A Learning Laboratory Approach for Business Improvement: The Case of Discontinuous Innovation

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ABSTRACT

This paper considers the current situation within Australian manufacturing SMEs and their approaches to innovation and international competitive advantage. Using the viewpoint and language of complexity theory, we consider the variety of possibilities available to SMEs in this area. We then consider a particular international project on Discontinuous Innovation, how this has been deployed in Europe and Australia and the knowledge gained from our interactions with Australian SMEs to date around this project. Finally we consider the general development of a "Learning Laboratory" approach to working with SMEs and the differences required to make such approach successful in Europe and in different settings in Australia.

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Keywords: Discontinuous innovation; Manufacturing technology; Operations improvement; Organisational performance; Learning networks; Action learning

INTRODUCTION

Manufacturing in Australia is under intense pressure due to rising costs, increasing import competition due to globalisation and tariff reductions, unfavourable exchange rate movements and an increasingly sophisticated and quality-conscious consumer. Even though exports have continued to rise, manufacturing net exports (exports minus imports) as a share of manufacturing value added, after remaining relatively constant from the late 1980s to the mid 1990s, declined sharply from the late 1990s to the present. The export performance of Australian manufacturing which surged over the 1980s and 1990s has deteriorated markedly over the last seven years. For example, the annual average rate of growth of expenditure on machinery and equipment, and scientific equipment increased by 15 per cent and 19 per cent respectively between 1986 and 1994. This rate of growth declined to just 2 per cent and 3 per cent respectively between 2000 and 2006 (House of Representatives 2007: 15). More broadly, exports of elaborately transformed manufactures (ETMs) have stagnated since 2000-01 whilst imports of ETMs have increased by more than a third.

These statistics point to long run declining international competitiveness. The increased share of local demand met by imports is constraining the growth of local output. Between 2000-01 and 2005-06 the

real value of manufacturing output increased by just 5.3 per cent compared to overall economic growth of 17.6 per cent (ABS 2006b).

Past experience would suggest that increased investment in innovation would support productivity improvement. Yet Australia's manufacturing export decline occurred despite increases in key inputs to innovation including R&D and capital investment. The R&D intensity (R&D expenditures as a share of value added) of Australian manufacturing industry has increased markedly over the last four decades (albeit with a period of stagnation between 1995-96 and 2002-03) to achieve its highest level of 4 per cent in 2005-06. Clearly, something has to be done differently. There is continuing growth in the global economy as the world population increases and developing countries become wealthier. Perhaps the answer is for Australian firms to be more innovative in the ways they do business, and where they do it, to supplement the available technological innovation initiatives.

One method of sorting through the many and varied improvement options for manufacturing firms being adopted in Europe is the use of a "Learning Laboratory" approach involving a number of non-competing firms and facilitated by an external party (often a University, or similar research institution), whereby the firms learn from each other and the facilitator through presentations, simulations, and group discussions. Ideas and outcomes are distributed to all participants by the facilitator and then the participants share the knowledge through their own firm. The aim of this conceptual paper is to present some observations and conclusions about learning and innovation from a particular international "Learning Laboratory" research program entitled DI-Lab (Discontinuous Innovation Laboratory). This international project involves academic and industry groups working together to identify tools that will help identify emergent discontinuities and frame innovative responses to them. We compare the learning approaches to complex adaptive systems and examine differences in the required approach between European and Australian firms.

OPPORTUNITIES FOR INNOVATION

The firms involved in the DI-Lab project are prepared to accept discontinuity as a fact of life, but they are not just concerned about technological discontinuities. Christensen (1997) has observed how technical discontinuities that change the dominant design can force some firms out of business. He

has also observed that some elements of infrastructure which he characterizes as resources, processes and values can influence what a firm can and cannot do in response. We have noted earlier that changes in external infrastructure (financial and labour markets) may combine to create a discontinuity where past practice is no longer viable. Kim and Mauborgne (1997, 2005) promote the idea of "value innovation" to establish new market spaces in a very competitive environment.

