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DEVELOPING INNOVATION CAPABILITY IN ORGANISATIONS: A DYNAMIC CAPABILITIES APPROACH

BENN LAWSON
Department of Accounting, The University of Melbourne
Victoria, 3010, Australia
e-mail: blawson@unimelb.edu.au

DANNY SAMSON
Department of Management, The University of Melbourne
Victoria, 3010, Australia
e-mail: d.samson@unimelb.edu.au

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This paper draws together knowledge from a variety of fields to propose that innovation management can be viewed as a form of organisational capability. Excellent companies invest and nurture this capability, from which they execute effective innovation processes, leading to innovations in new product, services and processes, and superior business performance results. An extensive review of the literature on innovation management, along with a case study of Cisco Systems, develops a conceptual model of the firm as an innovation engine. This new operating model sees substantial investment in innovation capability as the primary engine for wealth creation, rather than the possession of physical assets. Building on the dynamic capabilities literature, an "innovation capability" construct is proposed with seven elements. These are vision and strategy, harnessing the competence base, organisational intelligence, creativity and idea management, organisational structures and systems, culture and climate, and management of technology.

Keywords: innovation, dynamic capabilities, Cisco, new technology

Introduction

Ask many of today's CEOs and they are likely to tell you that the ability to develop new ideas and innovations is one of the top priorities of their organisations (Porter,

Stern & Council on Competitiveness, 1999). The emergence of the knowledge economy, intense global competition and considerable technological advance has seen innovation become increasingly central to competitiveness. Innovation is the mechanism by which organisations produce the new products, processes and systems required for adapting to changing markets, technologies and modes of competition (D'Aveni, 1994; Dougherty & Hardy, 1996; Utterback, 1994). As companies become increasingly focused on innovation, the performance hurdles for success have increased considerably. Escalating levels of commitment to innovation are required simply to stay in the same place, much less improve competitive position. However, managing the complex and risky process of innovation has been problematic and fraught with difficulty (Kanter, 1989; Quinn, 1985).

This paper provides a framework for managers showing that the process of innovation can be managed, systematised and replicated within organisations. Based on an extensive review of the innovation management literature, and supported by a single case study of Cisco Systems, a model of innovation capability is developed. We show that successful innovation contains core elements and processes, regardless of the industry or firm. High performing innovators are able to harness this innovation meta-capability to achieve outstanding performance.

Review of the Literature

The practical concerns and demands of managers have often driven research into organisational innovation. Consequently, predominantly normative theories have been advanced offering prescriptions for improving the innovation outcomes of firms (i.e. the number of innovations developed). However, despite an extensive literature and the depth and extent of empirical research, a dominant theory, or in fact, a consistent body of theory remains elusive (Fiol, 1996; Wolfe, 1994). Wolfe (1994: 405) argues, "the most consistent theme found in the organisational innovation literature is that its research results have been inconsistent".

Many models of innovation at the firm level have attempted to improve research consistency. These models have occupied a variety of theoretical positions, including institutional theory, cognitive theories, transaction cost economics, socio-technical approaches, market orientation (MO) and resource-based view. Each theory contributes a piece of the innovation puzzle. None can paint a complete picture. An accepted comprehensive and systematic framework guiding managers toward successful innovation does not yet exist. Many firms and academics have suggested that innovation management may be sector or industry specific, if not firm specific. Even so, evidence suggests that a number of core elements and processes exist which aid effective innovation outcomes (Tidd, Bessant & Pavitt, 1997). Firm-level differences, such as competitive environment, strategy, task

complexity and management style means that the importance of each innovation process may vary across firms. However, each innovation process is considered likely to exist in varying degrees within all high-performing innovators.

One of the more promising theories to evolve in the strategic management field over recent years is the resource-based view (RBV) of the firm. RBV has been able to bring a more systematic approach to firm-level analysis by characterising the firm as a collection of resources and capabilities, rather than a set of product-market positions (Wernerfelt, 1984). RBV assumes that performance differences across firms are due to differences arising from valuable, rent-generating, firm specific resources and capabilities that cannot be easily imitated or substituted (Amit & Schoemaker, 1993; Barney, 1986, 1991; Dierickx & Cool, 1989; Hamel & Prahalad, 1994). Accordingly, firms do not compete on new products, but rather on a deeper factor — the capacity to develop new products (Prahalad & Hamel, 1990).

Teece & Pisano (1994: 541) further developed the area proposing dynamic capabilities theory as the "subset of the competences/capabilities which allow the firm to create new products and processes and respond to changing market circumstances". Competitive advantage, therefore, rests on distinctive processes, shaped by the firm's asset positions and the evolutionary paths followed. Dynamic capabilities emphasise management capabilities and inimitable combinations of resources that cut across all functions, including R&D, product and process development, manufacturing, human resources and organisational learning.

