Technology Innovation Management Review

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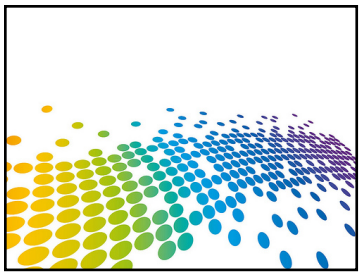

Insights

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

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Overview

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

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

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

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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.
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- Recommend colleagues as authors or guest editors.
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Editorial

Chris McPhee, Editor-in-Chief

Welcome to the November 2012 issue of the *Technology Innovation Management Review*. In this issue, our authors present insights about green innovation, supply-chain simulation, and process adaptability and alignment, along with lessons learned from globalization and entrepreneurship.

Tommi Lampikoski, a visiting scholar at the Haas School of Business, University of California Berkeley, identifies the managerial capabilities that companies require to gain competitive advantage through green innovations. The case of Interface Inc., a globally operating carpet manufacturer, illustrates how a strategy for environmental responsibility is compatible with radical innovation. This approach requires companies to invest in the three "R's" of managerial capability to continously *Research* innovations, *Recognize* opportunities, and *Revolutionize* the industry.

Giacomo Liotta, Assistant Professor in the Institute of Technology and Innovation at the University of Southern Denmark, argues that supply-chain simulation is not just for large companies. Although small and medium-sized companies rarely use simulation tools to improve their decision-making, this article shows how simulation can help smaller companies cope with uncertainty, increase their innovation capability, and gain competitive advantage.

Paul Renaud, Chief Executive of The Lanigan Group, and **Sonia Bot**, business and technology innovation leader, contribute two articles that build upon previous work on process ambidexterity for entrepreneurial firms. Companies that are process ambidexterous find a balance between the exploitation of existing opportunities for the firm and the exploration of new, entrepreneurial opportunities. Process ambidexterity utilizes both process alignment and process adaptability. Renaud and Bot's first article presents a framework for process alignment in IT; their second article examines process adaptability in the IT supply chain.

Sara Rauchwerger, Founder and Director of the Chamber of Commerce International Consortium for Entrepreneurs, answers the question: "What does a global startup need to know to enter China?" The author draws upon her experience helping American, Canadian, and European startups develop and implement their internationalization strategies. A seven-part internationalization strategy for startups is presented, including discussion and insights aimed at the Chinese market in particular.

This issue also includes a report on a recent TIM Lecture by **Wes Biggs**, President and CEO of Triacta Power Technologies, who shared the 29 key lessons he has learned through his experiences with entrepreneurship both within large technology companies and as part of the senior management and founding teams of technology startups. The event was held at Carleton University in Ottawa, Canada, on October 11th, 2012.

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

Chris McPhee
Editor-in-Chief

About the Editor

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

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Green, Innovative, and Profitable: A Case Study of Managerial Capabilities at Interface Inc.

Tommi Lampikoski

> *"Since 2003, we've sold over 83 million square yards of carpet with no net global warming effect. These climate-neutral carpets, Cool Carpets, have been runaway bestsellers. That's competitive advantage at its best – doing well by doing good."*
>
> Ray Anderson (1934–2011)
> Founder of Interface Inc.

This article describes the pioneering green-innovation management practices of a resource-intensive corporation, Interface Inc., which is a globally operating carpet manufacturer. Even during the current economic downturn, many companies remain committed to advancing their green business agendas. However, recent research suggests that most of these companies are far from reaching substantial competitive advantage from this commitment because they lack the connection between their green agendas and core innovation-management activities. This study illustrates how Interface succeeded with radical green innovations by investing in managerial capabilities that allowed it to conduct research, recognize opportunities, and revolutionize the carpeting industry. These capabilities enabled Interface to continuously challenge and disrupt well-established management recipes, existing knowledge, and proven industrial practices, and they enabled it to create a sustainable competitive advantage through a winning portfolio of radical green innovations.

Introduction

Going green can be a magnificent business opportunity and a potential source of competitive advantage, but it also presents a managerial challenge for companies operating in resource-intensive industries. Probably the most significant managerial challenge is finding the balance between short-term economic realities and a long-term vision of ceasing to pollute the environment. In addition, managers are under increasing pressure to demonstrate what their companies are doing for the environment and what role green innovation is playing in the solution (OECD, 2009; tinyurl.com/ana82xo).

This article examines the managerial capabilities of Interface Inc. (interfaceglobal.com), a large, US-based company that has systematically leapfrogged standard managerial routines, practices, and knowledge, and that is now recognized as a radical pioneer and green innovator. Interface is the world's largest manufacturer of modular carpets, employing 3500 employees and selling products in over 110 countries. In 2011, Interface's net sales exceeded $1 billion. The company operates in a resource-intensive business characterized by relatively stable operations and predictability. Radical innovation has been primarily associated with dynamic industries such as ICT and biotechnology; it is rarely associated with a traditional manufacturing industry such as carpet manufacturing. Due to the requirement for substantial start-up investments in building manufacturing facilities, the carpeting industry has a high barrier to entry and is characterized by stability, not radical change.

The carpet industry makes an interesting target for the study because it has a substantial impact on the environment. The industry disposes of five billion pounds of old carpets annually in the US (Anderson and White,

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2009; tinyurl.com/an74uv4), and it is highly dependent on petroleum-based fuels in production. Therefore, it can be viewed as an unexpected suspect in contributing a proactive innovator that excels in corporate sustainability and radical green innovation. Not long ago, most managers perceived "going green" as a threat to their existing business, an isolated set of ecological activities, or something that increases costs with little payoff. Moreover, some managers associate greening as a clever marketing trick to polish their corporate brands (Delmas and Burbano, 2011; tinyurl.com/akwukfe). This study asks "what kind of managerial capabilities are required to create and manage a systematic flow of truly radical green innovations?" The capability perspective is chosen because dynamic managerial capabilities are needed to cope with and make sense of the rapidly changing business environments and to create new innovations (Teece et al.,1997; tinyurl.com/ax9etfx).

This article is based on an analysis of transcribed interviews with the managers of Interface as well as on secondary data including content from websites, scientific and practice-oriented journals, and company reports. Interface's experiences are widely documented in the literature, yet prior studies remain silent on the types of radical green innovations commercialized and which managerial capabilities were needed in managing innovation. This article reviews relevant concepts and illustrates Interface's organization activities and portfolio of radical green innovations. It concludes by presenting three critical managerial capabilities required in managing radical green innovations and discusses the findings and their implications for practitioners and academics of corporate sustainability.

Corporate Sustainability and Radical Green Innovations

Corporate sustainability is a company's environmental action motivated by a variety of influences within a company's market and social domains, including considerations of business performance. A review of the literature of corporate sustainability reveals that considerable scholarly effort has been devoted to identifying the drivers of corporate ecological responsiveness and in debating whether businesses can gain competitive advantage through improved environmental behaviour. An organization's environmental competitiveness derives from a dynamic and innovative response to environmental issues that is encouraged by a supportive regulatory regime (Porter and van der Linde, 1995; tinyurl.com/c9ypj92). Hart (1995; tinyurl.com/c2opdr6) argues that sustained competitive advantage is likely to be rooted in developing environmentally orientated resources and capabilities that can simultaneously improve a company's economic performance.

Companies operating in resource-intensive businesses have been recognized as engines of change in pursuing and solving various climate change issues (Hawken et al., 1999; tinyurl.com/cvx4qfl). These global harms include the annual overuse of natural resources and increased greenhouse gas emissions. The solution to climate change is suggested to rely on companies' capacity for green technological development and innovation, and reducing the current environmental burden in a quick and sufficient way requires companies to redirect their focus of innovation. Azzone and colleagues (1997; tinyurl.com/angr2eh) suggest that companies may choose either a passive lobbying-based green strategy or an innovation-based green strategy. The latter strategy views the environmental variable as the most important competitive priority and seeks to introduce new technologies that radically improve the environmental performance of current technologies, and to create new market opportunities as a consequence of environmentally friendlier product innovations.

Choosing and implementing an innovation-based green strategy calls for understanding relevant concepts such as green innovation. Managers may ask how to define this concept and in what ways green innovation differs from traditional innovation. In prior research, green innovation refers to "new or modified processes, techniques, practices, systems and products to avoid or reduce environmental harms" (Beise and Rennings, 2005; tinyurl.com/b4npep7). This broad definition includes all the changes in the product portfolio or in the production processes that address sustainability targets. Therefore, it refers to an innovation that addresses waste management, eco-efficiency, and any other action implemented to reduce the company's environmental footprint. This definition is based on the effect of the innovation activities independent of the initial intent and novelty of innovation. That is, it includes both incremental and radical improvements.

In addition, prior research suggests that green innovation differs from traditional innovation and is a separate sub-group of innovation with a primary focus on reducing or avoiding harm to the environment (Carrillo-Hermosilla et al., 2010; tinyurl.com/aafz83d). First, green innovation is not an open-ended concept as it characterizes innovation that explicitly stresses the reduction of environmental footprints, whether intended or not (OECD, 2009; tinyurl.com/ana82xo). Second, it creates pos-

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itive externalities by providing knowledge during the research and innovation phases, and it then reduces environmental effects and generates externality in the diffusion phase, which can also be socially desirable. Green innovation can entail alteration of social norms, cultural values, and institutional structures (Rennings, 2000; tinyurl.com/b7ltg2n).

As previously suggested, green innovation should be discussed in conjunction with the novelty of innovation. O'Connor and Ayers (2005; tinyurl.com/anx72bo) define radical innovation as "the commercialization of products and technologies that have strong impact on the market, in terms of offering wholly new benefits, and the firm, in terms of its ability to create new businesses". These impact levels are correlated with high risk and high uncertainty in the firm, requiring it to develop new, situation-specific competencies in technology, market, and organizational domains. Radical innovations are different from incremental innovations considered as step-by-step improvements. They require more time for research and development and involve greater risk for market adoption; yet, they can yield a considerable positive impact on a firm's profitability as well as to industry and economic dynamics.

Radical innovations can alter, redefine, or rejuvenate existing industries by de-maturing declining technologies, or they can result in the emergence of new industries. The development of new businesses and product lines based on radical innovations, which are essential for the renewal of a company's competitive position, require management practices that differ substantially from those required for incremental innovation. Therefore, radically new products and business models involve the development or application of significantly new technologies; require considerable behavioural changes to existing markets; and require new skills, abilities, and systems throughout the organization. However, gaining support for radical initiatives can be demanding in companies where internal cultures and pressures favour low risk and immediate rewards from step-by-step improvements (O'Connor and Ayers, 2005; tinyurl.com/anx72bo).

Organizing for Green Innovation at Interface

In 1994, Ray Anderson, CEO and founder of Interface Inc., decided to embrace sustainability as a new primary strategy for the company. According to Anderson's vision, corporate sustainability would serve as a source of competitive advantage that could provide the firm with access to new markets, assist it in building new skills and competencies, and help the company pioneer market-winning radical green innovations (Anderson et al., 2010; tinyurl.com/abn2aab). However, the vision received initial resistance from managers, because at the time there was a shortage of corporate sustainability frameworks and prior success stories, scarcity of economically viable green technologies, and a lack of a "burning platform" for catalyzing a major strategic change.

Since 1996, Interface chose to adopt an innovation-based green strategy. Resource-intensive businesses, such as Interface, which operates in the carpet industry, are not obvious radical, green product innovators, because they mainly focus on achieving cost savings through operational efficiency. Prior research has emphasized the importance of technological and organizational capabilities in stimulating green innovations in manufacturing firms (Horbach, 2008; tinyurl.com/avta25m). However, Kesidou and Demirel (2012; tinyurl.com/bjjpq63) argue that firms differ by their capabilities and respective strategies for green innovation. Less innovative companies adopt green innovation to reduce production costs and comply with the minimum environmental standards, while more innovative companies adopt green innovation to enter new markets.

How did Interface's senior management cultivate the initiation of radical green innovations? Initially, the environmental vision and strategy took form through the development of a "7 Fronts of Sustainability" guideline. This guideline was crafted by the CEO, a small group of managers, and the Eco Dream Team, which was an external group of green business professionals. The initiative was pursued and supplemented by two supporting programs: QUEST and EcoSense. The QUEST program focused on eliminating all forms of waste from operations. Initially, top management set an ambitious goal to gain a 50 percent cost reduction in the first three years. The EcoSense program analyzed manufacturing processes in terms of the impact of each step on product quality, process efficiency, and their environmental impact, and it covered as many as 400 initiatives by 1997.

Next, Interface merged QUEST and EcoSense by forming 18 cross-functional teams with an assigned scope of investigation and implementation ranging from waste elimination to toxic material reduction. A Global Sustainability Council stimulated cross-functional development and rapid global scaling of ideas. In addition, Regional Innovation Officers and the Chief Innovation

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Officer facilitated a systemic and global exchange of talent, ideas, and best practices across global manufacturing locations. The guideline provided the firm with interesting results, many of them considered as incremental improvements forming a path towards industry-level change. Nonetheless, progress through incremental innovations proved to be too slow to make a radical environmental impact. In 2006, the Mission Zero program replaced the 7 Fronts of Sustainability guideline, with the goal of creating the first large-sized industrial firm with zero environmental footprint by 2020.

For Interface, the growth of markets for environmentally friendlier products accelerated with a growing base of loyal business customers who valued environmentally friendlier carpets. However, the green alternative was adopted only if it offered a compelling price point, equal-to-superior performance, and quality/durability. The company's sustainability strategy opened an access to new green innovations and markets. For example, Interface gained a differentiation advantage by pioneering a carpet manufactured using only solar energy. To accomplish these achievements, Interface had to construct radical innovation competencies, meaning the ability of a firm to successfully commercialize radical innovations repeatedly and across organizational settings (O'Connor and Ayers, 2005; tinyurl.com/anx72bo).

Interface's Portfolio of Radical Green Innovations

Interface's initial 7 Fronts of Sustainability and the new Mission Zero program addressed breakthrough innovations in multiple areas. These included: i) pioneering systemic innovation enabling the recycling and reuse of end-of-life carpets, and thus enabling the introduction of sustainably sourced materials and carpets; ii) radical elimination of toxic and petroleum-based fuels, chemicals, and materials; and iii) designing new radical product innovations based on the principles of corporate sustainability. Figure 1 illustrates a sample of radical, first-to-industry innovations pioneered by Interface between 1996 and 2012. It highlights the company's commercialized product and service innovations as well as its process and material innovations. These innovations were crafted and studied using the information from interviews with the firm's managers and secondary material consisting of publicized case studies and reports on Interface. For examples of these innovations, see the Interface website: tinyurl.com/b59o9pq.

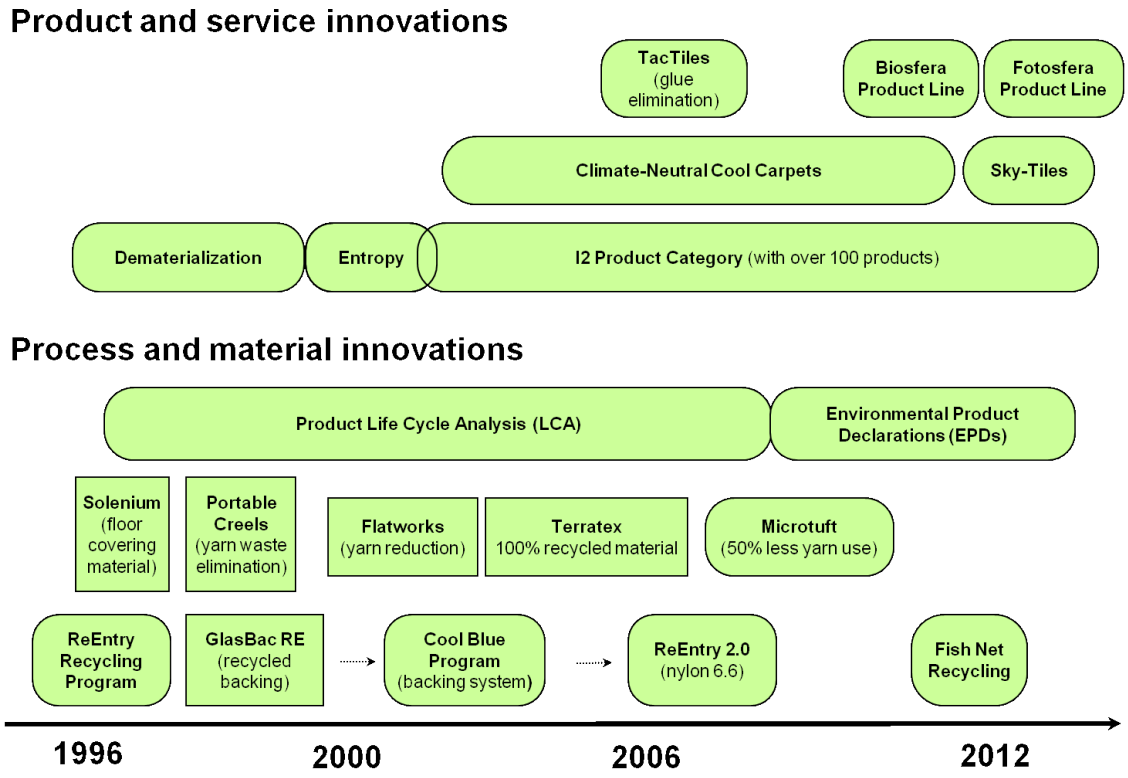

Figure 1. Interface's first-to-industry green innovations

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These pioneering, green innovations exemplify that companies going green are constantly required to launch a wide range of transformative innovations across their business operations over a long period of time. Interface's innovations assisted the company in its quest to introduce industry breakthroughs in strategically important areas and helped it to gain commercial success. The key innovations are further discussed in the following sections.

Product and Service Innovations

Entropy (tinyurl.com/amz79pz) is an innovative carpet model inspired by the asymmetrical, random patterns found in nature. After its launch in 2000, it rapidly became a best-seller; faster than any other product in the company's history. Entropy inspired the creation of the i2-product category, stimulating the commercialization of over 100 sub-products and reaching sales of $130 million by 2009. In 2003, Interface pioneered climate-neutral Cool Carpet, zeroing out all greenhouse gas emissions associated with the entire lifecycle of a manufactured carpet.

TacTiles, a carpet tile installation product, was introduced in 2006 and its innovative design was inspired by the sticky pads of a gecko. The toes of the lizard have a special adaptation that allows them to adhere to most surfaces without the use of liquids or surface tension. In addition, the tiles are stuck to each other, not to the floor, and their collective weight holds them down due to gravity as nature would do. Therefore, TacTiles eliminated the use of glue in carpet hard floor installation, enabled the full-recycling of end-of-life carpets and opened access to new commercial and residential markets. Interface sold about 15 million TacTiles in 2008 alone. In 2011, the Sky-Tiles carpet product opened access to a new market, commercial airplanes, through a five-year development project with Boeing.

