the reference is from a personal communication, ensure that you have permission to use the quote and include a comment to that effect.
7. Provide a 2-3 paragraph conclusion that summarizes the article's main points and leaves the reader with the most important messages.
8. Include a 75-150 word biography.
9. If there are any additional texts that would be of interest to readers, include their full title and location URL.
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.