An explicit examination of innovation is usually omitted in the discussion of dynamic capabilities. However, as a key mechanism for organisational growth and renewal, innovation is implicitly central to the theory. Dynamic capabilities theory is thus well-suited to the study of organisational innovation for a number of reasons. First, there is no special focus on technology. For example, research and development is but one resource among many available to the firm. This facilitates development of a holistic model of organisational innovation. Second, the innovation process may just as easily relate to the development of new products as it can to new processes, systems or even business models. Moreover, the requirement of asset heterogeneity reflects the expectation that there is no one generic formula of innovation capability. There are, however, common threads running between highly and lowly innovative firms that vary only in degrees of importance (Tidd *et al.*, 1997).

We can also distinguish capabilities based on the type of knowledge they contain (Verona, 1999). Functional capabilities allow a firm to develop its technical knowledge (Amit & Schoemaker, 1993; Pisano, 1997; Prahalad & Hamel, 1990). Integrative capabilities allow firms to absorb knowledge from external sources and blend the different technical competencies developed in various company departments (Cohen & Levinthal, 1990; Grant, 1996; Henderson & Clark, 1990;

Kogut & Zander, 1992; Pisano, 1997). Innovation capability is proposed as a higher-order integration capability, that is, the ability to mould and manage multiple capabilities. The concept of higher-order integration capabilities is developed in Fuchs, Mifflin, Miller & Whitney (2000). Organisations possessing this innovation capability have the ability to integrate key capabilities and resources of their firm to successfully stimulate innovation.

Despite the strong application to innovation, resource-based view and dynamic capabilities theory have a number of weaknesses. First, it is often difficult to identify within a firm which of the many resources, individually or collectively, account for effective performance. The identification process may also have an *ex post* quality — as the firm is recognised as successful, the resources behind the success are labelled as valuable. Similarly, the failure of a firm can invariably be attributed to the absence of a specific capability or capabilities. Furthermore, many resources are complementary, such that it is the system of resources that matters, not the individual component. The tracing of the general processes on which capabilities are based is still in formative stages (Leonard-Barton, 1995; Teece & Pisano, 1994). Without an understanding of the specific activities underlying capabilities, study replication and knowledge development in the area is difficult (Peteraf, 1993). Finally, the value of resources may change over time becoming a core rigidity of the organisation, even though the resource itself has not changed form (Leonard-Barton, 1995).

The Innovation Imperative

Throughout the 1980s and 1990s, managers and organisations faced operational challenges affecting their very existence. High quality, value-added imports were challenging the traditional dominance of Western industries in areas such as automotive, electrical and semiconductors. Initially hesitant to recognise and react to the significant changes occurring in their marketplaces, these organisations eventually responded spending much of the 1990s rationalising to core businesses, delayering, outsourcing and reengineering for productivity.

During this period, competitive advantage rested variously on mainstream variables like efficiency, quality, customer responsiveness and speed. In the new millennium, control over the above variables represents the minimum threshold to "play the game". Each factor remains important, but is unlikely of itself or as part of a group to provide a sustainable competitive advantage. Today's organisations face an additional challenge — the requirement to innovate, not just occasionally but often, quickly and with a solid success rate. The sphere of organisational and managerial attention has expanded to incorporate both mainstream variables and an innovation capability.

Innovation represents today's competitive advantage, supported by strong mainstream capabilities in quality, efficiency, speed and flexibility. Innovation can help firms play a dominant role in shaping the future of their industries. High-performing innovators are able to maintain a giant juggling act of capabilities, and consistently bring new high quality products to the market faster, more frequently and at a lower cost than competitors. Moreover, these firms use process and systems innovation as a way of further improving their products and adding value to customers. This combination creates a dynamic and sustainable strategic position making the organisation a constantly moving target to competitors (Kiernan, 1996).

This view of the world points to a need for managers to coordinate daily mainstream operations, while also cultivating innovation and change within their companies. Paradoxically, the need to manage mainstream competencies efficiently is often seen as hampering the development of successful innovation. Mainstream activities like manufacturing and marketing are often the key to current success with organisational processes built around stability, efficiency and profitability in generating cashflow. Processes are developed "programming" mainstream business units to perform routines, formalise structures and not to think outside the square (Starbuck, 1983). Operational challenges and quarterly revenue objectives further reinforce a short-term focus. Conversely, innovation is a force of instability, often requiring long-term vision and commitment to yield results. The uncertain and dynamic environment of the innovation newstream leverages knowledge to develop the new products, processes and systems that will underlie future success.

Many authors highlight the different characteristics of mainstream and newstream processes. Kanter (1989) argued that organisations are most effective where the different resource needs of the "mainstream" and "newstream" are recognised and their management largely autonomous. Managing business units in this way assists organisations in balancing the tensions of stability and change.