In 2011, the company introduced Biosfera, which is a carpet made of 100% recycled yarn (tinyurl.com/aq6u3s6), making it the most sustainably produced carpet launched to date. Soon after, another carpet tile product was launched: Fotosfera tiles (tinyurl.com/bboz3td) are made from yarn with 63 percent bio-based content, meaning that they use oil from the seeds of the castor bean plants.

Process and Material Innovations

To decrease the need for petroleum-based raw materials in manufacturing, the company introduced several process innovations. First, breakthroughs in process innovations include Flatworks, which reduces the need for yarn material by about 50 percent and the Cool Blue system, which eliminates the use of virgin vinyl in backing produced by the manufacturing line. Material innovations include Terratex fabric, the industry's first post-consumer recycled polyester fabric, which is fully recyclable and renewable. Moreover, Interface pioneered the Life Cycle Analysis (LCA) method, which analyzed the environmental footprint of products and processes from raw materials to final disposal. As a follow-up program of LCA, Interface recently introduced Environmental Product Declarations (EPD), which are based on ISO 14025 guidelines for transparency. EPDs are similar to nutrition labels found on food products; they display a carpet product's ingredients as well as the environmental impacts of the raw materials and manufacturing processes (tinyurl.com/bkxp5np).

In 2007, after a decade's worth of experimentation, Interface partnered with an Italian nylon recycler to pioneer the ReEntry 2.0 program, which enabled it to fully recycle any manufacturer's carpets. This was a major improvement because the original ReEntry program introduced in 1996 allowed for only partial recycling of the end-of-life carpets. Moreover, the company partnered with Aquafil to turn discarded fish nets into new carpet tiles. Such green innovation necessitates long development cycles, substantial financial investments, and risk-taking related to materials, business models, and technologies. Nevertheless, Interface's experiences exemplify that not every radical innovation result in commercial success. For example, the company had a letdown in launching a new business model called Evergreen Lease, which was based on leasing carpets to customers with a service agreement. Then there was Solenium, a lightweight, composite floor covering containing no nylon; this material innovation lacked long-term durability and was therefore a market failure. Further, Interface made a failed multi-million dollar investment in a technology to recycle nylon 6.6 that never succeeded.

On the other hand, Interface's green product portfolio highlights three company-perceived benefits. First, Interface earned intangible benefits in terms of goodwill and corporate image in the marketplace. Second, Interface created new product innovations such as Entropy, revealing new revenue streams and differentiation opportunities. Third, new insights unlocked interconnected sources of savings. By reducing the weight of a carpet by just an ounce per square yard, the company, which sells millions of yards of carpet annually, consid-

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erably reduced its use of petroleum-based raw materials and chemicals. Furthermore, through dematerialization, Interface received savings in energy and water use, paid less for shipping, and reduced its greenhouse gas emissions. Interface's designer, David Oakey, said: "Reducing the face weight of a US carpet tile by a one ounce per square yard – about four percent – would save half the amount of energy needed to operate an entire American carpet tile factory" (Anderson 2009; tinyurl.com/an74uv4). Since 1994, Interface has decreased the average face weight of their carpet tile by more than four ounces per square yard.

Through sustainability programs, including the Mission Zero strategy, Interface has doubled its earnings, sold 146 million square metres of carpet that was manufactured using climate neutral processes, cut 82 percent of its greenhouse gas emissions (relative to sales), reduced its landfill waste by 77 percent, and reduced fossil fuel consumption by 60 percent. Interface's cumulative waste savings since 1995 equate to $433 million (tinyurl.com/ayuoyfs). However, a new level of radical problem solving is needed to reach Mission Zero program's goals because Interface continued to release 162 tons of regulated air pollution, 59 tons of acid-rain-producing pollutants, and 142 tons of smog-generating photochemical pollutants in 2009 (Anderson and White, 2009; tinyurl.com/an74uv4). The next breakthroughs in sustainability may require a more open approach to ignite innovation, thus opening avenues for further research on how open-innovation networks for green innovation are orchestrated in resource-intensive businesses.

Three Managerial Capabilities

To succeed in creating a steady stream of breakthrough innovations, Interface needed to develop a set of new managerial capabilities for radical innovation. Prior research suggests that in order for companies to achieve and sustain a competitive advantage, they need to establish and nurture dynamic capabilities to cope with rapidly changing environments (Teece et al., 1997; tinyurl.com/ax9etfx). These managerial competencies include sensing (the identification of opportunities and threats), seizing (the mobilization of effective resources to deliver value to shape markets and customers), and reconfiguring capabilities for enabling continuous renewal.

This study contributes to innovation capability research by illustrating three critical managerial capabilities specific for radical green innovations based on the insights gained from the interviews with managers of Interface, company presentations, and an extensive literature review. Each capability reflects a unique purpose, task, and set of skills, as well as outcomes. These managerial capabilities are principally not consecutive, separate capabilities; rather, they evolve together as a combined set (Table 1).

The *Research* capability makes sense of the emerging sustainability paradigm by helping the firm to gain a holistic understanding of corporate greening. It assists in seeking inspiration and understanding of how to adopt and apply radically different corporate sustainability frameworks and design principles into the innovation development. The *Research* capability encourages managers to examine how other disruptive green innovators have connected sustainability with core innovation activities. It helps them in seeking out ways to unlock revolutionary green thinking through new frames and design rules, by exploring new paths to discovery, and by identifying potential ways of managing radical green innovations inside and outside their companies.

Ultimately, this relentless search focuses on identifying potential routes to connect green innovation to a manager's unique corporate context and industry setting, by giving a holistic picture of the emerging business paradigm, and by linking innovation to core strategy and business operations. As Interface's experiences indicate, the *Research* capability supports a long-term, persistent hunt for radically different, environmentally friendlier raw materials, and the need to identify radical ways to eliminate dependence on petroleum-based raw materials. Managers typically ask and solve "why" questions to make sense of how radical ideas contribute to solving the holistic, interrelated, and complex challenges of running an environmentally responsible business. Interface's renewed approach to its waste management illustrates the usability of the research capability. It allowed Interface's management and staff to rethink and research waste streams through novel perspectives, as directed by the CEO Anderson, who redefined the waste as any cost that does not add value to customers. The renewed thinking transformed the prior "take-make-waste" approach to view carpet waste as a valuable, renewable, and reusable raw material that has substantial cost-saving potential.

The *Recognize* capability refers to recognizing opportunities by building on the insights gained in research activities. It helps management to identify the missing pieces of the puzzle by recognizing new business oppor-

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Table 1. Managerial capabilities for radical green innovation

	Managerial Capabilities		
	1. *Research*	**2. *Recognize***	**3. *Revolutionize***
Purpose	• Make sense of the emerging paradigm.	• Recognize the missing pieces.	• Connect and scale the emerging dots.
Tasks	• Facilitate investigative curiosity through experimental re-engineering and reframing of challenges. • Borrow from nature's design principles. • Observe and look inside and outside the company for sources of radical ideas. • Search and discover new and unknown ways of doing things.	• Identify partners, suppliers, and stakeholders best equipped to fill the identified gaps with complementary skills, brands, and talent. • Identify senior leaders with respected track records and power to prioritize the radical experiments. • Discover emerging innovation opportunities and gaps across the emerging value system.	• Connect the strategy, entrepreneurial leadership, and environmental vision with a continuous flow of radical green innovations. • Seek answers to "what if" questions and push the boundaries of what is possible. • Eliminate old-fashioned industrial recipes and practices.
Critical question	• Are we able to make sense of the emerging green business paradigm?	• Do we possess the capable talent to design, develop, and cultivate the next wave of radical green innovations?	• Can we revolutionize the existing industrial system through radical green innovation?
Outcome	• Holistic understanding of how the environmental system works and how it is connected to strategy, leadership, and heart of innovation activities. • Collection of novel principles, values, and frameworks to apply across business functions.	• Established foundation for a strategic breakthrough innovation program, supported by senior leaders. • A talent and resource pool supported by an open network capable of making a difference.	• Culture of environmental leadership, experimentation, and innovation. • Systematic flow of differing radical innovations. • Competitive advantage through new profits, and access to new markets and differentiation.

tunities and identifying potential gaps and weaknesses within the existing industrial system. Managerial tasks related to the *Recognize* capability include identifying respected senior leaders to cultivate the green initiatives, identifying potential market size for green products, establishing business cases for radical innovations, and pinpointing potential risks and internal weaknesses. Further, managers seek the right partners and stakeholders who are capable of making a difference and filling in the identified gaps. This capability addresses a type of activity that can result in either failure or success depending on whether managers are able to locate, motivate, and attract internal and external talent that is capable of radical innovation. This type of talent is not afraid to put its face and reputation on the line, has a respected track record, and is capable of making things happen.

The combined outcomes of the *Research* and *Recognize* capabilities are likely to result in establishing a foundation and a platform consisting of continuous learning, guiding values, and principles for the design and realization of radical green innovations with capable internal and external networks. Managers typically ask questions such as "who can make a difference?" For Interface, initial research and analysis of its corporate-level waste footprint indicated a shocking result: 10 percent of sales, (70 million dollars) were going down the drain as by-product waste (Anderson and White, 2009; tinyurl.com/an74uv4). This insight led to the strategic ur-

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gency of eliminating waste from all operations by means of recognizing the right external expertise to educate and assist Interface staff in waste elimination. Furthermore, Interface proceeded to recognize the most critical sources and bottlenecks of waste streams and ideated how the waste streams could be reused, recycled, repurposed, and eliminated.

The *Revolutionize* capability enables managers to connect all of the pieces of the emerging green-business paradigm and set radical ideas as a corporate priority. With the help of this capability, radical green innovations are integrated deeply into the heart of the vision, strategy, culture, and entrepreneurial leadership. Managers and "intrapreneurs" (tinyurl.com/nvs5wb) aim to commercialize a holistic flow of radical initiatives that fill in the identified gaps and solve the problems, as the perspective of "how to do things around here" is radically altered. This capability supports a phase of evolution in which managers seek radical answers to questions about how to revolutionize the existing industrial system via particular radical green ideas. These questions typically lead to dialogue, debate, new insights, innovative partnerships, and renewal through constant learning.

Respected senior leaders set ambitious development targets and provide "permission to pursue", thus giving freedom to push beyond existing boundaries, to experiment and have permission to fail, as well as learn and build on momentum for successful cases. By asking "what if?" and "how can our products and services help in healing the environment?", managers unlock new revolutionary ideas that potentially make the prior know-how, technologies, and ways of operating obsolete. The *Revolutionize* capability leads to a realization and flow of different types of radical green innovation, offers competitive advantage and differentiation opportunities, and opens access to new markets and revenues. Ultimately, it results in the emergence of companies capable of conducting business with zero environmental footprint. That is, even large global firms can produce zero waste and emissions, be powered by 100 percent renewable energy, develop climate-neutral to climate-positive products, and operate via a closed loop manufacturing system. For Interface, the company's success in waste elimination started to result in radically different ways to design, manufacture, and innovate new products. Through the *Revolutionize* capability, Interface is currently progressing towards a zero waste goal, enabled by a closed loop manufacturing system ("borrow-make-return") and a series of incremental and radical innovations.

Is zero environmental footprint just an ideological vision or a de facto view of how all companies will operate in the near future? The interviewed managers and other research material uniformly suggest that most large-sized firms are beginning to apply one or two of the managerial capabilities identified in this study, but only a few companies, such as Interface, excel in advancing all three. These differentiating and hard-to-imitate managerial capabilities helped Interface to shape the entire industry and gain a winning position through radical green innovation. Furthermore, this study illustrates that managers capable of navigating successfully between the identified capabilities can potentially make better sense of the emerging green business paradigm, can contribute to solving some of the world's environmental challenges by seizing emerging business opportunities, can disrupt deeply rooted knowledge and industrial practices, can and consequently succeed in "doing well by doing good".

Conclusion

One way companies integrate environmental concerns into their strategies while consolidating their competitive advantage is through green innovations. Interface's 17 years of progress in corporate greening illustrate that even an incumbent operating in a traditional manufacturing industry can reach substantial competitive advantage through green innovation. Radical green innovation in terms of launching first-to-the-industry green products and sustainable process breakthroughs provided the company with cost savings, access to new markets, and increased sales and revenues. Interface's experiences suggest that firms can maximize the benefit of corporate sustainability by focusing on radical green innovation. However, this approach necessitates the establishment of three managerial capabilities that allow the company to continuously research, recognize opportunities, and revolutionize the industry. Top management and sustainability managers lead the building and nurturing of these capabilities, yet all managers across the company must focus on the constant navigation between these capabilities, and a lack of experience in one capability domain can prohibit success in others. In sum, these capabilities enable managers to better cultivate, manage, and realize radical green innovations in their quest to become more sustainable companies.

Green, Innovative, and Profitable: A Case Study of Managerial Capabilities

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Simulation of Supply-Chain Networks: A Source of Innovation and Competitive Advantage for Small and Medium-Sized Enterprises

Giacomo Liotta

> *"Simulation provides cheap insurance and a cost effective decision-making tool for managers. It allows us to minimize risks by letting us discover the right decisions before we make the wrong ones."*
>
> Robert E. Shannon
> Professor of Industrial Engineering
> (tinyurl.com/cgqjp74)

On a daily basis, enterprises of all sizes cope with the turbulence and volatility of market demands, cost variability, and severe pressure from globally distributed competitors. Managing uncertainty about future demand requirements and volumes in supply-chain networks has become a priority. One of the ways to deal with uncertainty is the utilization of simulation techniques and tools, which provide greater predictability of decision-making outcomes. For example, simulation has been widely applied in decision-making processes related to global logistics and production networks at the strategic, tactical, and operational levels, where it is used to predict the impact of decisions before their implementation in complex and uncertain environments. Large enterprises are inclined to use simulation tools whereas small and medium-sized enterprises seem to underestimate its advantages. The objective of this article is to emphasize the relevance of simulation for the design and management of supply-chain networks from the perspective of small and medium-sized firms.

Introduction

Simulation is a method for tackling a problem by constructing a model of the related system. It starts with an abstraction process, from which a dynamic model of the system and its logic is built. Simulation software provides the development environment in which the model is implemented, verified, validated, and experimented with to evaluate different scenarios of interest, which depend on the goals of the simulation. Researchers and companies may create their own "in house" simulation tools, although commercial software is also available and is widely used in industry. Prices vary according to feature availability, software updates, maintenance, customer service, add-on capabilities, and user friendliness.

The widespread use of simulation tools in large enterprises as well as in research institutions confirms its relevance and practical utility. However, this article emphasizes the increasing relevance of simulation in supply-chain network design and management and, more importantly, its relevance to small and medium-sized enterprises (SMEs) as a source of competitive advantage and predictive power in their decision making.

Imagine that you are the manager responsible for the logistics of a small manufacturing company that receives orders from its main customer, a large enterprise. Every single order from the large enterprise must adhere to specific quality standards and may have a different level of complexity and value. Your globally distributed (sub-)suppliers are specialized in the

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production of the critical sub-components you need in order to build and complete your deliveries. The procurement lead-times can strongly vary depending on market conditions, transportation, material availability, and prices. Your competitive advantage is based on the flexibility and reliability of your deliveries and on the quality of the items you provide due to your expertise in managing your suppliers, production operations, and customer-order cycle times. However, new competitors are accessing the market, and the demand for your components fluctuates due to changes in the demand of your main customer's customers. Some of your suppliers are encountering difficulties in meeting your requests due to the financial crisis. Your labour and energy costs are increasing. The value and levels of your inventory are dramatically increasing but you must be responsive in satisfying the demand.

How will you manage this complex situation in terms of supply chain configuration, capacity planning, business process improvements, and innovation needs? How will you predict the impacts of demand and lead-time uncertainty on your logistics-production performances and cash-flows throughout a reasonable time-horizon? How will you estimate the effects of introducing a new warehousing technology in your operations? Which are the interrelationships among the decision variables and their sensitivity to demand and parameter variations? How will you nourish the trust of your main customer (the large enterprise) in a way that you could maintain your reliability and competitive position within its value network? Your main customer also copes with the turbulence and volatility of market demands, cost variability, and severe pressure from globally distributed competitors. The challenge is to proactively manage the uncertainty about future demand requirements and volumes while being able to adjust or even re-engineer internal processes as well as the relationships with customers and supply-chain partners in response to sudden, unexpected changes or supply-chain disruptions.

Many firms facing these challenges use simulation in the decision-making processes related to their global logistics and production networks. It is becoming increasingly imperative for smaller firms to be able to fit the dynamic supply of their resources to the decision-making processes of their key large customers. The decision support can be performed from the strategic, tactical, or operational standpoints via the execution of "what if" analyses based on purposively designed experiments.

A number of simulation and optimization software tools for designing and managing supply-chain networks are available on the market, as illustrated in surveys by Swain (2011a; tinyurl.com/afqbbco) and Funaki (2009; tinyurl.com/axhqccw). These tools can be general-purpose modelling environments or specific tools that are dedicated to supply-chain issues. By looking at the websites of the major vendors (as listed in the two surveys cited above), one can see that the most important customers are mainly large enterprises. SMEs can be part of extended supply-chain networks while being suppliers of both large enterprises and other SMEs, or they can autonomously compete in the market arena. However, SMEs seem to underestimate the benefits of using these software tools. One of the key messages of this article is to point out that simulation capabilities are becoming a key competitive advantage and that SMEs need to consider the potential value of simulation tools for both the efficiency of their internal operations and their ability to facilitate the decision-making processes of their key customers.

The article is organized as follows. The next section introduces the role of simulation in supply-chain networks and its usage. Thereafter, simulation techniques for logistics and production networks are presented. Next, the relevance of simulation to SMEs as an enabler for gaining competitive advantages in networked logistics-production systems and in internal processes is highlighted. The second last section addresses the potential benefits of simulation for SMEs and accessibility issues. Conclusions follow.

Simulation Techniques for Logistics and Production Networks

A supply-chain network consists of suppliers, manufacturers, distributors, and retailers linked by material and information, as well as financial flows aimed at satisfying customers' demand at the lowest cost by means of diverse business strategies, cooperation mechanisms, and network configuration models. Simulation in production and logistics can be devoted to different system levels: from the evaluation of single nodes of a network (e.g., production cell, factory, warehouse, container terminal) to an entire network of interacting nodes (e.g., a production network with the related different tiers and logistics flows). The logistics-production system under investigation is modelled and reproduced in a software environment where input, parameters, variables, and stochastic elements can mimic scenarios defined by the model developers and users.