Individual firms may innovate through an interaction between technology, infrastructure and markets. For example, a Danish DI-Lab participant, Lego established the dominant design for a model construction toy around 50 years ago, but in recent years, sales were falling. It was observed that children were spending more time playing computer games than playing with building blocks. In response, Lego set up a simulation on the internet for children to create novel models. The model was listed under the creators name along with traditional models, and people can order a set of components to make the model in real life. This initiative was a new kind of interaction between infrastructure (the internet and the Lego logistics system) and the market that did not involve technological change. In a very different industry, but adopting a similar approach to an established market, one of the authors of this paper has been involved in a project where new technology is being developed, coupled with an innovative approach to several elements of infrastructure needed to support the product in the field. In Table 1 we outline some combinations of new and existing technologies, infrastructure and markets that characterize different forms of innovation.

At the top of the table radical innovation is associated with high levels of uncertainty – living on the edge of chaos. At the bottom of the table, incremental innovation is associated with known technologies, infrastructure and markets – although we may combine them in unique ways – we are living on the edge of stability. Operating between these two extremes is an attribute of complex adaptive organizations (Carlisle and McMillan, 2006).

Table 1 Different Forms of Innovation Related to the Innovation Focus

The Nature of the Innovation Process	Focus of Innovation		
	Technological change that may influence the dominant design (eg DVD replacing videotape) or changes in the dominant design that requires new technologies to be embraced (eg ICT in automobiles)	**Changes in internal or external infrastructure** that requires new developmental or market pathways (eg new regulations) or changes in the nature of technology/market interactions that requires new infrastructure (eg selling on the internet)	**Changes in user needs** that create new markets (eg confronting environmental issues) or the interplay between technology, infrastructure and markets that creates new needs (eg wireless communications)
Radical innovation – on the edge of chaos	New	New	New
Delivering new solutions to existing problems in new ways	New	New	Existing
Value innovation – meeting new needs through new ways	New	Existing	New
Venture capital territory: growth through technological innovation	New	Existing	Existing
New pathways to new markets	Existing	New	New
New business models, leverage from new infrastrucutre	Existing	New	Existing
Application adaptation	Existing	Existing	New
Incremental / recomb-inant innovation – on the edge of stability	Existing	Existing	Existing

The Toyota auto company provides an illustration of this, relentlessly pursuing incremental innovation through lean manufacturing practices, whilst at the same time introducing radical products like the Prius petrol/electric hybrid for which there was little market demand when it was first launched, and which required new maintenance infrastructure to be established. Today, more than one million Prius cars have been produced and the demand is increasing, being driven by climate change and fuel price considerations. In the wisdom of hindsight we can see that Toyota correctly forecast where initially weak trends might lead. Toyota have "agents" within the firm that are taking quite different innovation journeys, some of which may be successful, some not, but their collective actions lead to the emergence of new innovation pathways – another attribute of complex systems. Within Toyota and its supply chain there are strongly enforced but relatively simple "order-generating local

rules" – another attribute of complex systems. The rules are not the same in all parts of the organization, but they combine to represent "the Toyota way". Within operations functions there are rules associated with lean manufacturing that are flowed down to suppliers. Within the R&D parts of the company there are norms that tolerate ambiguity and the formation of multi-discilinary teams.

INNOVATION AND COMPLEX ADAPTIVE SYSTEMS

McCarthy et al (2006) have considered the iterative nature of more radical new product developments, and observed elements of agency and structure that combine to exhibit three characteristics of complex adaptive systems: non-linearity, self-organisation and emergence. Interactions between agents resulted in learning and the creation of new rules, structures and behaviours. Cheng and Van de Ven (1996) studied the development process of two biomedical innovations using ideas from chaos theory. They used mathematical analysis tools to explore the development of and interactions between action and outcome events and environmental events.