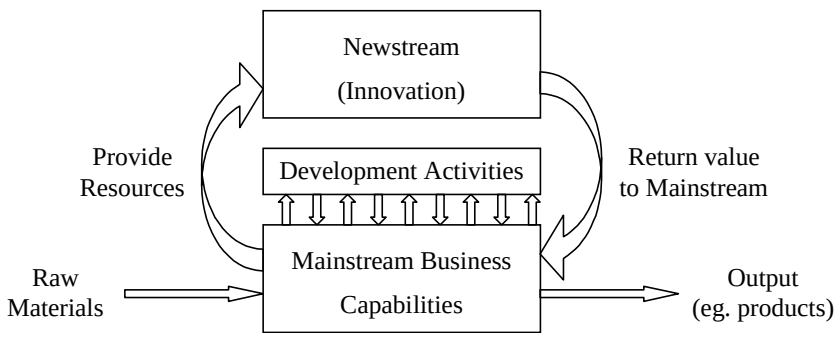

Fig. 1. Conceptualisation of Kanter's (1989) model.

Kanter (1989) showed that mainstream activities provide funding for newstream development. New products and processes are then assimilated back into the mainstream. Continuous development activities (i.e. doing the same things better) arise through constant communication between the two streams. Kanter's (1989) model is conceptualised in Fig. 1. Unfortunately, managing the different needs of the mainstream and newstream independently is unlikely to be successful in a dynamic and turbulent operating environment. There needs to be strong information flows and connections of effort between the two streams or else successful commercialisation is threatened.

Innovation Capability — A Way Forward?

We argue that the logic behind Kanter's model has limited application in a fast-moving and uncertain business environment. Such an approach generates "efficient" but not necessarily innovative business units. In terms of management attention, too much focus is placed on general management (such as quality, customer responsiveness and efficiency) at the expense of innovation. Although an intuitively attractive way of managing the tensions of stability and change underlying innovation, Kanter's model does not fully account for the importance of integrating all an organisation's capabilities into the innovation process. Effective innovation is difficult to achieve where the mainstream and newstream are managed separately or in isolation. High-performing innovators make innovation an organisation-wide effort that recognises the interdependency with the mainstream and manages accordingly.

Leading innovators encourage, expect and reward innovation from everywhere within the organisation — not just research and development. They make a point of linking organisational learning and knowledge to products, processes, technologies and mainstream capabilities. These companies do not see innovation as just a user of scarce resources for uncertain outcomes, but rather as a mechanism for creating new knowledge and competitive advantage. They recognise that business units producing profits today may not represent the best opportunities for business tomorrow. Mainstream factors and innovation are therefore managed integratively so that the two work in harmony. The co-founder of Hewlett-Packard, Bill Hewlett, is quoted as saying that "the creative process works well when it is not too structured. But, in the long run, it must be tamed, harnessed, and hitched to the wagon of mankind's needs" (Platt, 1997). It is the need to produce real products, on time and on budget that ultimately drive the success of a business.

A modified conceptualisation of Kanter's (1989) model (Fig. 2) is used to illustrate the innovation capability. Today's profit relies on the sale of established products and services. Mainstream operational activities convert raw materials into

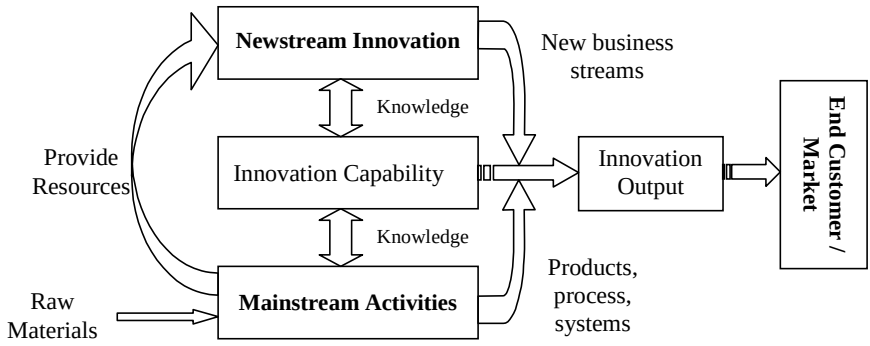

Fig. 2. An integrated model of innovation.

products that are delivered to customers. As customers pay their accounts, part of the money covers the cost of sales; the remainder produces profit or is invested in other parts of the business. Over time the ability of the mainstream to fulfil customer demands will decline as competition intensifies and the product line ages. Constantly decreasing product life cycles and short cycle times mean market leadership can be lost within a short period. The mainstream will therefore invest in the innovation newstream to create the new products, markets, technologies and businesses of the future.

The innovation newstream

The newstream may be conceptualised as all the resources possessed by the organisation that are devoted to identifying and creating new value for customers. Much of the prior research has either explicitly or implicitly viewed firms as autonomous entities searching for competitive advantage from external sources or their own internal resources and capabilities (Gulati, Nohria & Zaheer, 2000). Most studies have focused on looking at the firm and the resources it possesses as the key mechanisms driving innovation (Barney, 1991). Research and development, incremental mainstream investment programs and organisational systems all contributed to the innovation newstream.

However, the pace of technological change and fierce competition means that firms cannot maintain capabilities in all potentially relevant technical and market areas. This has led to increasing research into how firms develop exchange relationships with units and individuals beyond the traditional boundaries of the firm. Networks and alliances of customers, suppliers, competitors and other non-market participants are a key source of innovations (von Hippel, 1988). They are also an effective means of reducing cost, risk, achieving economics of scale and reducing

new product development time. Networks widen the opportunity and access to key resources from the firm's environment, like information, capital, goods and services which then have the potential to maintain or enhance competitive advantage (Gulati *et al.*, 2000). The ability of firm's to absorb knowledge gained through participation in an external network is critical to successful innovation (Cohen & Levinthal, 1990).