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The interest in simulation usage in supply-chain management has been demonstrated in a literature review by Terzi and Cavalieri (2004; tinyurl.com/aemsojo), who noted the high number of works cited in more than 80 papers on the subject. Four basic simulation types for supply-chain management can be identified: spreadsheet simulation, system dynamics, discrete event dynamic systems simulation, and business games (Kleijnen, 2005; tinyurl.com/anzhnpp). Several simulation techniques can be used in the design and management of logistics and production processes within supply-chain networks. An extended classification of simulation approaches adopted for modelling logistics and production networks simultaneously takes into account several categories, as shown in Table 1.

One of the most popular simulation techniques for modelling logistics and production networks is discrete-event simulation (DES; tinyurl.com/yzr6g2h). DES is often adopted for studying logistics, supply chains, and transportation systems (Swain, 2011b; tinyurl.com/chrq4j4), and it is particularly useful for simulating supply-chain environments (Terzi and Cavalieri, 2004; tinyurl.com/aemsojo). Several research works include more advanced approaches that combine simulation and optimization.

Current research emphasizes the need to focus on several open issues (Liotta, 2012; tinyurl.com/d4lfuj7), including: i) the use of complex adaptive systems (tinyurl.com/4sy942) to investigate the dynamicity and self-adaptation of network structures and collaboration mechanisms in supply-chain network evolution; ii) the effectiveness and good performance of control strategies in production networks at single-plant scale using approaches inspired by biology; and iii) the consideration of bankruptcy and failures from an economics and finance viewpoint using study approaches derived from physics. However, research to date has not included aspects concerning environmental, economic, and social sustainability with comprehensive approaches – in other words including, in parallel, the simulation of transport, emissions, land use and social impacts in supply chain and production networks (Liotta, 2012).

Concerning simulation in manufacturing and business, DES is a popular technique, but it does not entail the same level of stakeholder engagement as other techniques such as system dynamics and simulation gaming (Jahangirian et al., 2010; tinyurl.com/b7znoga). DES can entail time-consuming and difficult data-gathering

Table 1. Classification of simulation approaches for logistics and production networks*

Category	Description
Simulation technique	• Discrete-event simulation (DES) • System dynamics • Monte Carlo simulation • Agent-based simulation • Business simulation games • Hybrid/integrated approaches (intended as a combination of different simulation techniques or as an integration of optimization/mathematical modelling and simulation)
Simulation paradigm	• Local vs. distributed simulation
Network type	• Production network or supply-chain network
Scale	• Single site (single plant/facility) • Multiple site (network of plants, multiple tiers, or actors involved in a network)
Usage of interdisciplinary approaches	• Modelling approaches simultaneously involving several disciplines (e.g., engineering, biology, economics, physics)

*Adapted from Liotta (2012; tinyurl.com/d4lfuj7).

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phases, whereas system dynamics makes use of standardized conceptual modelling techniques and does not need the same level of hard data as DES (Jahangirian et al., 2010). On the other hand, simulation gaming is widely applied for education and training purposes as well as for research. A promising evolutionary trend relies on the combined use of either DES and analytical models (e.g., optimization models) or discrete simulation and continuous models. This aspect can be extremely helpful to: i) optimize the number of experiments to be performed in order to achieve the desired system performance in the virtual environment; ii) embody intelligence in a simulation control logic; iii) perform comparisons between solutions statically and dynamically obtained for verification and validation purposes; and iv) include into discrete systems the effects of several phenomena described by continuous functions in the reality (Liotta, 2012; tinyurl.com/d4lfuj7).

In terms of the simulation paradigm, distributed and parallel simulation represent a challenge because they can be suitable for simulating networked logistics and production systems with several actors/modellers involved in distributed scenarios controlled by a single company, or in scenarios with the engagement of multiple autonomous companies using different simulation tools (Liotta, 2012; tinyurl.com/d4lfuj7). Architectures such as "high-level architecture" (HLA; tinyurl.com/b92pyfe) are fundamental enablers for this purpose. However, there is still the need to overcome some deficiencies in the technology, which hinder wide and cost-effective adoption of distributed and parallel simulation in industrial practice. For simulation to be an effective decision-making aid for industrial users, cost-effective tools that produce valid models in a user-friendly manner are required. Suitable simulation technologies and architectures that enable interoperability are badly needed as well as solutions for the combined use of optimization and simulation techniques, thus facilitating the integration and interoperability of optimization and simulation engines (Liotta, 2012). Indeed, the current elaboration speed of commercial computers often does not allow rapid tests of complex optimization models in combination with simulation, although notable improvements have been made for the combination of optimization and simulation such as in the case of simulation optimization.

Simulation can help companies gain competitive advantages because it allows them to dynamically observe and rapidly predict the effects of external phenomena, stochastic events, as well as (and more importantly) system/process changes in a compressed time horizon defined by the user, without any perturbation of the existing system. For instance, by simulating the procurement of materials throughout a given time horizon in response to demand patterns that are statistically generated according to historical data, a dramatic reduction in inventory and production costs can be allowed through the prediction of the most likely sourcing needs. In time, a realistic estimate of the levels of inbound and outbound material flow can have a positive impact on cashflow, work-in-progress, stock obsolescence risks and resource usage. Again, the simulation of a new manufacturing technology or additional production resources supports the rightsizing of plants and the identification of potential resource conflicts, and it provides insights for improving the responsiveness capability to unstable market demands. Consider a further example: by simulating the vehicle routing of a freight-distribution fleet, the real capability of providing customers with on-time deliveries can be estimated together with continuous service-level improvements. In the same scenario, simulation can also allow managers to estimate the potential savings resulting from the implementation of routing optimization systems that may lead to a reduction in the distances covered and better usage of vehicle capacity. These are only a few brief examples of the simulation potential in terms of cost advantage and customer value.

Companies wishing to take advantage of the benefits of simulation must carefully choose between the various tools and techniques available. There are more than 50 simulation software tools currently available in the market (see Swain, 2011a; tinyurl.com/afqbbco); to choose between them, companies should consider the problem(s) to be tackled, data availability, software price, and effort required for data gathering as well as for system modelling. However, several additional criteria can be used with respect to the project goals. Simulation software can be evaluated on the basis of, for example: its typical applications, the markets to which the software is applied, model building features, statistical analysis tools for input distribution, output analysis tools, support/training services, user interface, and animation features. For details of these aspects, see the survey by Swain (2011a), which also includes the observation that logistics and supply chains are often included in both typical applications of software and primary markets of application.

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Relevance of Simulation to SMEs

SMEs are remarkable contributors to the economy worldwide. For instance, SMEs account for approximately 99% of European enterprises, 92% of which are micro-enterprises (European Commission, 2011: tinyurl.com/8hfg2bw; and 2012: tinyurl.com/2dlx5x9); the percentage of SMEs in the economy is comparable in China (Xinhua, 2012; tinyurl.com/awjnagv) and India (Government of India, 2012; tinyurl.com/c7tmfj5).

There is already some interest in the application of supply-chain network simulation tools within the context of SMEs, including interesting research insights (e.g., Albino et al., 2007: tinyurl.com/cgtzyej; Jain and Leong, 2005: tinyurl.com/blvb6tw; Byrne and Heavey, 2004: tinyurl.com/c23y3db; Swarnkar and Harding, 2009: tinyurl.com/c9juuqf). However, the number of studies is quite limited compared to the amount of literature dedicated to supply-chain network modelling scenarios for large enterprises (i.e., global companies). In many cases, these studies seem to represent research-oriented applications that may not have any practical implications from a SME manager's standpoint. Conversely, the relevance of simulation for large enterprises is evident as a tool for both designing and managing complex supply-chain networks or production systems.

The use of the various simulation techniques in SMEs can be analyzed in two different contexts: i) when SMEs are single users, for the analysis and evaluation of their internal processes, and ii) when SMEs are part of supply-chain networks that consist of other SMEs as well as large enterprises. In the first context, the use of simulation is relevant to, for example: total quality management; accelerating business process re-engineering projects (see O'Kane et al., 2007; tinyurl.com/cdad3l5); supplier, inventory, and demand management (thus for maintaining the competitive advantage in terms of flexibility); and rapidity and effectiveness of adaptation to changes. Simulation can be then devoted to the analysis of demand patterns and logistics/production processes with respect to key performance indicators.

In the second context, the simulation usage can be an unavoidable option due to the need for an SME to rapidly evaluate the feasibility of fulfilling orders coming from large enterprises or other partners in a supply-chain network. The process performances of SMEs should be aligned to predefined levels imposed or negotiated in a large supply-chain network depending on the cooperation mechanisms or strategic alliances implemented (e.g., continuous replenishment, vendor-managed inventory, quick response). In these contexts, simulation represents a useful enabler for analyzing "what if" scenarios.

Existing research highlights the fact that SMEs are often unable to fully gain the advantages deriving from the implementation of supply-chain management methods and tools based on information and communication technologies (ICT) (e.g., Vaaland and Heide, 2007; tinyurl.com/c6sa5ks). The potential of ICT for supply-chain management – including analytics and advanced software tools such as simulation – is generally overlooked due to the lack of specialized skills, reduced firm size, high acquisition and implementation cost, and SME managers' confidence of the practical impact on the company performances related to their usage. However, in strongly dynamic environments characterized by a high degree of uncertainty and risk, such as networked logistics and production systems, simulation is the most suitable method for predicting system performance, resource usage, and change impact throughout time.

Unfortunately, simulation modelling and the related tool usage require specific skills and substantial effort dedicated to: problem and system definition; data collection and analysis; model implementation; verification; validation; and experiment execution. Large enterprises are quite sensitive and inclined to use simulation tools in supply-chain management. Existing literature highlights that SMEs tend to give less attention to simulation and scenario analysis tools, among other planning and control ICT tools, with respect to large enterprises (e.g., Vaaland and Heide, 2007; tinyurl.com/c6sa5ks). Thus, a technology gap might arise, which will lead to a competitive advantage for large enterprises due to their ICT-enabled capability to plan their response to the market at lower costs and with higher service levels. It then appears that SMEs do not perceive the need to use this method as well as other techniques and software tools for supply-chain management.

O'Kane and colleagues (2007; tinyurl.com/cdad3l5) have demonstrated the relevance of simulation for SMEs through the relevant contribution of simulation to quality management and business process re-engineering focusing on production operations. Other studies (e.g., Ding et al., 2006; tinyurl.com/d6z7rjj) have discussed the potential role of SMEs in supply-chain networks while simulating business environments that may include also large enterprises .

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Kohn and Hüsig (2006; tinyurl.com/ap49nw6) present the case of German SMEs by discussing the modest use of computer-aided innovation tools (i.e., software technologies for supporting the creative phase of designers and process developers). In this case, the software products were previously unknown to the potential users, to whom the benefits were not clear and for whom the cost was a barrier. Virtual reality simulation was mentioned among other innovation software tools. An interesting aspect of this work is that the applicable fields for the identified innovation software categories encompass scenario management (i.e., specialized tools for generating methodical forecasts for the future) as well as holistic solutions/process engineering (i.e., solutions for facilitating the entire new product development process or, for example, dedicated portfolio/resource management). Simulation could be then included in tool categories for innovation management since it is also a support mechanism for change management; it may be an enabler for evaluating the feasibility and impacts of product and process innovations.

Although simulation can strongly contribute to the competitive advantage of large enterprises in the continuous improvement and innovation of their business processes, it seems that their potential benefits from the standpoints of SMEs are not sufficiently explored. However, they will significantly enhance their competitiveness by adding more resilience to their flexibility through the use of appropriate supporting tools for managing uncertainty. For example, in the event of a sudden, high-priority increase in order quantities and variety from a customer that will boost future sale opportunities, the prediction of the impacts of the delayed fulfillment of the orders in progress (e.g., potential penalties, material inventory on-hand), and of the additional costs for the new orders (e.g., materials to be procured, set-up costs, additional workforce needs) can help the manager of an SME to estimate and compare the costs in the new scenario. More importantly, it can allow the manager to forecast the related benefits in the medium-to-long term as well as the potential resource needs for maintaining the existing customers while fostering the company growth. Moreover, data gathering and elaboration concerning the company's internal performance can help to govern high variability levels of production and service times. In addition to the practical resource optimization supported by ICT, this manager's predictive power can be a decisive competitiveness driver. In the current, turbulent market scenarios, missing a market opportunity or failing to respect an agreed, or even expected, performance level can determine success or failure in business.

As Prahalad and Krishnan (2008; tinyurl.com/4yowma2) argue, business processes and analytics represent the mediation layers among innovation, business models, and day-to-day operations. Business processes are dynamic while analytics provide insights by elaborating data. Focused analytics can represent a unique opportunity for the identification of trends and intervention of managers. Moreover, in a ICT architecture, the two layers consisting of, respectively, proprietary and standard analytics, and ICT applications, can provide a source of competitive advantage (Prahalad and Krishnan, 2008). Therefore, since business processes and analytics can be sources of competitive advantages, simulation, as a method for modelling processes and obtaining data for complex elaborations and analyses, represents an enabler for boosting continuous improvement and innovation.

The Potential Benefits of Simulation for SMEs

An emblematic case study by Jain and Leong (2005; tinyurl.com/blvb6tw) shows how a simulation has contributed to an SME's success by contributing to its selection as supplier to a defence contractor. The readiness of the SME's simulated supply chain and of its capability to meet requirements and goals convinced the primary customers and large defence manufacturers, which then supported the contract award to the SME. Consider another case of an SME operating as supplier to a large enterprise. The SME proposed a new configuration of the procurement processes, which also involved other sub-suppliers of the large enterprise in the supply-chain network. Simulation experiments highlighted a remarkable increase in the system's stability and lower lead times while supporting the new supply-chain network configuration scenario.

The accessibility of simulation modelling and related tools to SMEs is mainly affected by two factors: i) the knowledge gap related to the lack of skills and awareness of simulation advantages, and ii) the acquisition and implementation cost. The SMEs' knowledge gap related to analytics and therefore to simulation in their operations can be bridged by training and competency development. Investing in such activities can represent a fundamental step in a roadmap towards the reinforcement of a competitive advantage in the medium-to-long term. This knowledge gap can be bridged, for instance, by forms of cooperation with other SMEs that are willing to share the competency development in this field or with research institutions and educational institutions.

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The cost barrier can be overcome by considering new business models that can be implemented by simulation software developers, vendors and experts. As illustrated by Heikkilä and Kuivaniemi 2012; timreview.ca/article/564), among others, business ecosystems are becoming more and more knowledge-intensive, therefore the selling of systems of products and technology-enabled services will become increasingly relevant in the near future. Thus, the provision of simulation as a service could increase the accessibility of simulation tools to SMEs by reducing ownership cost (e.g., license fees) and the amount of learning, training, and skills required in the usage start-up phase. In the survey by Swain (2011a; tinyurl.com/afqbbco), the prices of simulation software ranged between $700 USD to more than $15,000 USD). However, the total cost of ownership throughout a certain time horizon can be relevant considering also the effort necessary for data gathering and analysis, system modelling, and experimental campaigns in the simulation environment. SMEs should evaluate this cost and strive to compare it with the cost of their traditional decision-making processes and the opportunity costs associated to the lack of these tools (e.g., in terms of time-to-market, response time to unexpected events, efficiency and effectiveness of change management processes in response to product/process innovations).

A simulation project requires both experts of the system to be studied (i.e., essential members of the organization for which the project is conducted) and experts of simulation techniques and tools. Should the organization lack the latter category, the simulation study can be developed internally by hiring a specialist or training an inside resource, or an external consultancy can be contracted (Shannon, 1998; tinyurl.com/cgqjp74). More specifically, the training of internal people may require several months and may depend on the tool selected. The company's implementation effort and time can vary widely depending on several factors such as the problem complexity, level of detail of the model, data gathering and analysis, programming needs, number of experimental campaigns, output analyses, and tool features and user-friendliness. For instance, a skilled person can implement a DES project in a matter of weeks or months, depending on the mentioned factors. Moreover, input data gathering and evaluation may require up to one third of the total time necessary for the study (Shannon, 1998). Finally, it must be underlined that economies of scale and scope can be gained if the simulation model design is oriented to the reusability, flexibility, modularity, and scalability with an efficient use of parameters and variables. Thus, relevant savings of time and effort can be obtained in further experimental campaigns and new studies.

More generally, concerning the technology-based planning and control methods in supply-chain management (including simulation and scenario analysis systems), the adoption of SMEs lacking the necessary financial, human, and other resources can be based on horizontal cooperation with other SMEs, development of vertical partnerships in the supply chain, and extension of IT providers' product ranges by including support aimed at delivering turn-key solutions for SMEs (Vaaland and Heide, 2007; tinyurl.com/c6sa5ks). On the other hand, Funaki (2009; tinyurl.com/axhqccw) discusses the business models for supply-chain design software while proposing, for example, alliances between supply-chain-management consulting firms and vendors of supply-chain management software and design platforms, thereby providing an infrastructure on which companies can carry out supply-chain design and review processes as well as receive consultancy on demand.

Such business models could increase the accessibility of simulation to SMEs and the supply-chain networks intertwined in their business ecosystems would therefore benefit from improved responsiveness, reliability, and resiliency of partners. Public bodies, research institutions, associations, banking system, as well as investors can positively interact with SMEs and large enterprises in this environment that is increasingly oriented to technology-enabled business processes and innovation. The business ecosystem would be the arena where the supply-chain network becomes a real value network and where co-opetition takes place. The value co-creation based on the provision and use of simulation software tools could be then realized from two standpoints: i) users (i.e., SMEs) and ii) simulation vendors and consultants.

For users, value co-creation could be realized from opportunities to:

1. Autonomously create their own experiments and modelling customizations in the simulation environment. These opportunities occur in the context of internally performed model implementation and simulation-environment customization.

2. Exchange and co-elaborate information with supply-chain network partners, for example, while testing para-

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meters and variables of common use, or the output and parameters of the partners' models, through, for example, the distributed-simulation paradigm. These opportunies occur in the context of internally performed model implementation and selected data sharing through interfaces and architectures for running distributed models developed by different companies.

For simulation vendors and consultants, value co-creation could be realized from opportunities to:

1. Customize the SME simulation environment on the basis of the user requirements

2. Develop new features for tools, inspired by new user requirements

3. Operate as simulation service provider for the SME

4. Outline and transfer change-management and innovation patterns to the simulation user on the basis of past experiences or expertise in supply-chain design or re-design projects

In this way, simulation may represent a "user toolkit for innovation" (see von Hippel 2001; tinyurl.com/3dwqxlw): in the event of simulation provided as a service, the software vendor would be, in practice, the simulation user, while the SME would be the actor exploiting the output of the simulation service. In this scenario, an SME having unclear ideas about its real innovation needs could obtain insights and focused indications for driving its innovation processes. At the same time, the simulation service provider could innovate the tools offered on the basis of new customer requirements that emerged in this interaction and are relevant to the market.