> *By uncoupling actions and outcomes, a chaotic process facilitates the construction of repertoires of action experiences, outcome beliefs and contextual practices. These repertoires increase an organizations capacity for creative learning. The coupling of actions and outcomes narrows the repertoires to those that satisfy the linear combination of feasible actions and desired outcomes.* (Cheng and Van de Ven, 1996).

Webb, Lettice and Lemon (2006) also present the view that interpretations of complexity science are useful in understanding the process of innovation and learning associated with it, citing the work of Rose-Anderssen, Allan, Tsinopoulos and MCarthy (2005) and Harkema (2003). They further observe that learning about complexity science can be a daunting task, and reviewed a variety of mechanisms for facilitating such learning. Webb et al (2006) also considered that both experiential and cognitive activities were required, and developed a strategy where ideas were absorbed over time with interactions that facilitated sense-making.

DISCONTINUOUS INNOVATION

"Discontinuous Innovation" is considered herein to incorporate 'disruptive' and 'radical' innovation as discussed by others (Christensen, 1997; Leifer et al, 2000:1; Tidd et al, 2005:13). Innovation is

considerably more difficult when elements of discontinuity come into the equation. Such discontinuous challenges arise from shifts along technological, market, political and other frontiers and require new, or at least significantly adapted, approaches for effective management. Businesses need to understand the particular contexts in which different approaches might help, and what configurations of new and existing practices might enable organisations to deal with and benefit from such discontinuities. The increasing pace of change in technological, regulatory, environmental and global market developments is forcing firms to consider the strong possibility that discontinuity will almost certainly change the basis of the business sooner or later.

We contend that companies – or at least part of them – are often aware of emergent discontinuous innovation that will have a disruptive effect on their business. The trouble is that it may not be taken seriously enough, or by the time it is taken seriously, it is too late because of the timeframe and/or the amount of change needed. Christensen (1997) points to the blindness, hesitation, and incapability of management and organizations to change. Many other authors have written about cycles of continuous improvement disrupted by major changes (Imai, 1986; Adizes, 1999; and Churchill and Lewis, 1983). Even Schumpeter (1934) spoke of periods of temporary advantage punctuated by periods of destruction. Following March's (1991) concepts we believe companies need to maintain a balance between exploitation activities (continuous improvement, steady-state innovation) and exploration activities (searching for and reacting to, or creating, discontinuous innovation). Other authors have also discussed the difficulty of balancing the exploitative and explorative actions within the one company structure (DeTienne and Koberg, 2002; Boer and Gertsen, 2003; Benner and Tushman, 2003; Andreassen et al, 2007).

THE DI-Lab PROJECT

Overview

In trying to address the issues of how to recognize and perhaps benefit from discontinuities, European researchers have used networks of firms acting as a community of practice, or "co-operative laboratory" for articulating key research issues around discontinuous innovation, sharing experiences and developing and implementing experiments to develop new routines for dealing with it. The DI-Lab project was initiated by Professor John Bessant in the UK and expanded via a network of

researchers in several countries facilitating and researching interactively with learning networks of firms interested in a deeper understanding of, and sharing knowledge and experiences regarding, the challenges of Discontinuous Innovation. The DI-Lab Network currently involves firms and researchers in 10 countries.

Experience with a Discontinuous Innovation Forum (an experience-sharing network of around 25 firms funded by the UK Department of Trade and Industry) had demonstrated the potential for sustained involvement in this style of network. Other countries, including Denmark and Germany have established similar learning networks of firms. Within and across these networks, the firms involved are developing systematic structures for comparing and sharing experiences and articulating research issues. A 'benchmarking framework' is being developed that will allow firms to identify potential sites for learning from and with each other around the development of discontinuous innovation capabilities. The University of Western Sydney and Monash University have been involved as collaborative partners in establishing an Australian network as part of this project.

DI-Lab Methodology

The following approach has been adopted in forming and operating a DI-Lab group in Germany, and a similar approach is taken in most countries.