Innovation capability

In our model, the newstream is powered by the innovation capability. The innovation capability enables the newstream to act like a funnel seeking, locating and developing potential innovations that can be transferred into the mainstream. This is a key mechanism for self-renewal within the organisation and it's products. An innovation capability brings together the efficiency of the mainstream with the creativity of the newstream. This is achieved through the leverage of their knowledge base (Cohen & Levinthal, 1990). An innovation capability is therefore defined as the ability to continuously transform knowledge and ideas into new products, processes and systems for the benefit of the firm and its stakeholders. Innovation capability is not just an ability to be successful at running a business newstream, or to manage mainstream capabilities. Innovation capability is about synthesising these two operating paradigms. High performing innovators understand this linkage. For example, Dell Computer, one of the most successful start-ups in history, has made its mark providing low cost, quality computer products customised to customers needs. They have been able to combine mainstream management skills with a business model for innovation that has redefined their industry.

Bringing innovation to the market — The business mainstream

The mainstream of the business remains critical. The mainstream is the firm's interface with customers and the market. It is not enough for a company to be highly innovative. There must be controls and management practices in place that allow it to manage the tensions of growth and innovation versus control. A widely held example of the problems faced by these companies is Apple Computer in the 1980s. A highly innovative start-up company, Apple Computers, produced the Macintosh to great acclaim. However, it lacked the mainstream expertise for controlled growth. John Sculley, a former Pepsi executive, was installed with the charter of instilling strong management practices, yet retaining the highly innovative nature of Apple. This transformation nearly tore the company apart with significant problems in new product development and manufacturing processes (Sculley, 1987). The company's

innovative founder, Steve Jobs, also moved from the company during this period. And the tale is not uncommon.

For this reason, we suggest that a balance between mainstream and newstream resources is required for optimal performance outcomes. Moreover, the key requirement for success is the tight coupling of these streams throughout the new product or service development cycle, known as the company-wide innovation capability. This allows innovative companies to produce new products and services in a quality-focused, efficient and responsive manner. Innovation is clearly not just about technical research and development, nor it is something that can be successfully performed in an innovation department or a separate piece of an organisation. Rather, for those who do it well, it pervades all aspects of an organisation's existence, from the core value system to the measures and behaviours that are manifested on a daily basis.

A Case Study in Innovation Capability — Cisco Systems

Cisco Systems Inc. is a world-leader in networking solutions for the Internet. Their ability to harness technology has seen them outpace even Microsoft to become the fastest growing, most profitable company in the history of the computer industry (Cisco Systems, 1999). Cisco Systems was selected as a good illustration of the innovation capability model outlined in this paper. The company has systematically placed innovation at the core of their business, along with a fanatical devotion to customer needs and preferences. At its heart, Cisco is essentially an engine for innovation.

Cisco's operating paradigm has seen them outperform its peers on almost all dimensions of performance since shipping its first product in 1986. The company has averaged 55% per annum increases in net income between 1995 and 2000 (Cisco Systems, 2000). Cisco's market value per employee at March 2001 was $3.4 million relative to their technical peers at $0.8 million. Even during the downturn of first-quarter 2001, Cisco's share price was more resilient than its competitors and revenue per employee more than double that of other industry leaders (Häcki & Lighton, 2001). The strength of Cisco's intangible assets, including their innovation capability, has been recognised by the stock market with a market-to-book ratio of 3.9 times relative to technical-industry peers of 3.6 times.

Cisco has created a clear distinction between the newstream and mainstream components of their business. The newstream in Cisco is fundamental to their business. Cisco recognises that it cannot maintain technological superiority in all potentially relevant technological fields. Thus, Cisco maintains a smaller research and development department than its peers, and uses their strong stock to purchase

promising new technologies and companies. This is their innovation newstream, a combination of some internal product development, but more often than not, purchasing needed technologies from a mix of acquisitions and partnerships.

Similarly, Cisco recognises that its core capability is not in manufacturing. In 1992 it determined that suppliers could add more value than Cisco in this area. It has outsourced around 70% to 80% percent of everything it sells to a variety of suppliers, including Jabil Circuit Inc. and Automatron Inc (Bunnell, 2000). Cisco integrates this network of suppliers into their organisation using knowledge transfer and information technologies, such as intranet and extranet. Cisco was one of the first companies to extend an extranet for communicating with customers, suppliers and partners. Today they have automated their entire manufacturing and shipment process. Furthermore, using such networked applications has enabled their network of suppliers to form what is in effect, a single enterprise. Customer orders flow to the suppliers without the hierarchical systems of parent and subsidiary. By outsourcing most of its manufacturing, Cisco actually pays 30% less than it would cost to assemble the products in-house. A continual stream of new products at a low price, high quality and for a mass market is the result. Many of the finished products sold by Cisco never cross a Cisco building threshold.