Conclusion

SMEs are remarkable contributors to the gross domestic product of both advanced and emergent economies worldwide. They may operate independently in small-scale supply chains or in larger supply-chain networks including large enterprises. Simulation can be used by SMEs at the individual level for estimating their own performance capabilities. SMEs can also make use of simulation at the supply-chain network level for comparing their own performance estimates to network-integration requirements when cooperating with large enterprises. Finally, simulation can be exploited by SMEs for supporting their innovation-management processes. Indeed, simulation modelling relies on creativity, which is one capability for innovating.

Nonetheless, beyond the specific utility of simulation, ICT systems already represent a predisposition to the virtual test of scenario alternatives through the availability of information infrastructure and large amounts of data coming from the execution of business processes. ICT and analytics for supply-chain management and change management are enablers for the evaluation of complex decisions at strategic, tactical, and operational levels. Access to these technologies by SMEs can be hampered by knowledge and cost barriers. These hindrances may be overcome by means of cooperation and different business models involving the software industry and users in value co-creation processes within the business ecosystem. Large enterprises already benefit from the use of these tools, but SMEs should not lose this opportunity for gaining and maintaining their competitive advantages as well as for boosting their innovation capability.

About the Author

Giacomo Liotta is Assistant Professor in the Institute of Technology and Innovation at the University of Southern Denmark. His research interests concern sustainability and innovation in supply-chain networks, including the simulation of networked logistics-production systems as well as product-life-cycle management. He received a PhD in Economics and Management Engineering at the University of Rome Tor Vergata, Italy; he also holds MBA, MSc, and BSc degrees in Management and Industrial Engineering from this university. His current teaching activities focus on the design of global supply-chain networks and environmental issues related to their design and implementation. Dr. Liotta is author of more than 20 papers published in international journals, books, and conference proceedings. He has been involved in national and European co-funded research and development projects.

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Enabling Process Alignment for IT Entrepreneurship

Paul E. Renaud and Sonia D. Bot

> *"Fish discover water last."*
>
> Chinese Proverb

All firms use information technology (IT). Larger firms have IT organizations whose business function is to supply and manage IT infrastructure and applications to support the firm's business objectives. Regardless of whether the IT function has been outsourced or is resident within a firm, the objectives of the IT organization must be aligned to the strategic needs of the business.

It is often a challenge to balance the demand for IT against the available supply within the firm. Most IT organizations have little capacity to carry out activities that go beyond the incremental ones that are needed to run the immediate needs of the business. A process-ambidexterity framework for IT improves the IT organization's entrepreneurial ability, which in turn, better aligns the IT function with the business functions in the firm.

Process ambidexterity utilizes both process alignment and process adaptability. This article presents a framework for process alignment in IT. This is useful for understanding how the processes in Business Demand Management, a core component of the process-ambidexterity framework for IT, relate to those in IT Governance and IT Supply Chain Management. The framework is presented through three lenses (governance, business, and technology) along with real-world examples from major firms in the USA. Enabling process alignment in the IT function, and process ambidexterity overall, benefits those who govern IT, the executives who lead IT, as well as their peers in the business functions that depend on IT.

Introduction

This article presents a process-alignment framework based on the concepts of process ambidexterity. Then, it applies this framework to identify major processes and relationships that need to be aligned to enable an IT function to behave in an entrepreneurial manner.

Bot (2012; timreview.ca/article/547) described a process-based perspective for balancing mainstream exploitation and new-stream exploration in the management of innovation-based technology firms. The resulting capability is known as process ambidexterity and it requires disciplined, agile, and lean business management. Process ambidexterity is a capability that utilizes both process alignment and process adaptability. Process alignment deals with intent, rigour, discipline, consistency, and maturity of the processes. Process adaptability deals with agility, responsiveness, flexibility, and customization of the processes (Bot, 2012). Bot and Renaud (2012a, timreview.ca/article/596) subsequently examined how the concepts of process ambidexterity can be applied to the IT function within a firm whose mandate is to enable their firm's business strategy and execution.

Most IT organizations are primarily focused on the supply chain of technology (IT Supply Chain) and often are unaware of the differences in need for technology across the firm's business value chains (Business Demand). This article identifies the Business Demand Management component of the process-ambidexterity framework for entrepreneurial IT (Bot and Renaud, 2012a; timreview.ca/article/596) as the pivot-point for en-

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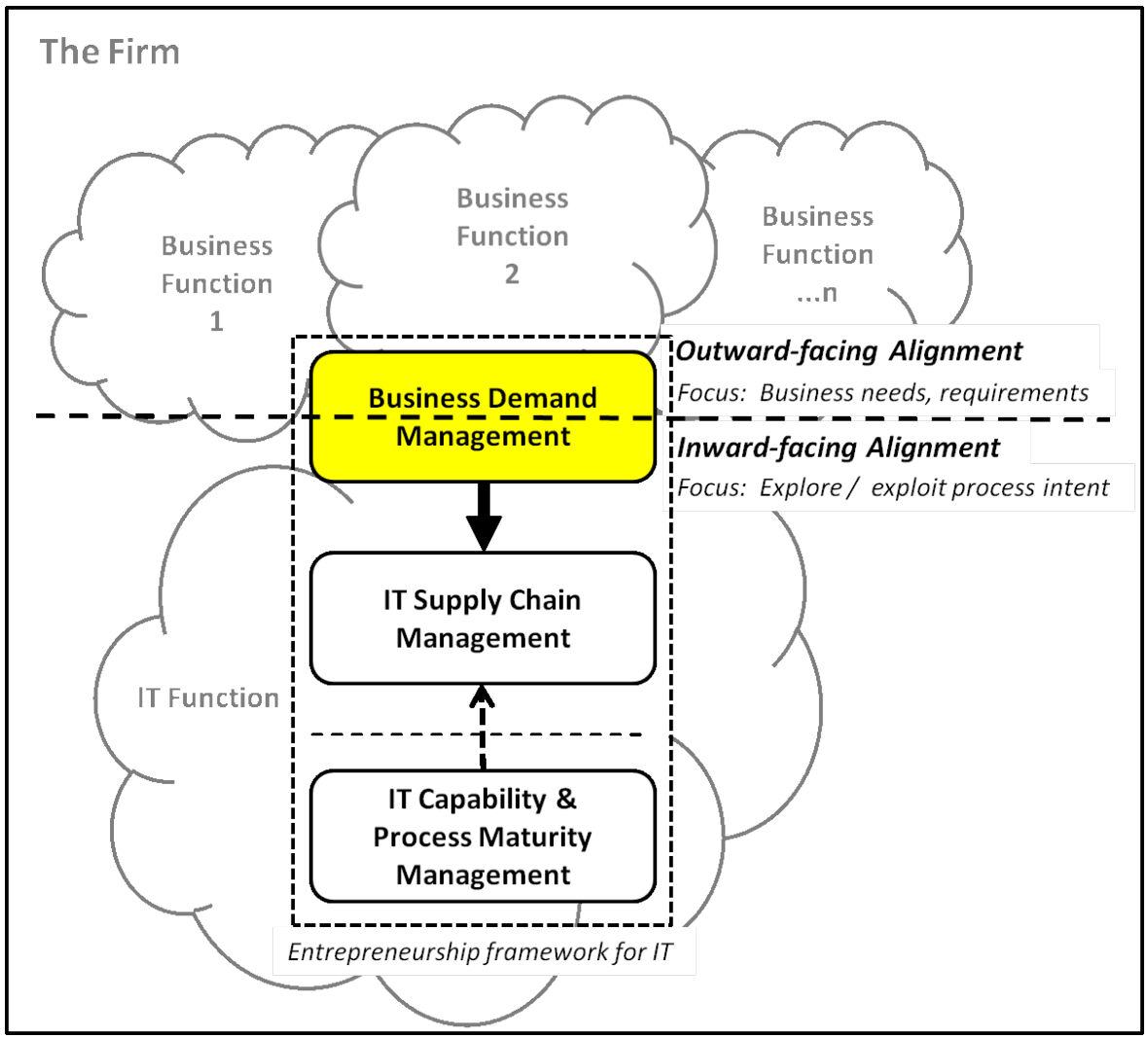
abling process alignment. Inward- and outward-facing process alignment is presented. This is followed by an introduction to the process-alignment framework for IT, along with a description of exploratory and exploitative process relationships through the lenses of governance, business, and technology.

Aligning Exploratory and Exploitative Processes in IT

In an IT context, mainstream exploitation refers to the evolution of the existing infrastructure and applications that service the current needs of the firm, while new-stream exploration refers to the entrepreneurial practice of new-technology adoption intended to enable new business activities or to transform the delivery of existing activities beyond the limitations of currently deployed IT solutions (Bot and Renaud, 2012a; timreview.ca/article/596).

As shown in Figure 1, Business Demand Management is the pivot-point for process alignment in order to enable entrepreneurial IT. Business Demand Management must address both the outward-facing alignment of processes to the firm's needs or business requirements (requiring rigour, discipline, and consistency) as well as the inward-facing process alignment between exploratory and exploitative process intent.



*Adapted from Bot and Renaud (2012a; timreview.ca/article/596).

Figure 1. Inward- and outward-facing alignment in the context of the process-ambidexterity framework for entrepreneurial IT*

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Outward-facing process alignment
From a practical perspective, aligning processes against business requirements involves identifying patterns in business requirements so that IT can be best employed to fulfill them. Ideally, a different IT solution would be used for each business pattern, however, this may be cost-prohibitive for many IT organizations. In practice, understanding business requirements is also difficult in large firms where no single person has a complete view of business requirements, let alone comprehends how they vary across several thousand applications. Many IT organizations struggle to obtain accurate business requirements because they fail to appreciate the difference between accuracy and precision.

It is often the case that an imprecise view of a business requirement is as accurate as a seemingly more precise version, yet an imprecise view is far easier to elicit from business users. For example, one business activity might require "high availability" for its applications while another might have a less stringent requirement. It is unlikely that their business users could express the requirement more accurately and any attempt to elicit greater specificity in terms of hours of downtime, frequency of failures, or other seemingly more precise quantification of that requirement are both unnecessary and irrelevant for the purposes of understanding how demand varies by business function. It is sufficient simply to categorize each requirement in broad terms because the purpose in gathering the requirement is to rapidly and accurately identify patterns in demand.

This phenomenon occurs whenever the perception of greater precision is illusory, for example, when business users simply cannot quantify their requirements past an undefinable limit. In practice, this is the natural state of affairs as most users have a hazy, yet definite view of their requirements. In such cases, a categorical instead of quantitative approach to elucidating requirements is best. Counting "trees" when trying to "see the forest" may be more precise but is unlikely to be more accurate.

Inward-facing process alignment
The objective of inward-facing process alignment is to align process intent, which ensures that exploratory and exploitative processes remain distinct with well-defined process interactions between them. Since the intentions of exploratory and exploitative processes are distinct, they should not be confounded by mixing both intents within the same process.

IT Process-Alignment Framework

Process ambidexterity requires an alignment framework that can be used to ensure disciplined IT process improvement. This is illustrated in Figure 2 and described in the following sections. Note that process ambidexterity utilizes both process alignment and process adaptability. This article covers the process-alignment aspect; a companion article (Renaud and Bot, 2012b; timreview.ca/article/627) presents a process adaptability framework for IT.

This framework has two dimensions:

1. An entrepreneurship aspect, which delineates the domains of Business Demand Managment, IT Supply Chain Management, and IT Capability & Process Maturity Management.

2. An orientation or focal aspect, which provides three foci (Governance, Business, and Technology) through which the processes in IT can be organized. Each of the three is useful for understanding process intent.

Business and Technology Focus

Exploratory practices support entrepreneurship when they are customer facing and value seeking. Entrepreneurship in IT requires processes for managing Business Demand by aligning to the firm's priorities and for exploring new ways of satisfying that demand. Process ambidexterity results in a balanced application of both exploitative and exploratory processes for managing IT and enables the IT function to behave as an entrepreneurial entity regardless of whether the firm as a whole might be characterized as mainstream or entrepreneurial.

The IT function's major challenge is to balance the demand for IT expressed by the firm with the supply of IT that the firm can afford. From an exploratory practices perspective, this means that the IT function should have exploratory processes for business-focused entrepreneurship as well as for technology-focused entrepreneurship.

The exploratory processes for business-focused entrepreneurship reside exclusively in Business Demand Management and the exploratory processes for technology-focused entrepreneurship reside exclusively in IT Supply Chain Management. In this context, "techno-

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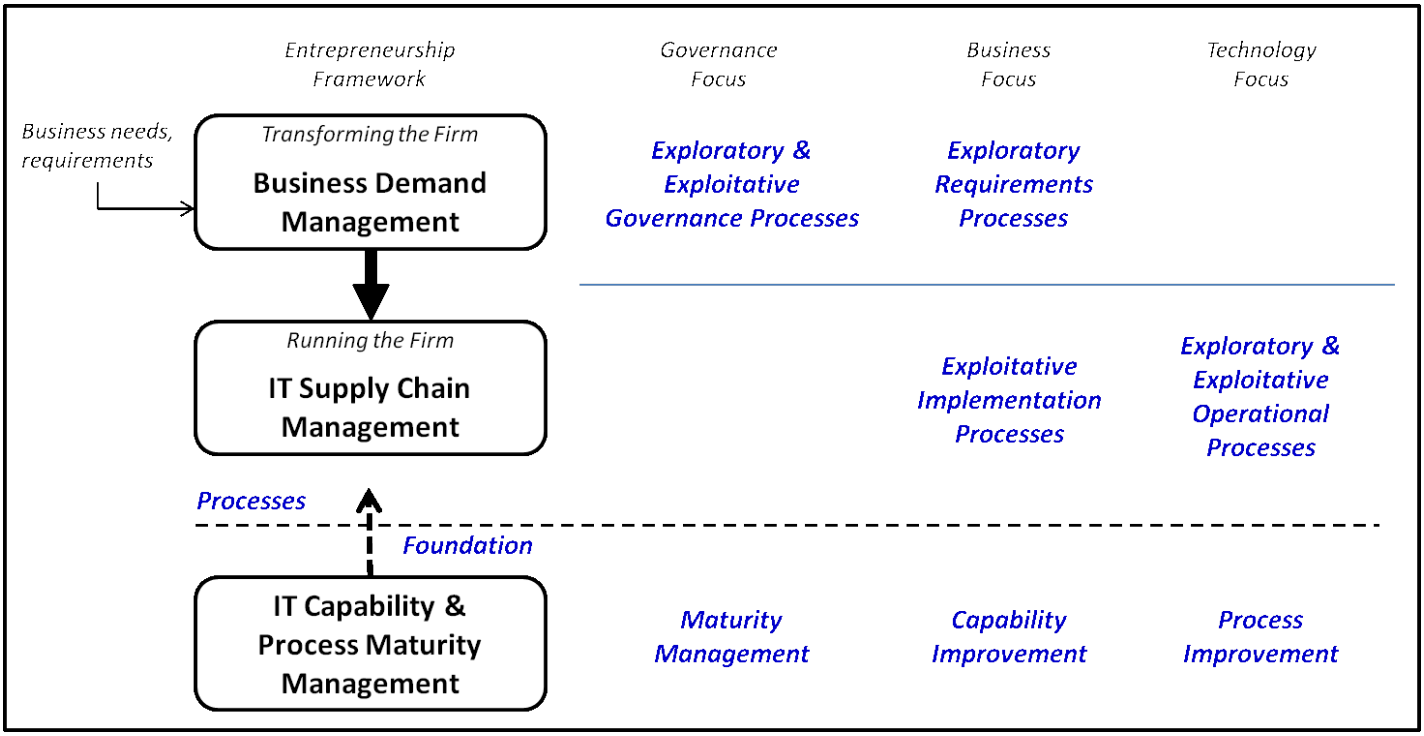

Figure 2. Process-alignment framework for IT entrepreneurship

logy-focused" encompasses innovation involving both applications as well as IT infrastructure.

From an exploitative process perspective, the vast majority of exploitative processes in the IT function reside in IT Supply Chain Management. Because many of these exploitative processes are well-known and are part of established process frameworks such as ITIL (itil-officialsite.com), the authors will not discuss them further other than to note that they are mostly concerned with the operational management of IT infrastructure or the implementation of applications.

Governance Focus

There are also a few exploitative processes that reside in Business Demand Management and they are the processes that pertain to the governance and management of the IT function itself – as opposed to the management of IT infrastructure or applications. Bot and Renaud (2012a; timreview.ca/article/596) previously determined that, since the purpose of IT Governance is to ensure that the IT function is aligned to the strategic objectives of the firm, the processes of Business Demand Management can significantly enhance IT Governance.

Lack of *dynamic* alignment to business objectives is the root cause of misalignment in which the IT function is so focused on operations that they do not realize that unmet needs are becoming more important than doing a better job of meeting existing needs. Business-focused processes are required to prevent lack of alignment and for ensuring that business needs are understood and prioritized, investment trade-offs are evaluated and weighed against existing initiatives, service-level objectives are established, and transition roadmaps are aligned to respond in time to support strategic business initiatives.

As the processes for Business Demand Management become formalized, the impact on IT Governance is profound because the processes in Business Demand Management assure dynamic and continuous alignment between the strategic priorities of the firm and IT decision making. Bot and Renaud (2012a; timreview.ca/article/596) identified that, as long as the differing needs of each business function are incorporated into these processes, a dynamic approach to business alignment can be integrated into how IT is governed.

Since the IT priorities of a firm will vary greatly by business function, IT alignment can be measured and max-

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imized by using a profile of Business Demand for IT by business function. Some business functions (such as accounting) may require very tight control and a low-risk computing environment characterized by high-availability computing clusters, while others (such as sales) may require more flexibility in using new technologies for messaging, collaboration, and mobility. IT Governance that allows for variation by business function can transcend these differences while maintaining a common governance framework and ensuring that the consumption of IT resources is aligned to investment priorities for each business function.

Interactions exist between the exploratory and exploitative processes. The relationships between the exploratory and exploitative processes, and their fit within the IT process-alignment framework, are summarized in Table 1. The following sections describe the interactions in further detail, as seen through the governance, business, and technology foci.

Process Alignment as Seen Through the Governance Lens

This section uses the governance lens to identify both the exploratory and exploitative processes that reside in Business Demand Management.

Demand Profiling and IT Capacity Management

Demand Profiling is an exploratory process for managing IT requirements by business activity using a common profiling method across all business activities. *Demand Profiling* allows for patterns of differences and similarities between business activities to be revealed. This process is illustrated conceptually in Figure 3, which shows that Business Activity M has the same demand pattern as Business Activity 2.