Contact with company delegates is mainly based on personal networks of team members. Often the person is invited to join the DI-Lab for one workshop and if they felt that someone else of the company could also be interested or be more relevant to the topic they asked them to join. Therefore we have a combination of participants from different hierarchy levels depending on the firm's organisation. According to the DI-Lab idea we followed the topic sequence of Search-Select-Implement. We spent one year on each topic. Each year we had two national workshops (one-kick off workshop and one workshop to dive deeper into the topic) and one international benchmark event. For the selection phase we had one additional workshop as we felt the topic to be not satisfyingly exploited after the conference in Munich. In between the workshops there should be time for research. At the moment this happens on a very informal level in Germany.

Firstly, the German research team determines the topic of the workshop. Then we gather ideas about "what do we want to present" and "who could present". We try to integrate industrial speakers who report about their best practice and their experience, and

academics who present methods related to the topic or results of their reseach. Also, we try to have an interactive element in each workshop - either an experiment or a discussion.

We try to spread the workshops over the year so that it is not too much for our delegates to participate in each workshop. The date of the workshop must fit all research team members, which is often difficult. Moreover we have a pretty broad base of companies, so we do not ask participants for their preferences. As the UnternehmerTUM is organizing and financing all German workshops they take place in Munich - generally where the UnternehmerTUM is located. 10am to 4pm, including coffee breaks and lunch has been a good model for the workshops. This was a very nice atmosphere to get to know them better. (DI-Lab Researcher from the Technical University of Munich)

In addition, a standard questionnaire and structured interview approach was used in all participating countries to help understand current practice in participation firms. Topics included:

- Learning about markets for discontinuous innovation
- Managing radical idea generation
- The existence of an entrepreneurial environment
- Culture support system for discontinuous innovation
- Helping employees solve their problems with discontinuous innovation
- Project management for discontinuous innovation
- Network management system for discontinuous innovation
- A flexible strategy for discontinous innovation
- Openness to external sources for discontinuous innovation
- Transitioning discontinuous innovation projects to operations
- Using alternative metrics for discontinuous innovation
- A venture capital system for discontinuous innovation
- Acquiring funding for discontinuous innovation

In total, about seventy questions were asked and discussed during the interviews. When the results were pooled, some patterns emerged, and a report was prepared for each firm showing how their responses compared with the pooled averages.

RESULTS AND DISCUSSION

At the time of writing, twelve search strategies had been identified in the DI-Lab project to help companies maintain an awareness of potential discontinuities, and twelve selection strategies had been identified. Some of these strategies such as probe and learn, and build alternative visions are

consistent with practices for working in complex or chaotic environments. For example, Snowden (2005) has observed that different strategies might make sense depending upon the particular context:

- In the a context of underlying order (but observable disorder), look for hidden order using a process of data collection and analysis, and if found, implement an established practice to re-establish order
- In a context of underlying complexity, seek out " attractors" that have led to the state of unbalance, understand how they might interact, and anticipate some possible outcomes
- In a context of underlying chaos, try out an idea, drawing on past experience, intuition, or suggestions from a trusted source, and look for emergent patterns that inform the next decision

In Table 2 we have compared some aspects of complex adaptive systems with the DI-Lab approach. We suggest that the two show reasonable correspondence in a similar way that Webb, et al (2006) found the learning strategies, styles and preferences that they reviewed to develop ways of teaching about complexity were "…..found to correspond with various aspects of complexity science…". It would seem that learning itself is a complex adaptive process.