What remains after all the outsourcing and "virtual organisation" concepts are applied is the innovation engine of Cisco Inc. Cisco's strength lies in its ability to scan the environment, identify and then develop profitable sources of newstream ideas and innovations. That is its innovation capability. The result is a company that is profitably growing revenues at 55% annually, yet is extremely nimble, efficient and innovative. It is not burdened by the considerable investments in technologies and manufacturing plants of its competitors. Cisco can quickly adapt to changing market conditions, product variations and customer needs. Nor is it committed to one dominant technology. The "not invented here" syndrome, so common in many other large firms is minimal. Thus, as new technology develops, the company will purchase, adapt the technology and capabilities, and integrate them with Cisco's own. The company's lack of organisational commitment to particular technologies allows it to cannibalise product lines in the search for the next innovation adding significant customer value.

What happens if the newstream and mainstream are disconnected?

It is useful to contrast successful, mature "innovation-capability-based" companies with pure "newstream-mainstream" Kanter (1989) companies. Unfortunately, where the newstream and mainstream of the company are disconnected and run independently, then considerable dysfunctional outcomes may occur. Examples abound of this phenomenon. Conventionally, organisations would create new venture

divisions as a way of developing radical innovations away from the bureaucracy of the parent company. The problem is that these start-ups were often treated like orphans lacking the resources and support required for success in their markets. Consequently, the extensive knowledge contained within the mainstream would also remain untapped, forcing the innovators to "reinvent the wheel". Brown & Eisenhardt (1998) describe a case study of a wayward product development effort in the computer software industry. Managers ignored the competencies in the existing mainstream and developed a new product in a new market with new employees. Communication was limited with existing business units, who were themselves too busy maintaining the mainstream. The result was a new product development process that almost sent the company bankrupt.

Furthermore, even if the newstream development effort is "successful", it may still mean millions or even billions in lost profits and opportunities arising from failure to integrate the two streams. The IBM personal computer (PC) project is such an example. The IBM PC was developed in a separate location far from corporate headquarters, and in the process created a new product development process that broke all the rules. However, the teams separation from the mainstream of the business meant they were unable to lever IBM's competencies in computer operating systems and semiconductors. The team therefore turned to outside partners, like Intel and Microsoft, and in the process ceded much of the profit potential available from their efforts (Rosenbloom & Spencer, 1996).

A final example of dysfunctional consequences arising from an inability to transfer technologies from the newstream to the mainstream is the Xerox Palo Alto technology park. The facility made historic advances in many technologies, sometimes creating what would become the dominant design for that industry. Their scientists created the world's first intranet, graphic user interface (GUI) (commercialised by Apple), the mouse and many other innovations. However, Xerox could not exploit their first-mover advantage due to their inability to transfer technologies from the newstream to the mainstream (Miller & Morris, 1999).

Inside the Innovation Capability

This paper proposes the notion of innovation capability. We have used the innovation management literature and case study of Cisco Systems to show how the innovation capability synthesises the newstream and mainstream to achieve effective innovation performance. The next section identifies the elements comprising the innovation capability.

Despite the inherent uncertainty of innovation, there are underlying patterns that can be identified. Tidd *et al.* (1997: 26) argue that "there is some commonality around the things which are managed — the key enablers — in successful

innovation… how these enablers are actually put together variety between firms but they represent particular solutions to the general problem of managing innovation". High performing innovators deliberately and systematically enable and motivate the chaotic, divergent behaviours required for breakthrough innovation. By contrast, less innovative firms promoting random or periodic behaviours may not meet with the same success (Van de Ven, Polley, Garud & Venkataraman, 1999).

The model of innovation capability is therefore aimed at building a theoretical framework highlighting the actions managers can take which most affect innovation success. That is, improving their innovation capability. The literature on innovation management contains numerous frameworks examining the technical innovation audit (Chiesa, Coughlan & Voss, 1996), the new product development process (Clark & Fujimoto, 1991), R&D management and technology acquisition process (Roussel, Kamal & Erickson, 1991) and implementation of production innovations (Voss, 1988). There have however been few attempts using a dynamic capabilities approach to generate a holistic model of innovation capability within the firm. The model of innovation capability developed in this paper is shown in Fig. 3. The model assumes that the organisation is focused on innovation and innovation outputs as their primary competitive strategy.