In practice, a range of 20–50 business requirements is sufficient to characterize demand. For example, a demand profile for over 160 business activities was created for a firm-wide set of 50 IT requirements at a major investment bank. This demand profile, as subset of which is shown in Figure 4, was used to group patterns in demand that were subsequently matched to the capabilities of different types of IT data centres. This identified the optimal placement of business-activity-related processing to the data centres that best satisfied their needs. *Demand Profiling* also revealed that processing for lower-priority business activities could be relocated to lower-cost regional data centres without impacting business needs.

Demand Profiling is related to, but distinct from, the exploitative process of IT Capacity Management. The pur-

Table 1. Relationships between exploratory and exploitative processes

Focus	Exploratory Process	Aspect	Related Exploitative Processes
Governance	*Demand Profiling*	Business Demand Management	*Capacity Management*
	Resource Balance Analysis	Business Demand Management	*IT Chargeback*
Business	*Application Portfolio Alignment*	Business Demand Management	*Application Portfolio Rationalization*
	Business Solution Management	Business Demand Management	*IT Service-Level Management*
Technology	*IT Solution Management*	IT Supply Chain Management	*IT Product Management, TCO Analysis*
	New Technology Assessment	IT Supply Chain Management	*New Product Introduction, IT Standards Management*

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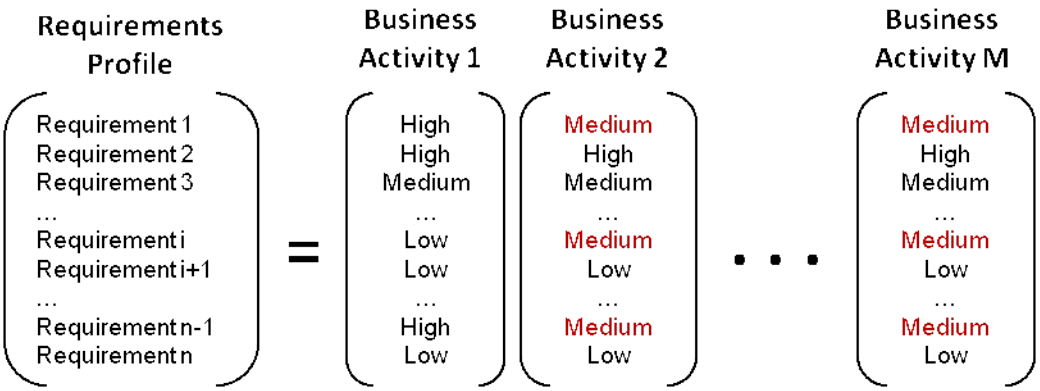

Figure 3. Conceptual demand profile of business activities

Category	Quality	Content Management	Authoring	Distribution	Equity Research	Fixed Income Research	Client Relationship Management
Availability	Hours of Operation	Med	Med	High	Med	Med	Med
	Fast Recovery Time	Low	Low	Med	Low	Low	Low
	Reliability	Med	High	High	Low	Low	Med
Business Context	Business Urgency	High	High	High	High	High	Med
	Extent of Business Change	High	High	High	High	High	Low
	Minimum Retention Period	Med	High	Med	Med	Med	Med
	Unit of Work Latency Sensitivity	Low	Med	Low	Low	Low	Low
	Reporting Requirements	Low	Low	Med	Low	Low	Med
	Criticality of Service Levels	Low	Low	Med	Low	Low	Med
	Retention Mandated by Compliance	Low	Low	Med	Med	Med	Med
	Sensitivity to Cost	High	High	High	High	High	Med
Performance	Required Level of Compute Performance	Low	Low	Low	Low	Low	Low
	Required Level of Internal Network Performance	Med	Med	Low	Low	Low	Low
	Required Level of External Network Performance	Low	Low	Med	Low	Low	Low
	Required Level of Storage Performance	High	High	Low	Med	Med	Med
Scalability	Growth Potential	Low	Low	Low	Low	Low	Med
	Seasonality	Low	Low	Low	Low	Low	Med
	Storage Workload Volume Variability	Med	Low	Med	Low	Low	Low
	Peak Duration	Low	Low	Low	Low	Low	Med
	Peak Frequency	Low	Low	Low	Low	Low	Med
User Experience	Desktop Integration	Med	High	Low	Med	Med	High
	Complexity of Visualization	Low	High	Low	High	High	Low
	Modifiability of Workflow	High	High	Low	High	High	Med
	Mobility Requirements	High	Med	High	Med	Med	Med
	Degree of Exception Based Processing	Low	Low	Low	Low	Low	Low
	User Interface Sophistication	Low	High	Low	High	High	High
Workload Communication	Asynchronous Communication	Med	Low	Med	Med	Med	Low
	Requirement for Guaranteed Message Delivery	Low	Low	Low	Low	Low	Low
	Messaging Volume	Med	Low	Med	Low	Low	Low
	QoS Sensitive Messaging	Low	Low	Low	Low	Low	Low
	External Connections	Low	Low	High	Med	Med	Med
Workload Data	Data Output Dissemination	Med	Low	High	Med	Med	Med
	Data Stewardship	Med	High	Low	High	High	High
	I/O Variability	Med	Low	Med	Low	Low	Med
	Throughput Variability	Med	Low	High	Low	Low	Low
	Data Federation	Low	Low	Low	Low	Low	Med
	Data Transformation Requirements	High	High	Low	High	High	Low
	Data Volume & Throughput Requirements	Med	Low	High	Med	Med	Low
	Data Sensitivity	High	High	Med	High	High	Med
	Unit of Work Granularity	High	High	High	High	High	Med
Workload Implementation	Information Integrity	Med	Low	Low	Low	Low	Med
	Coupled Workload Data	Low	Low	Low	Low	Low	Low
	Processing Concurrency	High	High	High	High	High	Low
	Preemption of Workload	High	Med	Low	High	High	Low
	Custom Development	Low	Low	Low	High	High	Low
	Stateful Components	Med	High	Low	Low	Low	Med
Workload Performance	Workload Complexity	Low	Low	Low	Low	Low	Low
	Intensity of I/O	Med	Low	High	Med	Med	Low
	Peak Processing Requirement	Med	Low	High	High	High	Low
	Peak Throughput Volume	High	Low	High	High	High	Low
	Event Driven	Med	Low	High	Low	Low	Low
	Workflow Rules	Med	Low	Low	Med	Med	Med

Figure 4. Example: Subset of a demand profile in investment banking*

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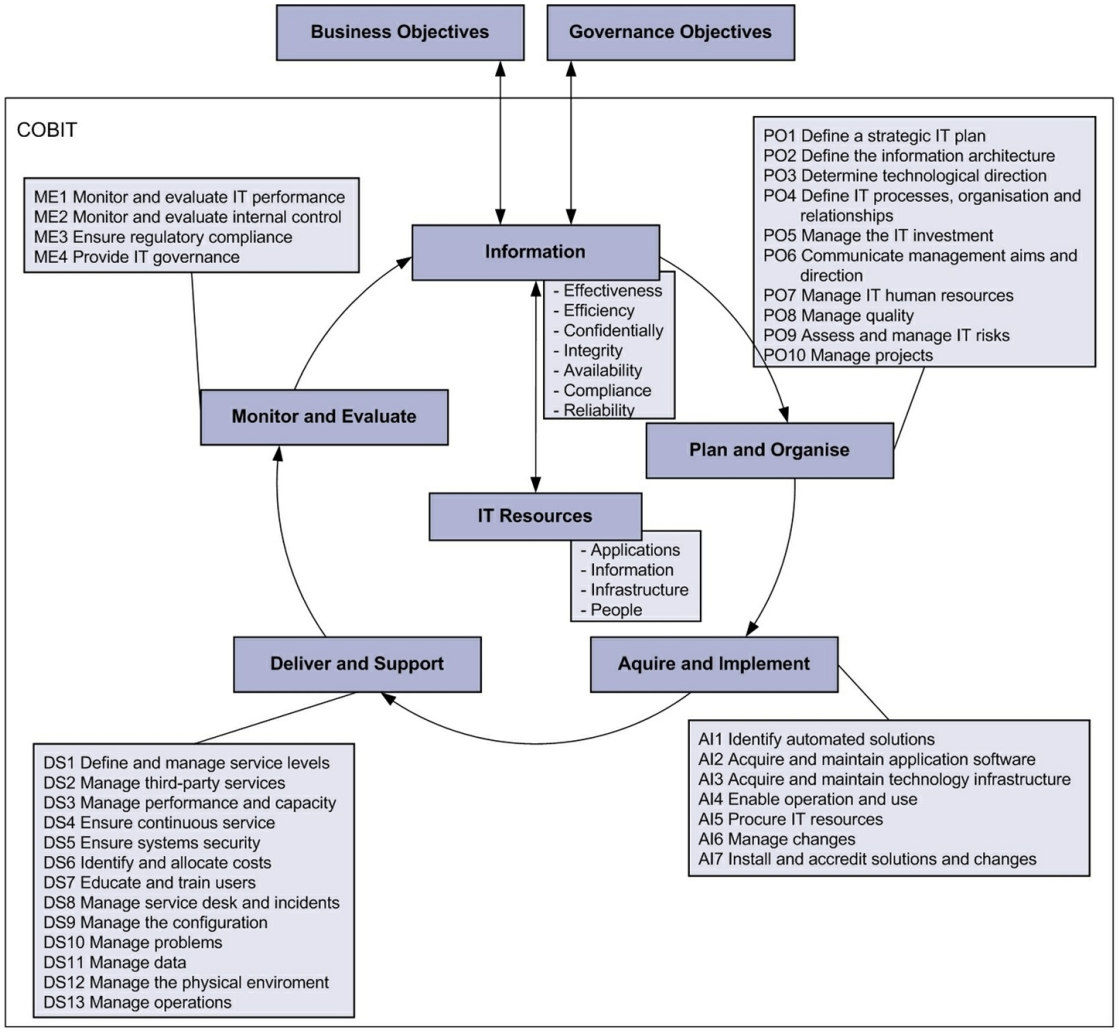
pose of IT Capacity Management as defined in ITIL (tinyurl.com/mukhg) is to monitor and trend the change in growth in consumption of different IT resources so that sufficient capacity for future increases in consumption of these resources can be planned in advance.

The focus of *IT Capacity Management* is to avoid resource exhaustion in the IT Supply Chain, whereas *Demand Profiling* is focused on understanding patterns in demand that ultimately lead to the consumption of those resources. *IT Capacity Management* is also related to the various IT management, planning and budgeting processes defined by the COntrol OBjectives for IT (COBIT) framework (See wikipedia.org/wiki/Cobit and isaca.org/COBIT/Pages/.)

COBIT defines a process framework based on a firm's internal control system for the IT function. Within this framework, a set of 34 high-level control objectives are defined, each with a corresponding process, and grouped into four domains: planning and organization, acquisition and implementation, delivery and support, and control monitoring, as illustrated in Figure 5.

The processes in the COBIT Monitoring domain are exploitative governance processes that reside in Business Demand Management, as are most of the processes in the Planning and Organization domain (the exceptions being PO3, PO7, and PO10 that belong in the IT Supply Chain Management and Process and Capability Management parts of the framework shown in Figure 2).



*Executive Summary for COBIT 4.1 (2007; tinyurl.com/5te5oeh). ©ITGI. All rights reserved. Used with permission.

Figure 5. COBIT defined processes*

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The remaining COBIT processes are exploitative processes that reside in IT Supply Chain Management.

COBIT does not define any exploratory processes and since COBIT is well-defined, we will not discuss these processes further.

Resource Balance Analysis and IT Chargeback

Resource Balance Analysis is an exploratory process that ensures that the allocation of IT resources is commensurate with business priorities. This process examines how the inventory of IT resources rolls up by the business function that it supports and then examines the proportional allocation of resources by business function in relation to business investment priorities for each business function. A typical rollup hierarchy is illustrated in Figure 6.

For example, an investment bank might view both its Accounting and Trading business functions as strategic, but it might be more interested in investing in IT to enable the Trading function to drive more revenue while controlling the cost of IT to support the Accounting function. Being able to roll-up a view of the extent of the IT Supply Chain devoted to serving each business activity within Trading and Accounting can provide valuable insights into where resource allocation may be viewed as out-of-proportion compared to the firm's business priorities.

The related IT Governance process is *IT Chargeback*, which is an exploitative process that accounts for consumption of IT resources so that cost allocations can be charged back to the business functions that employ them (Drury, 1997; tinyurl.com/cn92prb). Even though *Resource Consumption Analysis* may be able to use the data produced by an *IT Chargeback* process, it is a distinct process because it explores the extent to which chargebacks reflect desired levels of business investment in IT by business function. This can lead to identifying that IT solutions for a particular business activity are too costly for the benefit obtained, leading to potential outsourcing of the solution via a cloud or hosting provider.

For example, *Resource Balance Analysis* performed by the first author (Renaud) at a Fortune 500 company found that a significant percentage of application servers in expensive data centres were occupied by low-priority business activities that could be more cost-effectively hosted in lower-cost, remote facilities – such as an internal private cloud.

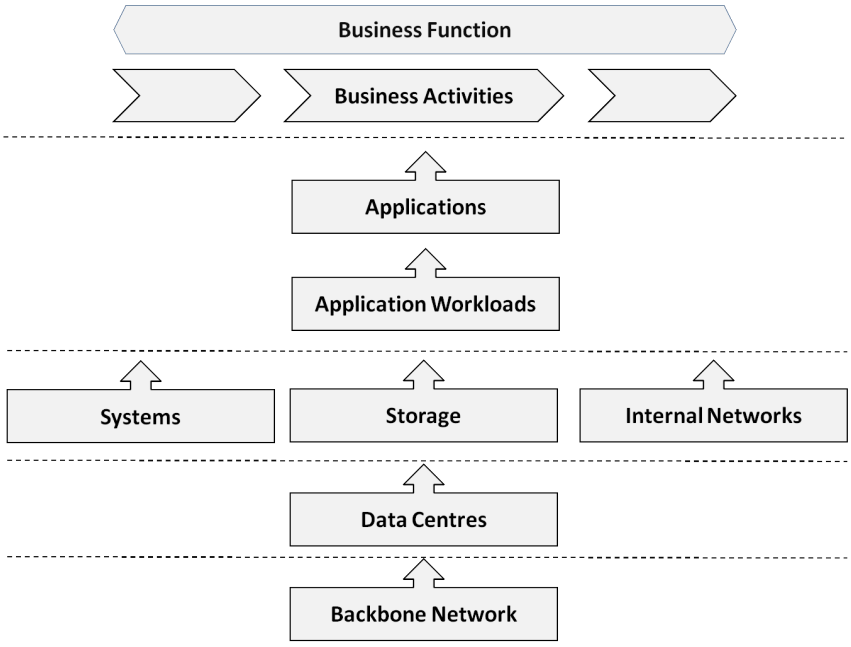

Figure 6. Rollup levels for Resource Balance Analysis

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Note that *Resource Balance Analysis* should not be confused with the forensic process of *Resource Consumption Monitoring* which is an exploitative IT Supply Chain Management process that ensures that IT resources are operating within their expected operational parameters.

Process Alignment as Seen Through the Business Lens

This section identifies the business-focused exploratory processes that reside in Business Demand Management, and links them to corresponding exploitative processes that are found in IT Supply Chain Management.

Application Portfolio Alignment and Rationalization
McKeen and Smith (2010; tinyurl.com/al3l3sn) describe the benefits of treating IT applications as a proactively managed portfolio. This is common practice within the IT function in the financial services industry and in other firms where IT is seen as an investment into the business of the firm.

Ignaganti and Behara (2007; tinyurl.com/ahqt6lw) describe a practical method for aligning the application portfolio in a service-oriented enterprise architecture by relating application functionality to the business value chain and using a services layer to refactor applications. The first author of this article (Renaud) observed that applying this method at Wachovia resulted in a 50% reduction in application development and sustaining costs as well as faster time-to-market for new business products. Applying the business lens in the process-alignment framework, we can identify two distinct processes involved in their method.

Application Portfolio Alignment is an exploratory process that maps each application to the business activities that it serves and then examines the opportunity for rationalizing applications that service the same business activities. Within any firm, small applications may service a single business activity, while larger applications may service multiple business activities. Even larger application suites such as SAP or Peoplesoft may service entire business functions. The relationship between applications and business activities is illustrated in Figure 7. In a large firm with hundreds or thousands of applications, many of these applications will overlap in functionality. The root cause of application overlap is usually due to parallel implementation of similar applications to support different business products.

For example, *Application Portfolio Alignment* conducted by the first author (Renaud) at Sprint found that over two dozen different applications existed for the same business activity of billing. Each billing application had been developed independently as an expedient means of introducing a new telecommunications network service offering (managed routers, frame relay, Internet access, business voice, consumer voice, etc.). A similar exercise at Wachovia found over a dozen similar loan management applications, each one supporting a different type of loan (mortgages, business loans, investment financing loans, etc.).

In general, multiple overlapping applications occur whenever a unique application is developed or purchased to service the needs of a business product and more than one such business product exists for the same business activity.

Since most firms have established configuration management databases (CMDB) that track the allocation of resources by application, it should be observed that the process of *Resource Balance Analysis* is straightforward once *Application Portfolio Alignment* has identified the conjoint relationships between applications and business functions. This enables a two-step mapping involving a rollup of resources to applications and then a rollup from applications to business activities or business functions (allocating resources appropriately when multiple business activities are serviced by an application).

Application Portfolio Rationalization is the follow-on exploitative process that reduces application overlap by either decommissioning applications, refactoring them, or truncating their functionality to eliminate overlaps. *Application Portfolio Rationalization* is typically a multi-year process whereas application portfolio analysis is a process that can complete in under a year in a firm that has several thousand applications.