Table 2 Aspects of Complex Adaptive Systems Compared to the DI-Lab Approach

Aspect of Complexity	DI-Lab
Living between the edge of stability and the edge of chaos	The firms involved are generally regarded as innovative, but most are at the incremental innovation end of Table 1. Having said that, one Australian participant firm was concerned about retaining its capability to manage at the edge of chaos as it grew. In broad terms, most participants are searching for ways to innovate in more than one area simultaneously (see Table 1)
Emergence	The DI-Lab project does not presume a pre-existing Best Practice will emerge. The intention is to identify a number of tools that can be utilized at different times to support individual firms in developing their own practices through experimentation
Adaptation and evolution	Participants are encouraged to report back on their experiences with use of the toolkit developed and contribute other relevant observations in an interactive shared space. Combined meetings of individual national groups are held to share experiences. A culture of cooperation and continuous learning is encouraged.
Unpredictability and non-linear dynamics	Non-linear effects arise from chance interactions that cause a departure from current paths. Having participants from a variety of industry sectors in a number of countries increases the potential scale and scope of interactions that can initiate non-linear trajectories.
Diversity and order-generating rules	The DI-Lab arrangements do not require participants to work on a particular aspect of discontinuous innovation together. Participants are encouraged to try out ideas as independent agents. However, the whole idea is to develop tools, the use of which may be framed as introducing order-generating rules
Sensing "attractors " and pattern recognition	The DI-Lab Search stage tools are intended to help discover ideas, trends and opportunities that provide a scope for some form of innovation. The selection stage tools are intended to help frame business cases and ways forward in an environment of uncertainty. The implementation tools are intended to support the survival and growth of emergent innovations in a potentially hostile environment.

In Australia, two DI-Lab workshops were run in Sydney, and one in Melbourne. Except for one large telecommunications firm, the Australian firms were smaller than those in overseas groups. Two academic visitors from the European groups (one from the UK and one from Denmark) visited Australia and gave presentations on what had been learned to date there. From our direct observations and discussions with these visitors, we noted differences between the function of the Australian group and the European ones. The (smaller) Melbourne workshop rapidly developed a very interactive style, with considerable discussion between the slides presented by one of our overseas visitors. Unfortunately, we did not have the foresight to record these very rich discussions. The Sydney workshops followed a more structured path with presentations followed by focus group activities and report-back. Some notes from the focus group activity were retained. In our view the more interactive style suited the smaller firms better. In addition, from our experience with other projects, one has to make personal feed-back visits to SME firms (rather than simply sending out a written report), and at that stage, they are often prepared to share their views more comprehensively. However this requires a higher level of facilitation effort.

Many of the European firms had already started working on discontinuous innovation initiatives before the DI-Lab project started, and some firms established project teams to try out the DI-Lab ideas and report back. This was not the case with the Australian firms. The impression gained was that many European firms had started to embrace complex adaptive systems practices, but most Australian firms were lagging in this respect. Having said that, the larger European firm representatives felt there was a strong internal resistance to embracing anything to do with discontinuous innovation, with fear at a personal level underlying much of it. A workshop report commented: “A discontinuity often threatens individuals deeply held beliefs (cognitive dissonance) and can threaten their ‘professional feeling of worth’ considerably by promoting a different skill set”. We suspect that the smaller Australian firms have a stronger orientation towards learning-by-doing, but this was not practiced in the DI-Lab context. What the Australian firms appreciated was an opportunity to help them think about the world differently.

The complex world of discontinuous innovation involves operating in an environment of greater uncertainty and working with imagined futures rather than concrete market statistics and known technologies. Scharmer (2000) considered two questions in relation to knowledge in emergent situations: "what kind of knowledge does it take to sense and actualize emergent market opportunities?" and "what processes allow for generating this form of Knowing?" He characterised twelve types of knowledge that support the actions of organisations as shown in Table 3. Two kinds of tacit knowledge are referred to as embodied (tacit) or yet-to-be embodied (self-transcending).

Table 3 Types of Knowledeg Supporting Orgnisation al Action (from Scharmer, 2000)

Action type	**Epistemological knowledge type**		
	Explicit	Tacit	Self-transcending
Performing: delivering results that create value	Know-what	Knowledge–in-use	Reflection-in-action
Strategizing: improving the process-based context of performing	Know-how	Theory–in-use	Imagination-in-action
Mental modelling: reframing the assumption-based context of performing	Know-why	Metaphysics-in-use	Inspiration-in-action
Sculpturing: reconceiving the identity-based context of performing	Know-for	Ethics/Aesthetics-in-use	Intuition-in-action