Innovation capability itself is not a separately identifiable construct. The capability is composed of reinforcing practices and processes within the firm. These processes are a key mechanism for stimulating, measuring and reinforcing innovation. The elements making up an innovation capability are grouped into seven major elements. These elements have been built up from the literature on the management of innovation, as well as best practice models, such as the

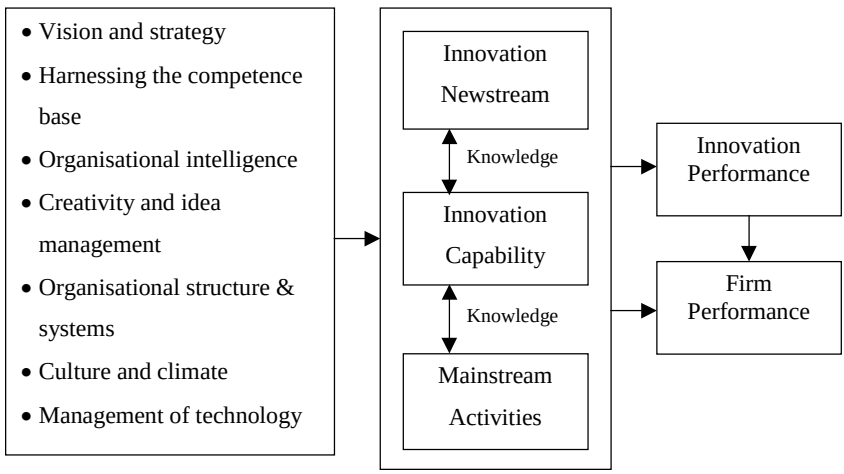

Fig. 3. A model of innovation capability.

Baldrige Quality Awards. It was also informed by studies of innovative firms. We note that there is no clear agreement of what the real variables of innovation capability might be, and that there are likely to be disagreements as to how best "cut the innovation cake". A holistic model of innovation capability will thus attract debate about the categorisation of elements, but it is a necessary step in order to facilitate analysis and construction of an innovation framework. The following elements are proposed to exist, to some degree, within innovative firms. They are vision and strategy, harnessing the competence base, organisational intelligence, creativity and idea management, organisational structure and systems, culture and climate, and the management of technology.

Innovative firms lever these elements to integrate and manage both their newstream and mainstream activities in an effective manner. The innovation capability will influence the configuration of newstream and mainstream activities leading to continuous product, process and systems innovation. The stronger the innovation capability possessed by a firm, the more effective will be their innovation performance. The literature also indicates a positive relationship between innovation performance and enhanced firm performance. Empirically, it is shown that innovative firms are more profitable and valued at a premium by the share market relative to their less innovative counterparts (Figg, 2000; Jonash & Sommerlatte, 1999; Roberts, 1999). Anecdotal evidence supports the existence of such a relationship as well. For example, Akio Morita, the founder of Sony attributes the company's success to its ability to innovate (Morita, Reingold & Shimomura, 1986).

The core elements of innovation capability are discussed in detail in the next sections.

Vision and strategy

The link between vision, strategy and innovation is important to effective innovation management. Strategy determines the configuration of resources, products, processes and systems that firms adopt to deal with the uncertainty existing in their environment. It requires that firms make decisions about what businesses and functions they should be performing and in what markets. Successful innovation requires a clear articulation of a common vision and the firm expression of the strategic direction. This is a critical step in institutionalising innovation. Without a strategy for innovation, interest and attention become too dispersed.

The most innovative companies seek to be "the best of the best". Their employees have clarity of purpose and issue a challenge to find totally new ways of doing things in order to achieve the goal. For these companies, innovation is more than benchmarking. They do not try to succeed simply by matching others.

Instead, they create a vision, a target which if achieved will create products that outperform and provide a distinct market position. For example, researchers at Canon were asked to envision a personal photocopier that everyone could afford. The results were radically new technologies and manufacturing techniques that enabled Canon to dominate the market virtually overnight (Miller & Morris, 1999).

Innovation strategy is critical in directing organisational attention. In general, organisations that adopt an offensive strategy of trying to create the future (as opposed to protecting the past) are more innovative. The success of companies who broke the rules of their industry through innovation — with or without technology — and went on to become a dominant player has been well-documented (Hamel, 1998; Kim & Mauborgne, 1999; Markides, 1997; Markides, 1998). These companies were able to stimulate demand, expand existing markets and create new ones through an accessible and competitive market price. The ability of the innovation capability to integrate newstream and mainstream is therefore ever more important. The newstream enables the creation of new products and services while the focus on lowering costs and improving quality reinforces the need for strong mainstream capabilities.

Harnessing the competence base

The ability to correctly and effectively direct resources to where they are required has long been recognised as critical to innovation success (Burgelman & Maidique, 1988). Important variables include resource management, availability of funding channels, innovation champions and the adoption of e-business principles.

Resource management

Innovative organisations are able to lever, combine and recombine knowledge and resources into disparate markets, technologies and products — a capability few firms have mastered. The CEO of Pfizer Inc, William C. Steere, Jr., states that their ability to compete with new products is "critically dependent on integrating advances in many other fields" (Porter *et al.*, 1999). Effective resource management helps increase the number of innovation initiatives and improves the probability of stimulating innovation. As firms successfully manage innovation, they accumulate experience and learning, supporting still further improvements.

Variety of funding channels

Innovative firms employ a variety of funding channels to encourage risk taking and entrepreneurship. For example, 3M product managers can request funds from their

own division, corporate research and development, or the new ventures division. Such measures help retain innovations and their champions who would otherwise leave the company.

Innovation champions

Successfully mobilising resources requires the support of key individuals at various stages of the innovation process to act as technological gatekeepers, business innovators or organisational sponsors (Tidd *et al.*, 1997).