Business Solution and Service Level Management

Business Solution Management is an exploratory IT-engagement process that assists business functions in choosing the right set of IT products that best meet their needs. The engagement process facilitates adoption of existing IT products by internal users and identifies gaps in the IT product portfolio. *Business Solution Management* is exploratory because it is focused on exploring the needs of the business to determine if exist-

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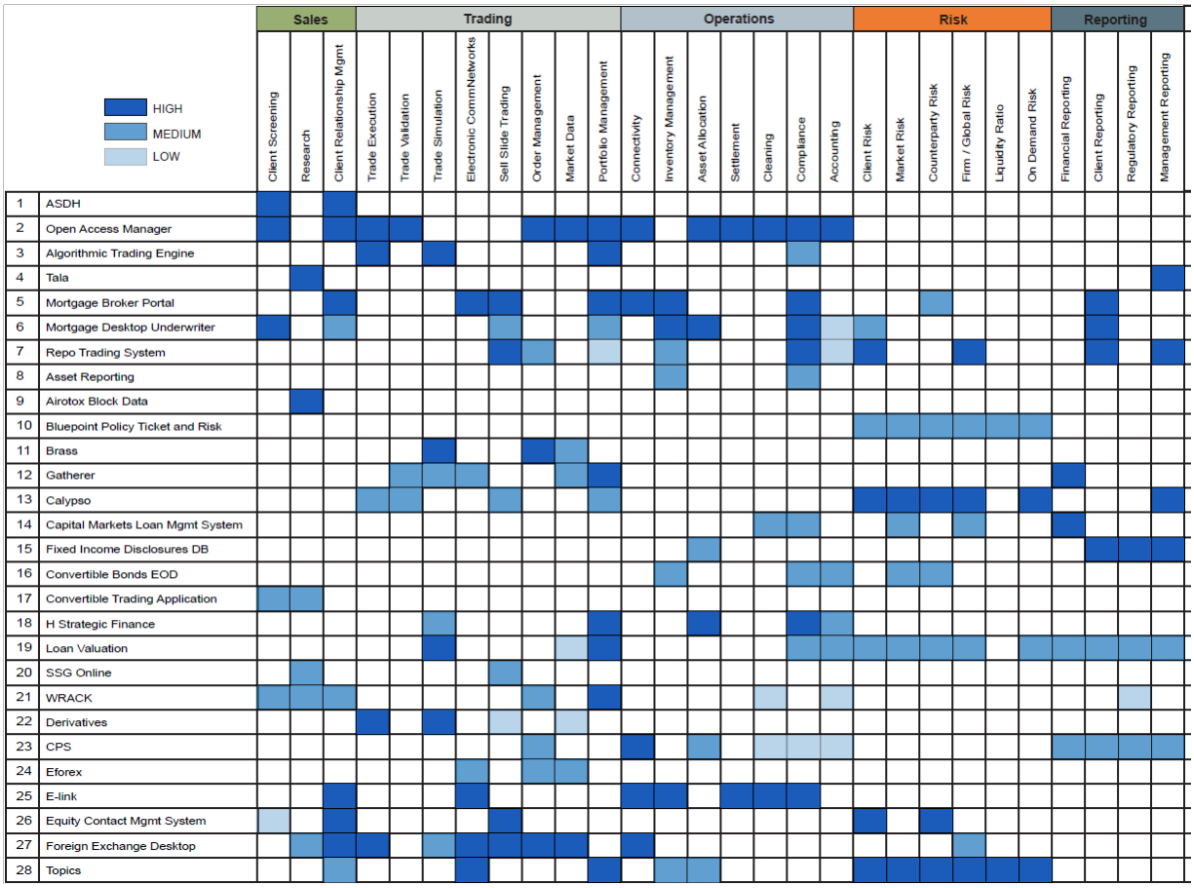

*Adaptivity, Inc.'s Design Studio™ [Planning Studio™] application portfolio analysis software product (adaptivity.com). Adapted and used with permission.

Figure 7. Example of Application Portfolio Alignment in financial services using Adaptivity*

ing IT products can be used to create the solution that the business needs or whether new products are required. *Business Solution Management* also identifies the most appropriate service and recovery levels for new business needs.

Business Solution Management should not be confused with the exploitative, *IT Service Level Management* process, which is an ITIL-defined process ultimately based on delivering desired service levels against a predefined catalog of IT products and services that can be ordered from the IT function (Mazvimavi and Benyon, 2009; tinyurl.com/bl3hy7h). *IT Service Level Management* is appropriate when a business function requires more of the same kind of IT product that it is already using (for example, provisioning a new database and server), while *Business Solution Management* is more appropriate when new or changed business needs (other than scale) must be met.

Process Alignment as Seen Through the Technology Lens

Solution and Product Management

IT Solution Management and *Product Management* in IT is the definition and delivery of IT product solutions to the internal customers within the firm. *IT Solution Management* is the exploratory process for managing how IT product technologies get integrated into solutions to meet business needs, whereas *IT Product Management* is the exploitative process for managing the lifecycle of how IT product technologies are selected, standardized, and transitioned across new versions over time (Espinosa et al., 2009; tinyurl.com/ckuw7v9).

Just as product companies cannot satisfy all needs in all potential markets, the IT function cannot support the bespoke needs of all internal users and must determine the optimal balance between introducing products and

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meeting priority needs. Similar to the process of product management in technology product companies, successful *IT Solution Management and Product Management* requires:

1. Clear delineation of the addressable market for each product. In an IT context, this involves determining which business activities would use each product and whether there is sufficient product appeal to enough business activities to justify the time and expense of product creation and support.

2. Identifiable value proposition for each product. In an IT context, this involves identifying the business requirements that each product satisfies best.

3. Attention to total product cost. In an IT context, the total cost of ownership of a product must include facilities, power, cooling, support labour, and other attracted costs. For example, a total cost of ownership (TCO) analysis conducted by the first author (Renaud) in a major US financial institution found that data centre-related costs were two-thirds the total cost of an IT storage solution. This insight led the IT function to configure higher-capacity disks in its storage area networks (SANs) and abandon the prior engineering practice of using more, smaller disks to reduce I/O latency. The larger disks meant that less rack space would be consumed by the petabytes stored in its SANs, significantly reducing TCO while only slightly increasing latency due to the faster rotational speeds on the larger drives.

Business changes require ongoing changes to IT solutions, which can be implemented in most IT organizations by establishing solution and product management processes. In firms where *IT Product Management* already exists, the product management process invariably must become more customer facing and less IT-infrastructure facing. This is difficult because *IT Product Management* is inherently an exploitative process that is concerned primarily with managing the evolution of existing product technologies. Meanwhile, *IT Solution Management* is inherently an exploratory process that determines whether product variations can be integrated into a generic IT solution. Best practice in process alignment indicates that a separate, exploratory process is required for *IT Solution Management* and that it is better to design appropriate process interactions between solution and product management than to try to combine an exploratory process with an exploitative process.

To assure this outcome, key metrics in any balanced scorecard should include at least one leading indicator that measures alignment to business objectives/requirements and at least one lagging indicator that measures the incremental benefit from better delivering to aligned priorities.

Technology Assessment

The introduction of new technologies into the firm is typically managed by the CTO organization with the IT function. It is important to recognize that there are three distinct aspects to new technology introduction:

1. *New Technology Assessment* is the exploratory process of managing how new technologies can be employed to better meet business needs. This process must consider potential opportunities for cost or productivity benefits for using new technologies to meet existing needs, or to better service unmet or poorly met needs.

2. *IT Standards Management* is an exploitative process of managing the selection of normative standards and supported product suppliers for the firm's IT. For example, Oracle or MySQL might be selected as the "standard" relational database technology to be used firm-wide. Most firms will define tiers of standards based on their lifecycle of adoption such as: emerging/experimental (requiring special approval), standard (no approval required), supported (may be used but no new purchases allowed), sunset (used within the firm but unsupported by IT).

3. *New Product Introduction* is the exploitative process of managing the controlled introduction of new technologies into the IT Supply Chain. *New Product Introduction* is well established as a process in manufacturing and telecom operations and is also sometimes referred to as "release management" in IT. This process starts with a technology that has already been selected for introduction (as a result of either a *New Technology Assessment* process or user-led technology selection), and it evaluates potential sources of supply, selects vendors, engineers appropriate configurations, conducts field trials, negotiates support and maintenance agreements, trains operations staff, and generally eases the impact of introducing a new technology into the operational IT environment.

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Conclusion

This article provides a process-based framework for enabling process alignment in IT. This article makes three contributions:

1. It identifies the Business Demand Management component of the process-ambidexterity framework for IT entrepreneurship as the focal component that enables process alignment.

2. It presents a practical and real-world framework for process alignment in IT.

3. It identifies the exploratory and exploitative process relationships though the lenses of governance, business, and technology.

Process alignment and process adaptability are the key components of process ambidexterity. A companion article (Renaud and Bot, 2012b; timreview.ca/article/627) presents a process adaptability framework for IT. Together, these pave the way for growing the capability of process ambidexterity, which in turn improves the performance of the IT and business functions, and the firm overall.

Acknowledgements

This article uses the terminology of "business value chains", "business functions", and "business activities" established by Porter (1985; tinyurl.com/8ul8upn).

Demand Profiling is based on a prior unpublished collaboration with Sheppard Narkier at Wachovia and is based on his earlier work at UBS Investment Bank.

About the Authors

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Process Adaptability in the IT Supply Chain

Paul E. Renaud and Sonia D. Bot

> *"If everyone is thinking alike, then no one is thinking."*
>
> Benjamin Franklin (1706–1790)

The continuous pressure to minimize IT costs challenges the IT function to achieve a balance between its own effectiveness and the productivity of the users in the business functions that it serves (i.e., user effectiveness). In many cases, user effectiveness is sacrificed to ensure IT function effectiveness. Process adaptability improves the IT organization's entrepreneurial ability by balancing these conflicting productivity and performance objectives.

This article applies a process-ambidexterity framework to examine how process adaptability in IT is affected by the choice of different strategies for IT Demand Management as well as different fulfillment strategies for IT Supply Chain Management. Alternative fulfillment strategies are presented, along with criteria and indicators that impact IT and user effectiveness that have been applied within major firms.

IT and senior business executives will find this article valuable for helping understand how they can influence the balance between IT and user productivity through their choice of different Demand Management and IT fulfillment strategies. Academic readers will discover that, while process adaptability in IT is an important enabler for implementing dynamic alignment between business and IT function objectives, there may be circumstances where IT process adaptability is not a priority for the business.

Introduction

Entrepreneurship in IT requires processes for managing the IT Supply Chain in a way that adapts to the firm's priorities and does not limit new ways of satisfying business needs. Process adaptability affects the extent to which the fulfillment strategy for the IT Supply Chain is responsive and flexible to meet the changing needs of the firm and enables the IT function to behave as an entrepreneurial entity regardless of whether the firm as a whole might be characterized as mainstream or entrepreneurial.

Balancing the trade-offs between demand and supply is difficult in practice. Building the capability of process ambidexterity within the IT function helps achieve this balance. Process ambidexterity requires disciplined, agile, and lean business management, and it encompasses both process alignment and process adaptability. Process alignment deals with intent, rigour, discipline, consistency, and maturity of the processes. Process adaptability deals with agility, responsiveness, flexibility, and customization of the processes Bot (2012; timreview.ca/article/547).

Bot and Renaud (2012a; timreview.ca/article/596) examined how the concepts of process ambidexterity can be applied to the IT function within a firm. Most IT organizations are primarily focused on the supply chain of technology (*IT Supply*) at the expense of the differences in need for technology across the firm's business value chains (*Business Demand*).

Renaud and Bot (2012b; timreview.ca/article/626) subsequently identified that Business Demand Management is the pivot point for enabling process alignment. From a business alignment perspective, exploratory processes are primarily related to managing Business Demand while exploitative processes are primarily related to managing the IT Supply Chain.

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This article uses the process-ambidexterity framework for IT, illustrated in Figure 1, in the context of process adaptability to:

1. Examine how Business Demand Management influences the adaptability and flexibility of the IT function

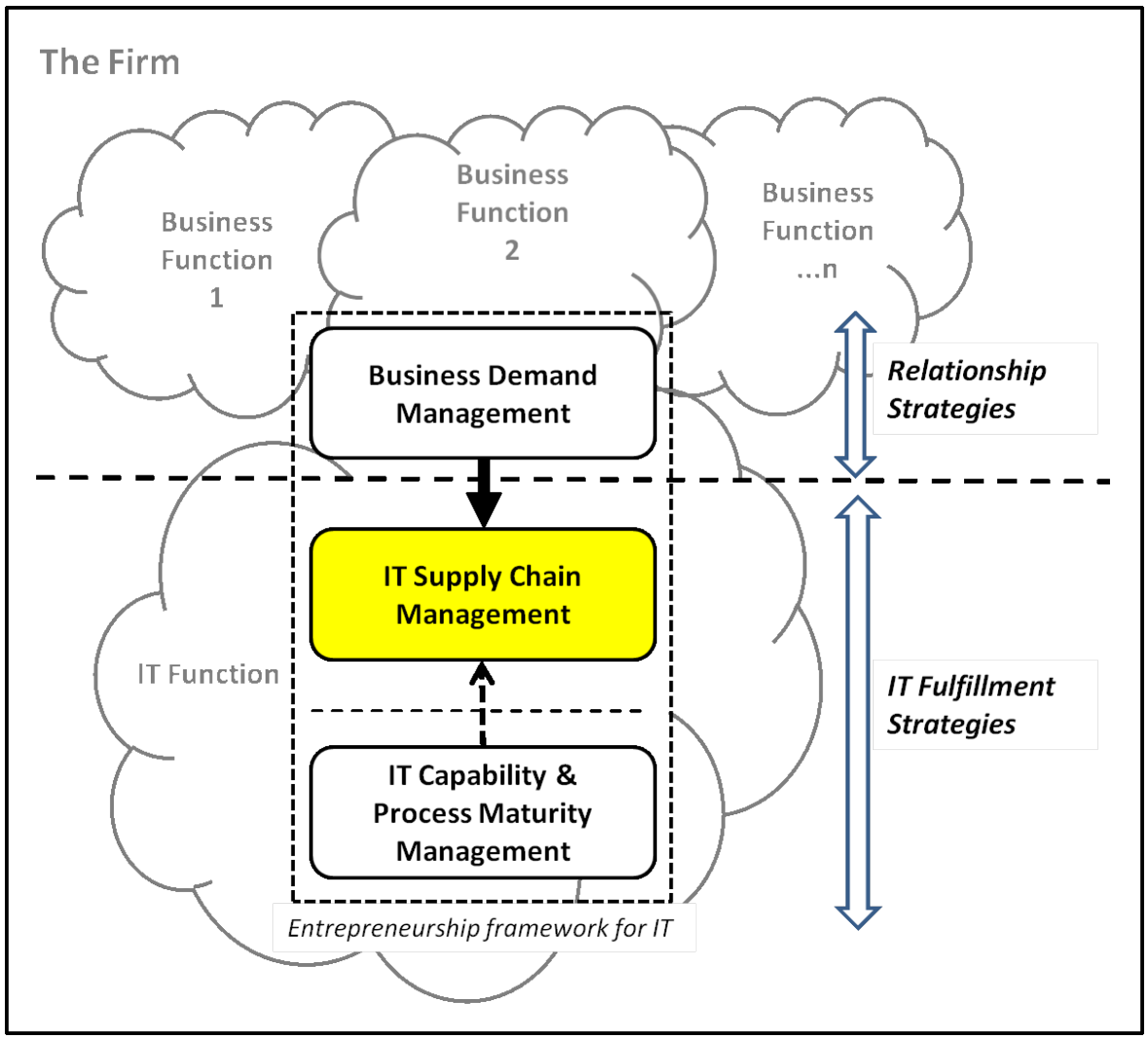
2. Identify IT Supply Chain Management as a focal component for enabling IT process adaptability

3. Examine process adaptability within the context of four IT fulfillment strategies, as observed in major firms

Process Adaptability in Business Demand Management

Process adaptability in Business Demand Management relates primarily to the relationship between the IT Function and its internal customers within the firm. In practice, this relationship can be characterized along a spectrum from full-service to self-service.

In a full-service relationship, the responsibility for process adaptation falls on the IT function. Usually, infrastructure and facility services are delivered through a full-service relationship because of the significant, long-



*Adapted from Bot and Renaud (2012a; timreview.ca/article/596).

Figure 1. Process-ambidexterity framework for IT*

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term costs involved (not to mention the magnitude of risk in making the wrong decisions). A full-service relationship does not necessarily result in an agile, responsive, or flexible process, however, it is a pre-condition for process adaptability because the IT function assumes responsibility and is accountable for servicing the business.

Historically, most IT-user relationships were full-service until the advent of the Internet. The World Wide Web fostered new economic and technology fulfillment models based on mass customization and self service. Self-service relationships are less costly for the IT function because less is required from them, so self-service relationships have become popular within enterprise IT functions since the late 1990s. In a *self-service* relationship any process adaptation is the responsibility of the internal customer who must be knowledgeable enough to weave together the elements of IT that their business function requires.

As an example, off-the-shelf application software is often purchased or created through a self-service relationship because end-users are typically more intimately aware of their application needs than a central IT function. The IT infrastructure that hosts and runs those applications tends to be a large, fixed cost, which makes it difficult, if not impossible, for an internal customer to introduce new technologies to meet new needs. Mass customization is rarely possible due to the need for IT to control the variety of permissible environments and configurations. The trade-off between control and flexibility is discussed in more detail below.

Between those two extremes, a range of hybrid relationships can be designed by using either a full-service or self-service fulfillment model for each component of the IT Supply Chain Portfolio. For example, facility and data centre space consumption is usually based on a full-service relationship that may be triggered by self-service selection of servers and storage. An internal user needing to install a new application, or expand an existing one, might simply order the type and capacity required through a self-service internal web portal, triggering the behind-the-scenes IT fulfillment process.

The type of relationship between the IT function and its users determines the context for process adaptability. At a contextual level, a self-service paradigm depends on a fixed set of choices being made available to users to choose between. This severely limits process adaptability because the fulfillment processes tend to be optimized around a few alternatives. Meanwhile, a full-service relationship enables the possibility, but does not assure, that IT processes will be adaptable.

At the process level, the processes for *Business Solution Management* and *IT Service Level Management* have the most direct influence on Business Demand Management process adaptability because these are the processes that implement how relationships are managed. These processes are described in more detail by Renaud and Bot (2012b; timreview.ca/article/626).

Process Adaptability in IT Supply Chain Management

An IT Supply Chain consists of the applications, infrastructure, facilities, and technologies used to provide IT for a firm. Managing this supply chain requires an ongoing investment in IT that ideally is aligned to satisfying the needs of the firm. The three major factors that influence process adaptability within IT Supply Chain Management are:

1. Enterprise IT Architecture: the extent to which a "master blueprint" for how all the IT in the firm fits together within a coherent architectural framework greatly determines the extent to which change can be accommodated in a modular fashion without destabilizing other parts of the IT environment.

2. IT Portfolio Management: how the internal portfolio of IT solutions is organized and managed often shapes the range of flexibility that the IT function can provide to the firm.

3. IT Fulfillment Strategy: the trade-off between the extent of control by the IT function versus the degree of business flexibility permitted when accommodating different IT solutions largely limits how adaptable processes can be within IT Supply Chain Management.

Enterprise IT architecture

The ISO/IEC standard 42010 (2007; tinyurl.com/cmtuclf) defines *architecture* as: "The fundamental organization of a system, embodied in its components, their relationships to each other and the environment, and the principles governing its design and evolution." In an IT context, *enterprise IT architecture* refers to the organization of, and interrelationships within, the IT Supply Chain.

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Good architectural principles enable modularity, making it easier for different solutions to be accommodated without cascading complexity into other aspects of the IT infrastructure. The extent to which the IT Supply Chain is well organized architecturally determines the extent to which the IT Supply Chain can accommodate greater diversity in the solutions and technologies that comprise it.