Scharmer (2000) suggests that performing actions directly support customer-driven value creation whereas strategizing, mental modelling and sculpturing represent streams of contextual action that improve the context and qualities of performing. In this context we suggest that those engaged in discontinuous innovation draw on self-transcending types of knowledge to reflect, imagine, inspire and to develop intuition. Thus, it concerns knowing about the originating sources for doing things, for example understanding the attractors in a complex, un-ordered environment. It draws on both external views of objective reality and internal views on enacted reality. The European DI-Lab feedback suggests a need for reframing mental models in some firms. Snowden (2005, p 48) observes:

> *Introducing complexity thinking systems is not easy. Within our centre, it has taken some five years of active experimentation to develop methods that do not readily relapse into the conventions of order. The retrospective coherence of complex systems can easily be used to provide false evidence of order. In other words, hindsight is a common sin in the process of strategy.*

If this experience is representative, then the DI-Lab project still has considerable work to do.

Scharmer (2000) discusses what facilitates the creation of not-yet-embodied knowledge. He introduces the Japanese concept of *Ba,* (attributed to Nishida, 1992) that can be thought of as a shared mental place for emerging relationships. Through an action research project, Scharmer observed three activities used to "organize and strategize around not-yet-embodied knowledge" (p49):

- Shared praxis – shared experience that enhances the nature of relationships
- Shared reflection on common experiences that supports a sense of community
- The formation of shared will, emerging when "participants come together to articulate a sense of shared commitment and will" resulting in "communities of commitment" (p50).

It seems to us that these concepts establish some general requirements for an effective learning laboratory related to topics of a complex nature.

CONCLUSIONS AND IMPLICATIONS

In this paper we have suggested that many Australian (and other) firms have to embrace the innovation landscape on a number of fronts as "steady-state" technological innovation (Tidd et al, 2005) alone may not be sufficient to retain a competitive market position. More radical forms of innovation may be necessary, with associated increases in levels of uncertainty and complexity, and notions of organizations and projects behaving like complex adaptive systems were briefly introduced. A particular project aimed at identifying tools that support disruptive innovation, DI-Lab, has been described and some of its attributes were compared with those of a complex adaptive system, leading to the following suggestions:

- The learning laboratory approach taken in the DI-Lab project is like a complex adaptive system itself;
- The type of new knowledge produced is more concerned with imagined futures rather than more tangible ones based on a continuation of current norms, and the creation of this type of knowledge requires a special kind of space.

Some suggested considerations for practitioners and facilitators establishing a learning laboratory emerging from the discussion presented earlier are summarised in Table 4 in terms of elements of structure and agency. DI-Lab is an international project, with collaborating groups working in several countries in Europe and one in Australia. It was noted that the way the Australian firms participated

was different from the way the European firms participated, and this could be the topic of further research.

Table 4 Suggested Considerations for Establishing a Learning Laboratory

Emergent Capabilities	Specific Focus	Outcome to be Facilitated
Elements of Structure	Tools and methodologies	Tool Identification/development. In the DI-Lab case these were concerned with search, select and implement related to discontinuous innovation
	Place/Space	The concept of *Ba* – creating an interactive shared space for emerging ideas and relationships
	An Iterative Strategy	Taking action to look for subsequent emergent patterns in an environment that seems chaotic
Elements of Agency	Interaction between agents	Enunciating shared experience from multiple perspectives
	Both Experiential and Cognitive activities	Ideas absorbed over time with interactions that facilitiate sense-making
	Sense-making	Shared reflection on common experiences
	The creation of "not-yet-embodied" tacit knowledge	Knowledge about attactors and trends stimulates imagination and the development of intuition

From the limited experience gained, we consider that the learning laboratory idea is a good way of working with SMEs, but in Australia it needs a more personalised approach, possibly with higher levels of facilitation than the European model. The differences noted may simply be related to smaller size of the participating Australian firms, but there is some anecdotal evidence that this is not the only factor, with cultural and societal factors also contributing to required differences in approach for Australian SMEs.

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