E-business

E-business has considerable potential to enhance the innovation process. Traditional uses of IT have often been aimed at performing the same function better. Organisations adopting e-business have huge scope for innovation to discard old processes, diffuse local innovation globally, remove constraints to innovation and create entirely new innovative practices and models (Metz, 1999). E-business may also radically alter knowledge management within organisations and outside to their external networks. Product development could become an on-line process reducing the need for physical proximity, linking knowledge competencies worldwide, aiding process efficiencies and increasing speed to market.

Organisational intelligence

Organisational intelligence has been defined as "the capability to process, interpret, encode, manipulate and access information in a purposeful, goal-directed manner, so it can increase its adaptive potential in the environment in which it operates" (Glynn, 1996: 1088). Since knowledge and ideas are primary imports into the innovation process, intelligent firms can use this information to reduce the inherent uncertainty and ambiguity of innovation. It allows them to identify new avenues for investigation and to more quickly eliminate unprofitable options. This relies on being able to generate, communicate and act on the most relevant, up-to-date information available about their environment. For example, Saleh & Wang (1993) show that high-performing innovators proactively used environment scanning, technological forecasting and competitive analysis toward this goal.

Organisational intelligence is primarily about learning from customers and learning about competitors. Burgelman & Maidique (1988) highlight the critical importance of understanding both competitors and markets to innovation management.

Learning about customers

Innovators create an awareness of customers — both internal and external — which extends throughout the organisation. Employees are actively encouraged to search out customer needs and problems, both known and latent, in order to solve them in a value adding manner. This frame of mind is illustrated by the following quote by a manager at 3M, "If you are working on a next-generation medical imaging device, you'll probably talk to radiologists, but you might also sit down with people who enhance images from interplanetary space probes" (Coyne, 1996).

Various techniques have been used to generate more accurate customer information and insight into their problems. A major approach to understanding customer needs has been lead-user innovation (von Hippel, Thomke & Sonnack, 1999). Companies focus on their most demanding customers and attempt to innovate to solve their problems thereby creating a product or service which is likely to add value to the vast majority of customers with less stringent requirements. Moreover, Leonard & Rayport (1997) illustrated how skilled observation of customers in everyday settings could be used to stimulate innovation and solutions to problems which customers were not even aware existed.

Learning about competitors

The process of generating, learning and applying knowledge about competitors' products and strategies is also critical. The competitive intelligence literature states that competitor learning plays two significant roles in product competition: position diagnostic benchmarking and position advantage building (Day & Wensle, 1988; Dickson, 1992). A firm with superior competitor information can use this knowledge to advantage. First, it can apply its strengths against a rival's weakness, internalise competitors' strengths by imitation and improvement or discount the strength of others by differentiating their products.

Creativity and idea management

Creativity operates along a continuum. It can come from the millions of small acts by employees that cumulates in significant continuous improvement, or alternatively, creativity can result in a radical idea that transforms business strategy or creates new businesses. Organisations need to encourage creativity right along this continuum and at all levels. Creativity requires divergent thinking of what may be unrealised, unproven or untested. It may be knowledge-driven (how do we apply new knowledge?) or vision-driven (this is our goal, what new knowledge do we need?). Creativity may be viewed as the process of generating ideas.

Structures and systems

Successful innovation requires an optimal overall formal business structure (Burgelman & Maidique, 1988). Unless this structure and its resulting processes are conducive to a favourable environment, other components of the innovation system are unlikely to succeed. Further aspects of structures and systems for innovation are discussed below.

Organisational structure

As businesses grow there is a tendency to add layers, becoming more mechanistic and institutionalising bureaucracy (Kanter, 1983). High performing firms motivate and enable innovative behaviour by creating permeable business boundaries helping break down the barriers separating functions, product groups and businesses (Ashkenas, 1998; Maira & Thomas, 1998). The more permeable and organic the structure, the greater the potential for innovative ideas to spring. For example, 3M keeps divisions to less than $200 million in sales, while Hewlett-Packard limits division size to 1,000 employees.

Reward systems

Reward systems are a powerful motivator of behaviour and therefore, key to successful innovative activity. Saleh & Wang (1993) found significant difference in the entrepreneurial aspects of reward systems used by highly innovative against low innovative firms. Highly innovating firms constructed a reward system fostering creative behaviour, including the "dual ladder" system, suggestion schemes, public recognition and financial bonuses.

Managers do need to be aware of the effects of reward systems on behaviour. An improperly focused system encourages people to act in potentially unintended ways. For example, Angle (1989) found that individual rewards tend to increase idea generation and radical innovations, while group rewards tend to increase innovation implementation and incremental innovations. Further, Mezias & Glynn (1993) found that without explicit support to the contrary, managers are likely to adopt a less risky course of action and focus on developing incremental variations of existing products. This approach would not stimulate radical innovation required to create new markets and alter the basis of competition.