The use of enterprise architecture methodologies such as Zachman (tinyurl.com/4axvn2e) or TOGAF (tinyurl.com/6rxyq8), or the use of service-oriented or cloud-based virtual resource paradigms, facilitates the development of enterprise IT architectures that can promote process adaptability. However, there is no assurance that the resulting architecture will be implemented by using adaptable processes.

IT portfolio management

IT portfolio management is well understood as a capability for managing the return on IT investments (Kaplan, 2005; tinyurl.com/cjz6ghl) under the assumption that the financial return on each investment can be independently evaluated.

Within an IT portfolio, a *horizontal* IT solution delivers a generic or common infrastructure service across all business activities. Examples include email, printing, storage area network (SAN), file systems, database servers, application servers, and web servers. A *vertical* IT solution delivers a specific infrastructure or application service for a single business activity or a set of related business activities. Examples include high-velocity trading and market data distribution.

IT portfolio management favours investments that provide horizontal applicability because the scope for return on IT investment is more limited when considering vertical IT solutions. For example, a horizontal solution has the potential to be used across several business functions to deliver benefits to a broad range of users while the cost to engineer, deploy, operate, and maintain it are simultaneously amortized over a large user base. Hence a portfolio management approach is biased towards horizontal solutions that appear to offer a higher return on investment than a vertical solution that offers benefits to a handful of business functions and whose cost is amortized over a smaller user population.

Horizontal IT solutions do not need IT processes to be as adaptable as vertical solutions because there is less opportunity for variability in the use of the solution by different business functions. However, variation by business function still occurs and should be accommodated if the IT function is to behave entrepreneurially. For example, one business function (such as compliance risk management in a bank) may need a horizontal storage solution optimized for document storage while another business function (such as client account management) may need a storage solution optimized for transactional databases.

A common trap in comparing the return on investment in a horizontal versus vertical IT solution is to not fully account for the hidden end-user costs of using a horizontal solution that may not fit existing business processes as well as a vertically optimized solution would. Hidden costs such as lost productivity, additional data management overhead, and learning costs can skew the return-on-investment calculation. The lack of adaptable IT fulfillment processes often causes these hidden costs to be ignored because a fixed process that delivers a stock horizontal solution is easier for the IT function to implement. The inherent bias needs to be offset by greater process adaptability in the processes that implement portfolio management.

The capability of IT portfolio management is implemented by the processes for *IT Solution and Product Management*, *IT Capacity Planning*, *New Product Introduction*, and *IT Standards Management*. The extent to which these processes are agile, responsive, flexible, and customizable determines the process adaptability of IT portfolio management. Taken together, these processes largely determine an IT function's fulfillment strategy.

IT fulfillment strategies

Different IT fulfillment strategies can be chosen to implement the IT portfolio and the choice of fulfillment strategy often dictates the organizational model for the IT function. The three most common organizational alternatives are:

1. Decentralized: the business functions decide which information technologies to implement. The IT function is distributed under the management of each line of business or major business function of the firm with little to no IT coordination across business functions.

2. Centralized: the IT function is centralized under a single management team, typically reporting to a Chief Information Officer (CIO), whose mandate is to decide how to implement IT and to provide a consistent level of IT service delivery to all aspects of the firm.

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3. Outsourced: one or more external organizations decide how to implement IT. The IT function is externalized under the management of a third party who delivers IT services subject to a contract that defines scope and service level of IT services to the firm.

Weill and Ross (2004; tinyurl.com/ammeuay) identify that creativity and discipline are often in conflict when responding to business needs. Discipline is about architectural control by IT and creativity is about new ways of using IT to make the firm more flexible and effective. This trade-off between the need for increased control by IT and business flexibility becomes more pronounced with the size of the firm. Smaller firms are typically more entrepreneurial and require business flexibility to survive, while the cost of IT can be a significant expense in larger firms.

In practice the IT function will pursue one of the four types of IT infrastructure fulfillment strategies illustrated in Figure 2 depending on how the balance between *control* versus *flexibility* is resolved within any given firm:

1. Decentralized: the IT portfolio is implemented differently in different business units. Process adaptability is generally higher in a decentralized strategy because the IT function is subservient to business functions.

2. Outsourced: the IT portfolio is implemented in a highly standardized manner so that the outsourcing provider can reduce costs. Process adaptability is generally lower in an outsourcing strategy because the range of IT response to any situation is cemented into contracted service levels and subject to contractual scope-change processes that move slowly, if at all.

3. One Size Fits All (Centralized): the IT portfolio is implemented in a highly standardized manner so that the IT function can reduce costs. Process adaptability is generally low in this type of strategy because variability is discouraged by design.

4. Solution Portfolio (Centralized): the IT function provides a customized portfolio to meet the diverse needs of the firm. Process adaptability tends to be higher with this strategy because more degrees of freedom are permitted in the resulting IT portfolio.

Strategies that emphasize greater business flexibility admit higher levels of process adaptability. A full-service relationship that inherently prioritizes vertical needs of business user productivity over horizontal interests of IT staff productivity results in a fulfillment strategy found in the top row of Figure 2. Alternatively, a self-service relationship that inherently prioritizes IT staff productivity over business user productivity results in a fulfillment strategy found in the bottom row of Figure 2 and is accompanied by lower levels of process adaptability.

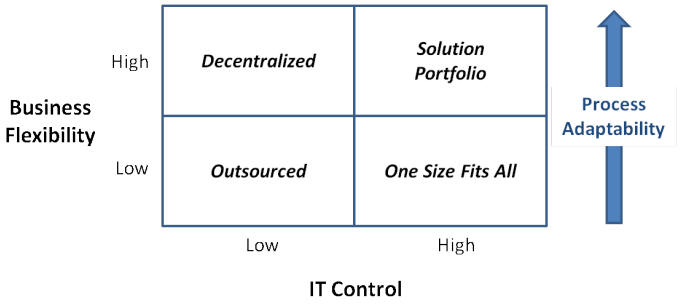

Figure 2. Landscape of IT fulfillment strategies

The next two sections discuss these relationships in greater depth by examining how process adaptability (which includes agility, responsiveness, flexibility, as well as customization of processes) varies under different levels of IT control.

Strategies involving low levels of IT control

In firms where any failure to align IT to business priorities is a significant risk to the firm, IT control is not a business priority. These firms will choose a fulfillment strategy found in the left hand column in Figure 2.

In firms where time-to-market is less important, but business alignment is paramount for productivity reasons (e.g., pharmaceutical, healthcare, legal, engineering, and other industries having expensive labour using IT), the IT function is usually decentralized so that each business function can dictate its own IT needs independently from other business functions. This combination results in highly disparate and bespoke IT environments that are optimized for each unit, may be costly, and may not interoperate well, but deliver high levels of IT service flexibility and process customization to users.

In firms where cost control is paramount and IT is a significant expense that has a large impact on operating costs (e.g., firms having low margins in industries such as retail and transportation), the IT function is frequently outsourced as a cost-savings measure to free cash flow for other capital investments. IT process adaptability is not a business priority compared to the importance of maximizing free cash flow.

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In firms where the overriding business priority is time-to-market speed (e.g., firms whose success rests entirely in the digital economy), much of their IT infrastructure and applications may be outsourced to software-as-a-service clouds that provide basic applications (e.g., customer relationship management and accounting). This outsourcing enables the firms to focus their IT investment on the applications that differentiate them as they pursue revenue growth. The remainder of the IT function will typically be decentralized into the business units that depend on that differentiation. In the outsourced aspects, IT process adaptability is low, with little or no flexibility; however, process adaptability is highly specialized or concentrated where it may be needed to deliver differentiated capabilities to the firm.

The combination of low levels of IT control coupled with high levels of business flexibility typically results in higher cost of IT service delivery but this is accompanied by a high degree of process adaptability, which facilitates the perception that IT is more entrepreneurial and worth the extra cost.

Firms choosing the combination of low IT service levels coupled with lower level of business flexibility (due to an emphasis on controlling the cost of IT) will end up with low levels of process adaptability due to fixed service levels provided by largely inflexible outsourcing arrangements. In these firms, an entrepreneurial IT function is not necessarily desirable, particularly if IT is not considered to be strategic to business differentiation (e.g. mining, metals, oil and gas extraction, and industries having high capital costs outside of the IT function). The loss of IT process adaptability in such firms is inconsequential compared to other business priorities.

Strategies involving high levels of IT control

Many firms drive down the cost of IT by giving the IT function a mandate to implement centralized control over permissible IT products and technologies (usually referred to as *IT standardization*). Fewer solutions to manage reduces IT costs by making IT personnel more productive – often at the expense of end-user productivity as illustrated in the upper portion of Figure 3. A high degree of IT standardization ultimately results in a *One Size Fits All* approach in which the pursuit of IT function productivity is paramount. Given that differences in need by business function can rarely be accommodated by a single standard and any process adaptation is perceived as costly from the perspective of optimizing IT staff productivity, a *One Size Fits All* strategy reduces process flexibility and customization.

The distinguishing feature of the *One Size Fits All* fulfillment strategy is that it is applied without regard to differences in need across business functions by implementing the entire IT portfolio with a set of horizontal products (e.g., file storage and database storage). The IT Portfolio Management process, by design, results in a single investment for each horizontal IT product need.

However, several US investment banks have discovered that it is possible to broaden their *One Size Fits All* approach by using a *Solution Portfolio* fulfillment strategy that balances the inherent trade-off between IT function and business function productivity as illustrated in Figure 3. In a *Solution Portfolio* fulfillment strategy, the IT function may deliberately invest in more than one implementation for each horizontal solution with the goal of achieving a better and more responsive fit to commonly recurring vertical needs across business functions. This strategy inherently applies process adaptability to improve responsiveness and flexibility. For example, some business activities such as ticker data management, may require a database solution optimized for non-transactional streaming of millions of serial trading records, while other business activities, such as trade execution, require a database solution optimized for a much smaller number of concurrent transactions.

As illustrated by the trade-offs in the lower portion of Figure 3, an *IT Solution Portfolio* fulfillment strategy can balance both user and IT staff productivity. Limiting the portfolio of IT solutions to a handful of business-aligned variations for each horizontal need enables the IT function to exercise control and reduce costs via standardization without disregarding differences in needs between different business activities. This results in a higher level of process adaptability.

Firms that have a centralized IT function using a *One Size Fits All* strategy for IT fulfillment can improve process adaptability and increase business flexibility by evolving to *Solution Portfolio* strategy. The challenge is how to select and manage the IT Supply Chain portfolio to minimize horizontal duplication while simultaneously balancing the need to be responsive to different vertical business needs. Renaud and Bot (2012b; timreview.ca/article/626) determined that employing exploratory processes for Demand Management is one way to meet this challenge.

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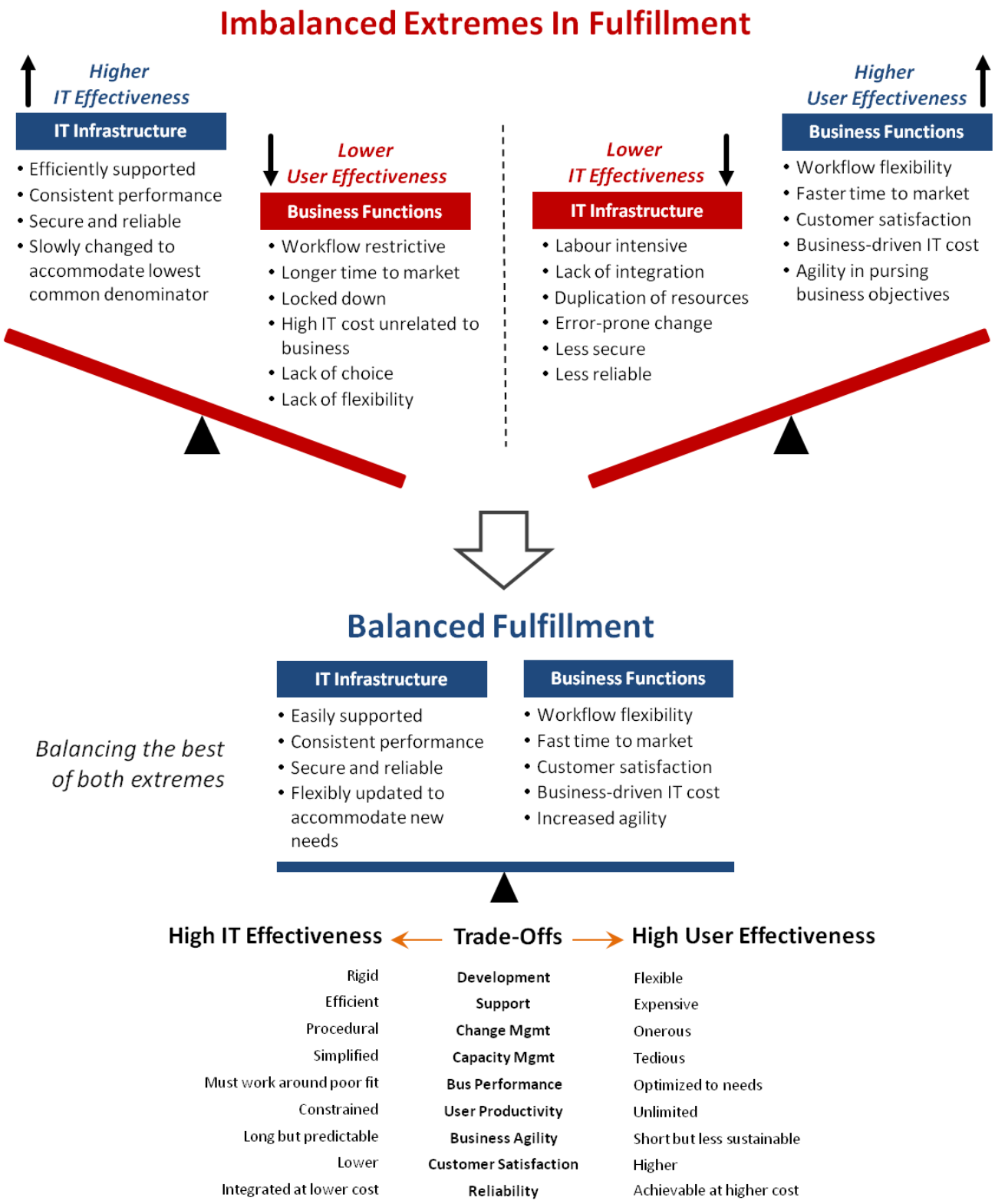

Figure 3. Balancing trade-offs between IT and business function productivity

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Conclusion

This article makes several contributions:

1. The relationship strategy chosen for Business Demand Management can either enable or limit IT process adaptation but does determine it. The decision to implement a self-service model essentially trades off user productivity to improve IT productivity. Conversely, a full-service model trades off IT function productivity to improve end-user productivity. The choice of relationship strategy will also influence which IT fulfillment strategy is most feasible to pursue.

2. IT Supply Chain Management is the focal point for enabling process adaptability. Improving the adaptability of these processes is necessary to accommodate greater diversity within the IT portfolio. Greater diversity is supported by modular or service-oriented enterprise architecture and generally results in a better fit between IT and the needs of the business.

3. The type of IT fulfillment strategy chosen can have a significant bearing on an IT function's ability to implement process adaptability. While different fulfillment strategies for IT Supply Chain Management may be pursued in firms whose overriding business priorities trump the importance of IT process adaptability, a portfolio-based fulfillment strategy is generally the best option for promoting process adaptability.

Process alignment and process adaptability comprise the key components of process ambidexterity. A companion article (Renaud and Bot, 2012b; timreview.ca/article/626) presents a process alignment framework for IT. Together, these pave the way for growing the capability of process ambidexterity, and in turn improve the performance of the IT and business functions, and the firm overall.

Acknowledgements

This article uses the terminology of "business value chains", "business functions", and "business activities" established by Porter (1985; tinyurl.com/8ul8upn).

Figure 3 has been adapted from prior unpublished collaboration with Robert Hintze.

About the Authors

Paul Renaud is Chief Executive of The Lanigan Group, which specializes in customer-driven product strategy and business-aligned IT service delivery. He is an advisor to CEOs, CTOs, and CIOs in the technology community and he is a member of industry advisory boards, including Queen's University's Innovation Council for the School of Computing and Ubiquity's Chairman's Advisory Board prior to its acquisition by Avaya. His previous roles include VP Business Intelligence Development at Cognos, Director of Computing & Networking and the Advanced Computing Research Lab at Bell Northern Research, Director of Nortel's Public Network Switching Capacity program and Chief Architect at SHL Systemhouse. Mr. Renaud authored *Introduction to Client/Server Systems*, which was published in four languages and widely used as a university textbook. He has a BSc degree in Computer Science and Mathematics from Queens University.

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Q&A

Sara Rauchwerger

Q. What Does a Global Startup Need to Know to Enter China?

A. With the continuous change of business environments and a competitive global economy, companies cannot afford to ignore international markets. The dependency of nations around the world on each other's products and services has raised awareness among companies of the need for a more global outlook in their approach to business. The opportunities are abundant; however, the means to success must be carefully analyzed in the targeted markets. Exploiting market opportunities is about making the right decisions based on a sound analysis of the each environment and target market.

Today, in some industry sectors, the only means to succeed is to become a global company from the day of inception (Bailetti, 2012; timreview.ca/article/614). Many entrepreneurs, particularly in the technology sector, now have the means to instantaneously jump-start a global company. For example, the Internet, cloud services, and mobile wireless access help entrepreneurs reach global customers and partners, and receive payments in almost any currency. Moreover, the use of the Internet and mobile wireless access has spread by leaps and bounds. More than one third of the world's population is online (ITU, 2011; tinyurl.com/6cwry5s), where they can access information, products, and services.

Since most companies are geared towards growth and expansion, companies will look to find the greatest market opportunities, and many have set their sights on China as a large and relatively untapped market. Despite the global economic downturn, China is one of the fastest growing markets and accounts for almost 25% of Internet users globally (ITU, 2011; tinyurl.com/6cwry5s). China represents a wealth of opportunity; however, these opportunities bring specific challenges. When entering the Chinese market, companies must understand the nature of these challenges, adopt appropriate strategies, and take a long-term perspective on the market's potential.

Below, seven components of an internationalization strategy are presented: market research, competitive analysis, government and legal requirements, cultural habits, marketing plan, financial analysis, and risk analysis. All of these components must be considered to meet a company's objective for growth and profitability. These components are relevant when considering any market – global or domestic – however, the discussion will focus on the particular challenges of entering the Chinese market. These insights are based primarily on the author's experience helping American, Canadian, and European startups develop and implement their internationalization strategies, especially when China is the target market.

1. Market Research

Companies entering the Chinese market are strategically positioning themselves for a long-term competitive advantage in a global market rather than only focusing on their own domestic market. Market research is an essential component when seeking a competitive advantage in a foreign market. Many companies would like to avoid this step and justify this line of thinking by downplaying the value of market research in a rapidly changing environment. However, the effort required for market research is minimal in comparison to the cost of not planning ahead, and it can help companies anticipate and respond quickly to industry changes.

Companies must be informed and understand their global positioning in the industry to meet their objectives. It is therefore vital that information is gathered about the trends, customers, competitors, and all other forces that play a role in the industry to be able to make sound decisions and gain a competitive advantage for strategic positioning. Market research is a process that helps identify and define market opportunities and complexities through the gathering of information. It is always thought that market research is a lengthy and formal process, and it can be. However, the pace and movement of technology, reforms, and policy changes – particularly in China – is rapid and continuously changing. The gathering of information and market intelligence must be focused on a specific target. Companies can then quickly evaluate the opportunities and position themselves strategically, and they can avoid mak-

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ing mistakes. Companies that do not conduct such market research may only later learn about the opportunities that they missed.

Consider an example of how an entrepreneur can evaluate an opportunity in a specific sector of the Chinese market. The largest global market in wireless software in the consumer space today is device applications or "apps". Companies from around the world are building apps with the hopes to be the next Rovio (developer of the popular Angry Birds app; rovio.com) and selling their apps in the largest market: China. As of May 2012, China has more than 1 billion mobile subscribers and has overtaken the U.S. as the world's largest smartphone market (MobiThinkin, 2012; tinyurl.com/cqupf6r). In 2011, China had a 298% increase in application downloads and a 187% increase in revenue generated from applications (TechNode, 2012; tinyurl.com/89uwjvr). Based on the numbers, it is evident that the Chinese market has become an important entry port for application developers because of the large demand and continuous growth.

Given this top-level insight into the market, as shown in the example above, the next steps are to determine how to capture market opportunities. This might include an evaluation of the most common types of downloads relevant to a niche market, trends, and cultural preferences for applications types. For example, online and mobile games in China are a huge market. If there are characters drawn in the game, a thorough evaluation of cultural styles should be considered. If improperly drawn, facial gestures in characters can be perceived as rude rather than entertaining, and the audience can be quickly lost due to such a cultural misunderstanding. Based on market research, a strategic plan can be put in place to help the company decide whether or not to adapt and localize their existing application.

2. Competitive Analysis

When entering any new market, companies should identify key competitors, along with their strategies, weakness, and strengths through a competitive analysis. It is critical to draw attention to the opportunities and the threats to the company. This analysis should evaluate the company's current industry positioning relevant to its competitors.

Entering the Chinese market brings a few additional variables into the competitive analysis. There are still many Chinese companies that are state-owned enterprises, and the government's involvement in many aspects of business brings a twist to the competitive analysis. In addition, local Chinese companies with similar brands and focus may sprout overnight in different parts of the country.

Family-owned companies can spread throughout China rapidly through their own internal network known as guanxi, which translates to "trusted relationship". Entrepreneurs should understand the central role of guanxi in the daily lives of Chinese business owners; it can make or break an opportunity. The importance of guanxi, and the need for global entrepreneurs to understand it, is discussed in more detail below and in an article by Daniel Zhou (2012; timreview.ca/article/524).

In many Chinese industry sectors, foreign brands are perceived as superior in quality, and there are many examples of companies of all sizes being received in China with open arms. This perception of quality provides an advantage to a foreign company, yet from a competitive standpoint, this perception extends to other foreign companies. An entrant's competitive analysis should not only consider local companies and state-run enterprises, it must also compete against other foreign companies.

The competitive analysis should also consider legal issues, including the potential for "copycat" products and companies. Fortunately, China's previously lax attitude toward business practices has changed slowly over the years. Following its accession into the World Trade Organization in 2001, China has provided many commitments, one of which includes adherence to international rules and conventions. Now, many legal, accounting, venture capital, and technical firms, and others in the business ecosystem, have established cross-border units of operations. Their sole objective is to help companies of all sizes understand the local environment and work closely with local government and private enterprises to create uniformity in processes that protect companies.

It is therefore vital to conduct a competitive analysis that evaluates all fronts. Not only should companies learn about the competitive landscape in China, but they should also learn about competitors from other countries that are also targeting China. Moreover, companies should determine how their ecosystem can support their entrance into a foreign market.

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3. Governmental and Legal Requirements

When considering entry into any foreign market, companies should understand the regulatory and legal requirements for international trade. The United States and Canada tend to have more flexible regulatory policies, when compared with China or even similar territories such as Europe. In China, regulatory policies and processes are constantly changing.

The regulatory process and government policies may seem mundane and ever-changing when viewed as a process; however, in Chinese business practice, cultural values and traditions are important considerations in implementing these processes. These values are also important in the formulation of a general entry strategy. As discussed earlier, business transactions are conducted through the establishment of networks known as guanxi. A Chinese business network operates on trust and requires relationships to be established. Building a network is imperative for the long-term success of any company entering the Chinese market.

Another challenge for global entrepreneurs is the support of the Chinese government for companies that have been "home grown" in China, some of which are replicas of foreign companies. Examples include Renren (tinyurl.com/4m55s2u), which is similar in nature to Facebook (tinyurl.com/kkn7l), and Tencent, with its most popular division: QQ (tinyurl.com/6hfte3). As of August 2012, Renren had over 150 million users and Tencent QQ had over 700 million users – compared with 900 million Facebook users – and both of these companies have been praised by the Chinese government as local success stories.

Beyond praise, the Chinese government's policies provide support to local companies, such as Renren and Tencent, to complicate a foreign company's entry into that market. Chinese policies create a major barrier to entry for Facebook, which has been blocked in China. The Chinese government favours local companies because it can easily monitor their social media platform for any suspicious activity and instantaneously take action without having to deal with international treaties and legal regulations.

This degree of government intervention might scare away new entrants to the market, but it should not. New entrants must understand the logic and cultural difference and work together with government entities and local companies. For example, given the circumstances, it is probably not wise to start a social networking site that targets the Chinese market to later find it blocked. Rather, entrepreneurs should look at alternatives such as partnership opportunities with local companies or value-added services. Companies that wish to enter the Chinese market should seek to understand the policies and issues related to their targeted sector through research and relationships within their ecosystem.

Entrepreneurs should also evaluate their intellectual property rights in China. In the past, piracy has been the norm, but the legal landscape in China is changing. The laws in China have changed and continue to change to ensure that they follow the conventions of international trade. However, it is better to have a defense mechanism in China than lose out on the market from day one, because disaster can ensue if companies do not adequately protect their intellectual property. Early-stage companies with great ideas and minimal funding often delay filing patent applications and then find that their market opportunity in China is quickly eroded by copycats.

Patent applications are the best defense mechanism a company has for its long-term operation, and patents should be filed in both the company's home country and in China. The Chinese government has made great efforts to bring change to a previously lax system and stop patent infringement. Today, there are more Chinese companies filing for patent than ever before. The services of an intellectual property attorney with expertise in Chinese patent filings can be a great asset to companies deciding whether or not to enter the Chinese market and file patents in China.

Finally, companies wishing to enter the Chinese market should research the processes for busines registration, import and export, taxes, foreign exchange, profit repatriation, and financial standards. Registering a business in China can be a lengthy process and startups should evaluate the different registration options with respect to the company's long-term objectives.

4. Cultural Habits

China's culture deeply influences its business practices. From the 1950s to the 1980s, China was a closed society, and therefore many of the older generation lack global business experience. Businesses in China are trying to play under the same rules as the global markets yet their ideology and isolationism influence their

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thinking. There are also regional differences in China, which result from divisions between provinces, historical factors, language, and differences in weather and terrain.

The Chinese business culture has been adapting to western business ethics while establishing its own unique culture. In China, everyone over the age of 40 grew up in an era where the state provided everything, and this experience applies to most of the country's business leaders. Recognizing this background and changes to the cultural climate will help entrepreneurs understand how to work with local partners and supporting organizations.

5. Marketing Plan

A marketing plan provides a process and an action plan for market entry. A well considered marketing plan must include an appropriate sequence of steps that can be easily executed. The marketing plan should describe the requirements necessary to adapt to the local market, including the pricing structure, promotions, and distribution medium.

The marketing plan should also consider any language barriers that a foreign company must overcome. The first mistake that many companies make, particularly when entering China, relates to the naming of their product or company. Startups get excited about their name but do not conduct enough research to learn if the selected name can be used across global boundaries. Care should be taken to make sure the name does not potentially mean something completely different, is not offensive, or lacks its enticing qualities when viewed through the lens of a different culture. Also, it is better for companies that are entering the Chinese market to use the local language and be able to write the company or product name in Chinese characters. Companies should not underestimate this aspect of the marketing plan; a brand name can make or break a company in a foreign country.

6. Financial Analysis

The decision to enter a new market should always be based on a sound financial analysis. The information collected through consideration of the topics discussed above (e.g., market research, competitive analysis) will impact the financial analysis. The financial plan should evaluate returns based on a minimum level of risk where the cost of pursuing market entry is within the target budget. The plan should allow flexibility for rapid responses to external changes because the Chinese economy is growing rapidly and changes occur regularly.

Currency fluctuation can also impact the financial analysis, especially if revenues will be repatriated. Many foreign companies in China have chosen to reinvest revenues back into the company due to the complications of repatriating funds.

Another important financial consideration relates to human resources. China has been known for cheap labour rates, particularly in manufacturing. However, many startups entering China today are not hiring employees for manufacturing purposes. These companies are often looking for administrative, on-the-ground support or engineers for development and value-added services. Foreign companies are often shocked to learn that the salaries for these types of employees in China can nearly match the salaries of employees in their own country. This situation is primarily due to economic growth and the low unemployment rate for college graduates in China, who are increasing in number. Furthermore, college graduates now have the opportunity to move from job to job just to get a higher salary, and this movement has created very little company loyalty. The cost of running a business with high turnover can impact the bottom line, especially if training is necessary. A company's financial analysis should include human resource requirements because it tends to be the largest expense on the income statement.

7. Risk Analysis

Any strategic decision comes with some risk. Important considerations when analyzing risk include the type, source, and magnitude of the risk. This information helps a company mitigate against specific risks and devise alternative actions.

Despite its potential, the Chinese market is risky because it is still emerging and future changes are difficult to anticipate, and for a foreign company, further hidden risks may exist due to a lack of experience or understanding. A well-developed strategic positioning plan can mitigate against such risks.

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Conclusion

Companies have been forced to think globally and expand their products and services across international boundaries due to the dependency of nations around the world on each other's products and services. Startup companies are no exception; entrepreneurs are trying to reach target markets that involve global opportunities. In search of these opportunities, all eyes have recently been on China and its continuous growth. In China, companies can leverage growing market opportunities in many business sectors that are growing at a faster pace than any other region of the world.

To succeed in China, companies must understand the local environment they intend to enter, leverage reliable resources, and build trusted partnerships. Completing an analysis of the seven key components of internationalization described here, and then building an appropriate strategy based on the results, will better prepare a company to succeed in the Chinese market.

About the Author

Sara Rauchwerger is the Founder and Director of the Chamber of Commerce International Consortium for Entrepreneurs (CCICE; ccice.org), an organization that connects entrepreneurs globally. She is also the Founder and Managing Director of BG Strategy (bgstrategy.com), a leading global market entry services company, specializing in helping clients enter global markets including industry-specific investment opportunities. Ms. Rauchwerger brings over 20 years of business development and business strategy experience from both private enterprises and government contracts from various telecommunications, aerospace, and information technology companies. She has helped companies extend globally and has particular expertise in the Chinese market. Ms. Rauchwerger participates regularly as a speaker presenting globally, at board meetings, investor pitches, lectures, conferences, forums, university lectures, and other events. She holds an MBA Degree in International Business from the Grenoble Graduate School of Business, France, and a BS Degree in Aeronautical Engineering from San Jose State University, California.

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TIM Lecture Series
29 Lessons Learned in Entrepreneurship

Wes Biggs

> *"To me, entrepreneurship is all about building.*
> *Building a team.*
> *Building a product.*
> *Building a company."*
>
> Wes Biggs
> President and CEO
> Triacta Power Technologies

Overview

The eighth TIM lecture of 2012 was presented by Wes Biggs, President and CEO of Triacta Power Technologies (triacta.com). Biggs shared the 29 key lessons he has learned about his experiences with entrepreneurship both through roles within large technology companies and as part of the senior management and founding teams of technology startups. He retraced his career history up to this point and extracted lessons learned through each of his varied experiences. The event was held at Carleton University in Ottawa, Canada, on October 11th, 2012.

The TIM Lecture Series is hosted by the Technology Innovation Management program (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.

Summary

Wes Biggs drew upon his 30 years of experience in technology companies to distill 29 lessons he learned about entrepreneurship. Biggs described five key roles he has played as case studies to show how his perspective in each role influenced the lessons he learned. As he transitioned through each of these roles, he sought out increasingly entrepreneurial environments because he was attracted by the ownership opportunities. In this sense, "ownership" refers to more than equity; it refers to involvement in strategy development, technology selection and development, and the development of the company itself. Biggs started out as an engineer in an established telecommunications company, and he is now the President and CEO of an energy management hardware company, which he joined during in its early, startup phase.

Below are the 29 key lessons learned by Biggs, which come in the form of advice to other technology entrepreneurs:

1. Get in early. The very early days of a company are filled with energy and opportunity.

2. Have a product and market focus. You can't do everything, especially at the beginning. If you try to, you will likely find that you will accomplish nothing. At first, you should focus on one market and one product.

3. Too much money can be as bad as too little. Having too much money can stifle innovation. It is better to focus on getting customers, not spending money.

4. Give people a "fraction of the action". This means not only giving equity in the company, but it also means giving team members ownership of problems and responsibility to make decisions. Note that the "early ones" tend to get the largest fraction of the action; it is a decreasing scale.

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5. Find the right mix of "veterans" and "new blood". Effective teams are diverse. Young people often bring energy, new technology, and room to grown and learn, but experience is also important.

6. Surround yourself with proven and trusted colleagues. In an entrepreneurial setting, it is critical to work with people who you know will deliver, even under time pressure, money pressure, etc.

7. Adopt a connectionless management scheme. Organizational hierarchies are only useful for human resources purposes and for displaying on organization charts. Cultivate an environment where people are free to talk to whoever can give them the answers they need. Communication is key; don't let hierarchies get in the way.

8. If you want to find out what is really going on in R&D, install a beer keg next to your office. You need to understand the key issues happening in R&D. Often, the best way to do this is to create opportunities for informal discussion.

9. The outside-affiliate model can be great for innovation. Creating affiliate companies (or spin-offs) outside of the company can be a great way to promote innovation. This model gives an outlet to employees who wish to be entrepreneurs, while maintaining control of intellectual property; it is also a way to retain engineers who might otherwise leave the company.

10. Some people may not perform to the same level in a startup as they would in a large company with "infrastructure". A startup is a much different environment than a large company, and you can't always predict how a given person will respond based on their past performance in a large company. Some people thrive in startups, and some people struggle.

11. In your business plan, take the most pessimistic timeframe you can imagine to achieve your first sale... then double it. Once you know what the pessimistic timeline is, ask yourself whether you, your employees, and your company can survive it.

12. Successful people who bring money to the company typically also bring an engrained formula for success. When people have had success in the past, they are unlikely to want to deviate from the formula that brought them this success. But, every situation is different. Be aware that these engrained formulas can help you, but they can also hurt you.

13. Taking money from individuals brings one level of expectation. Taking money from individuals who have taken other people's money ratchets up the level of expectation. When individuals bring other people's money, they have already committed to the expectations of their group or fund.

14. Those with the money call the shots. If you have no skin in the game, you ultimately have no say.

15. Those with big money typically look for "Type A" CEOs. Make sure you are the right "blood type" for a startup backed by venture capital. Venture capitalists are looking for aggressive, assertive CEOs that will drive the growth and revenue of the company. If you aren't this type of person, think twice about accepting venture capital.

16. Your board is important; try to have one or two independent board members. The board plays an essential role in the company's success. Listen to them. And, make sure some board members do not have a vested interest in the company beyond a shared desire to see it meet its growth objectives and contribute to its success.

17. Build a management team that has interchangeable parts. There is risk when one individual is the heart and soul of a company. If something happens to a company or one of its senior management team, it helps to have redundancy in the skill sets of senior managers.

18. Have a first customer as early as possible. Early customers are not only a source of early revenue, they can validate that you are on the right track.

19. Nobody ever gets it right in their first PowerPoint slides. Be prepared to change direction. As you develop the product and meet with potential customers, new markets may present themselves.

20. Regulations can make markets, and regulations can take markets away... quickly. In some cases, you need to commit the company to a particular market. However, regulatory changes can open new markets or shut others down, sometimes with very little warning.

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Wes Biggs

21. Recruit employees that will ride it out through the tough times. A dedicated core team is essential. This dedication may be tested if the company struggles.

22. If it's not fashionable, you may be onto something. Depending on what you are building, you may be better off developing your product in obscurity and letting the market come to you, rather than chasing a crowded market.

23. It doesn't have to be the next "New New Thing"; it just has to be new to your customers. When moving into new industries, you may find that what is "well known and ordinary" to you may be perceived as new and innovative, either because it is unfamiliar or because it may not have been used in that way before.

24. Ignorance of industry norms sometimes gives you an advantage. Industry norms can sometimes stifle innovation; when moving to a new industry, ignorance of these norms can lead you to doing things that others perceive as innovative.

25. Don't forget about patents. It can be easy to focus on building technology and forget about patents. However, patents affect your valuation, and they can also be used as a defensive or offensive tool.

26. Recruit board members that have built companies (preferably in your industry). Use their expertise and experience. Ask for their advice, and listen to it.

27. All investors want an exit. If you take money from people, don't forget that they will want to get their money out at some point. Plan for it.

28. Key revenue milestones are $3 million and $10 million. For hardware companies, these are magical numbers that signal that you are going to "make it". Reaching the first milestone with further opportunities for growth can reinvigorate employees and investors. The second milestone tells you that you are a "real company" in terms of the number of customers, consistent repeat buying, and greater opportunities for acquisition.

29. Building a company can take a while. Be patient, but also plan ahead for a long journey.

About the Speaker

Wes Biggs is a technology company veteran with over 30 years of experience in established technology companies such as Nortel, Mitel, and Newbridge plus several startups along the way. He has learned many lessons both as an engineer and as a founder/executive. Wes joined Triacta Power Technologies as the VP of Engineering & Operations in 2003 and is now President and CEO. Prior to joining Triacta, Wes was co-founder, President, and CEO of Meriton Networks.

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