"Stretch" goals for innovation

Firms can also set high-difficulty stretch goals for their employees to help institutionalise the drive for innovativeness. For example, 3M are notable for setting

reaching goals like 30% of all sales from products introduced in the past four years, and 10% of sales derived from products in the market for less than one year. This forces a bias for innovation upon all employees, particularly where executive compensation is explicitly tied to achievement of these targets.

Culture and climate

The appropriate culture and climate within the organisation is also vitally important to innovation success. The components underlying the culture and climate construct are tolerance of ambiguity, empowered employees, creative time, and communication.

Tolerance of ambiguity

Many studies have identified the willingness to take risks as a preferred behaviour for innovative firms (Saleh & Wang, 1993). Innovative firms do not, however, take unnecessary risks. They tolerate ambiguity, but seek to reduce it to manageable levels through effective information management and tight control over project milestones. It is akin to the analogy of a horse race, where the innovative firms narrow the odds to a horse and waits until the last possible moment to bet their money. When failure and mistakes do occur, innovative firms learn the lessons and do not hide them from corporate view. They have generally incorporated a systematic process for reviewing failed projects as a valuable opportunity to learn and improve (Grady *et al.*, 1993).

Empowered employees

One of the best ways of developing an open innovative culture is to respect and invest in people. Management hire the best quality researchers, experts and inventors, and then empower them. Management recognise that these employees may have different visions for the future and seek to incorporate these views into their innovation direction.

Expect creative time

Innovators need sanctioned time to think, or "creative slack". Often managers and employees are caught up in short-term operational challenges and do not have time for "blue-sky" thinking. Organisations can institutionalise a little innovation by providing employees with time, funding, facilities and a creative environment. For example, at 3M all technical employees are allowed to devote 15% of their time to a project of their own invention. The important message is "if you have a good idea, and the commitment to it, then there is slack in the system" (Coyne, 1996).

Communication

Communication within the company and its network of firms is necessary to achieve innovation and learning outcomes. Communication facilitates knowledge sharing by combining the wide variety of experiences, opening dialogue, building on others ideas and exploring issues relevant to innovation. Innovative firms reward cross-functional, cross-hierarchical, cross-cultural and cross-technological exchange of information and knowledge. They recognise that it is not just the original technology or discovery which is important, but also the ability to combine it with other disparate technologies.

Management of technology

The management of technology is crucial to today's organisations. The shift toward external networks and leveraging the entire corporate knowledge base has meant we are more concerned with the management of technology within the overall organisation, rather than research and development per se (Fusfeld, 1995). A number of authors have developed "technological competence audits" allowing firms to assess their technological capabilities, needs and possibilities against overall business objectives (Bessant, 1994; Coombs, 1994).

Innovative firms are able to link their core technology strategies, with innovation strategy and business strategy. This alignment generates a powerful mechanism for competitive advantage. Roberts (1995) in a global survey of 109 firms found that the effectiveness of the linkage between technological strategy and business strategy was a major determinant of R&D performance.

Effective forecasting helps organisations to identify future developments in technologies, products and markets, generate more refined information, reorient the company to avoid threats or grasp new opportunities and to improve operational decision making (Burgelman & Maidique, 1988). A number of methodologies have been developed to aid technology forecasting, including the Delphi technique, scenario planning and the analytical hierarchy model.

Conclusions and Future Directions

This paper proposed the construct of innovation capability to describe the ability of high-performing innovators to achieve effective performance. The notion of capability is useful to apply to innovation as it is the capability to innovate that creates the potential for firm-wide behaviours leading to systematic innovation activities within the firm. We have determined from the literature that innovation capability can be considered to have some seven aspects, namely vision and

strategy, harnessing the competence base, organisational intelligence, creativity and idea management, organisational structure and systems, culture and climate, and the management of technology. It is proposed that organisations that consciously and explicitly develop and invest in these aspects of innovation capability, individually and collectively, have a higher likelihood of achieving sustainable innovation outcomes as the engine of their business performance.

This paper has highlighted the need for further rigorous investigation of innovation and its antecedent variables. Many previous studies have looked at only a thin slice of what makes for an innovative organisation, or else have proposed a "black-box" solution to innovation, such as Kanter's newstream. This paper illustrated the importance of adopting a holistic company-wide approach to the management of innovation, incorporating both the mainstream and newstream.

The concept of innovation capability identified in this paper can be refined, validated and tested using other research methods, including case studies and surveys. Through the application of scientific methods of investigation to this concept, further progress will be made in unlocking and analysing the complexities of organisational innovation processes, and the business performance that results. Detailed exploratory case studies can provide richer, more textual background into innovation variables. Given that practitioners are often ahead of academic practice, this provides opportunity for new data and raises the basis of new research questions. Survey research will help make generalisations about the innovation process. This article has integrated disparate literatures and uses a single case study to progress development of an innovation capability construct.

Further research should be directed at identifying and refining measures for different forms or degrees of innovation capability. For example, there may be different emphasis on elements required for radical versus incremental innovation. This would provide a fuller picture of innovation within organisations. The innovation capability construct has the potential to be developed to make a significant contribution furthering knowledge in the management of innovation.

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