



---

## **Entrepreneurial capacity and the new technology-based small firm**

*A paper for the Small Enterprise Association of Australia and New Zealand 16<sup>th</sup> Annual Conference,  
Ballarat, 28 Sept-1 Oct, 2003.*

John Yencken  
Research student and PhD candidate  
Australian Graduate School of Entrepreneurship  
Swinburne University of Technology  
PO Box 218  
HAWTHORN VIC 3122  
Tel: (03)9214-5870  
FAX: (03)9214-8381  
E-mail: [jyencken@groupwise.swin.edu.au](mailto:jyencken@groupwise.swin.edu.au)

Murray Gillin  
Emeritus Professor  
Australian Graduate School of Entrepreneurship  
Swinburne University of Technology  
PO Box 218  
HAWTHORN VIC 3122

### **Abstract**

The development of a new technology small firm, such as a spin-off from a university or other public research provider, proceeds through a number of phases. The paper first discusses the concept of requisite holism as applied to the entrepreneurship involved in technological innovation through New Technology-based Small Firms. The various players involved in these various phases include the original “inventor”, technology transfer office staff, the technology champion, the new CEO or surrogate entrepreneur and the first investor(s). Each of these brings to the new venture specific and differing knowledge resources that are the key elements of the Penrosian bundle of resources that result in competitive advantage. In this paper the data from case studies of the early phases of development of Australian university spin-off companies have been used to explore the relevance of such knowledge resources as the entrepreneurial capacity of the new venture. This analysis supports the definition of entrepreneurial capacity as a set of disparate knowledge resources.

# Entrepreneurial capacity and the new technology-based small firm

## Abstract

The development of a new technology small firm, such as a spin-off from a university or other public research provider, proceeds through a number of phases. The paper first discusses the concept of requisite holism as applied to the entrepreneurship involved in technological innovation through New Technology-based Small Firms. The various players involved in these various phases include the original “inventor”, technology transfer office staff, the technology champion, the new CEO or surrogate entrepreneur and the first investor(s). Each of these brings to the new venture specific and differing knowledge resources that are the key elements of the Penrosian bundle of resources that result in competitive advantage. In this paper the data from case studies of the early phases of development of Australian university spin-off companies have been used to explore the relevance of such knowledge resources as the entrepreneurial capacity of the new venture. This analysis supports the definition of entrepreneurial capacity as a set of disparate knowledge resources.

*Key words:* Entrepreneurship, innovation, spin-off.

## Introduction

The research presented here has been part of doctoral research on the role of New Technology-based Small Firms (NTSF) as spin-off ventures for the commercialisation of research outcomes from universities and other research providers. This paper has sought to address two issues. The first issue was to explore the nature of the process involved in technological innovation and wealth creation through the generation of such new NTSF spin-off ventures. This has been used to test statements in the literature that entrepreneurship is the engine of innovation (Drucker, 2002) and that entrepreneurship is a dynamic holistic and non-linear process (Bygrave and Hofer, 1991 p.2)

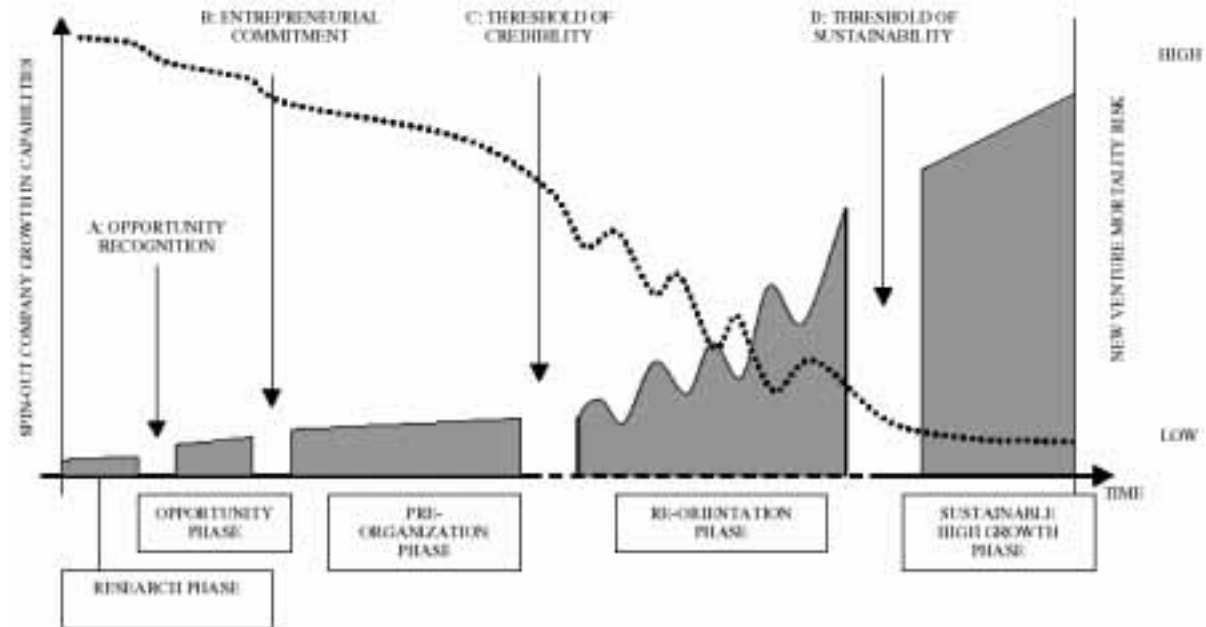
The second issue addressed was the manner in which elements of entrepreneurship — particularly entrepreneurial capacity — provide knowledge resource inputs and how these interact in the early phases in the development of a new technology-based small firm (NTSF). This involved consideration of the phases of development and the critical junctures between these phases (as identified by Vohora, Lockett and Wright, 2002), through which such a start-up passes:

- *Research* Phase, where IP is created
- *Opportunity* Phase, that is Opportunity recognition or Discovery involving the identification of a commercial opportunity
- *Pre-organisation* Phase, when the focus changes from doing more research to developing the first product
- *Re-orientation* Phase, often when an imported CEO or surrogate entrepreneur with start-up experience is recruited
- *Sustainable High Growth* Phase (Vohora, Lockett and Wright, 2002).

These are illustrated in Figure1. This framework has been preferred to that developed by Bhave (1994) in an earlier study of twenty seven new businesses in up-state New York with only three main stages: Opportunity Stage, Technology Set-up and Organization Stage, and the Exchange stage in which transfers (sales) across the supply demand boundary take place. For the analysis presented here the Vohora et al. (2002) Framework with more but overlapping phases has been preferred. It also placed less emphasis on the production development activity than the Bhave analysis. This has been less relevant to early stage spin-offs where there is no and often not likely to be any internal production development activity.

The scope of the research has involved qualitative case studies and other comparative survey data collection on twenty spin-off companies in Australia and two in Scotland, involving a range of research providers and a range of technologies (Appendix A). Thirteen of these, for which there were adequate interview data to ensure triangulation, have been included in the analysis.

Figure 1 The different phases of spin-off company development and critical junctures



Source: Vohora et al., 2002.

This framework suggested that the development of a university spin-off company is essentially a linear process. The Bhava (1994) analysis indicated an iterative and non-linear conceptual process on new venture generation. This conflict has been tested later in the case study analysis findings.

## The relevant constructs

As a start it was necessary to clarify the meaning of the relevant constructs, including innovation, entrepreneurship, entrepreneurial orientation, entrepreneurial capacity and entrepreneurial cognition. The many definitions of entrepreneurship and innovation have been explored in a recent paper by Hindle and Yencken (2003).

### Innovation

In the perception of many people, including many in government in Australia, innovation equates with newness. Hindle (2002) has called this *small-i innovation* in contrast to *BIG-I innovation*, which extends to the commercial exploitation of this new knowledge.

In an earlier paper, Olson (1985 p.27) identified the different tasks involved in the development of a new venture. The first stage involved “the perception of awareness of a new idea”. He saw this as involving mainly the “right hemisphere (*of the brain*) which provides intuitive, synthetic and simultaneous processing”. “Processing information of this kind in a synthetic, holistic manner typically generates the impressions and feelings (the hunches) that focus entrepreneurs on an opportunity and excite them to action”. In contrast he suggested that the left hemisphere of the brain which operates in a rational, analytic, and linear thinking mode as dominating the second phase “where attention has to be given to the detailed plans necessary to produce and distribute the refined product to customers”. He suggested that these second phase activities were often known as *innovation*. More recent analysis as quoted earlier (Hindle, 2002; Hindle and Yencken, 2003) would include all phases from idea to commercial application as the scope of *BIG-I* technological innovation.

## **Entrepreneurship, the entrepreneur and entrepreneurial orientation**

The literature contains many definitions of the various entrepreneurship constructs. These have been recently reviewed by Hindle and Yencken (2003) and Yencken and Gillin (2003a).

This present review started with Bygrave's paper (1989) that involved "a philosophical look at entrepreneurship research methodologies". It started with the statement that "entrepreneurship begins with a disjointed, discontinuous, non-linear (and usually unique event) that cannot be studied successfully with methods developed for examining smooth, continuous, linear (and often repeatable) processes". He identified as an important aspect of scientific research that "physicists examine nature by remorselessly isolating the parts from the whole"; it was reductionist in nature. "Entrepreneurship research on the other hand requires a non-reductionist approach".

And I am certain that we cannot separate entrepreneurs from their actions. After all in a start-up company, the entrepreneur and the company are one and the same... We should avoid reductionism in entrepreneurship research. Instead we should look at the whole (Bygrave, 1989 p. 20).

The need to define the concept *holistic* and to develop tests for holism has been reviewed in a recent paper by the present authors (Yencken and Gillin 2003). Rebernik and Mulej (2000) have explored the concept of *requisite holism*:

A brief summary of the law of requisite holism may thus read as follows: In consideration of complex features and processes, the exaggeration of false holism, which is caused by limiting consideration to a single viewpoint, and the exaggeration of total holism, which is caused by the absence of any limitation on the selection of a system of viewpoints, must be avoided. A requisite system is introduced by a "dialectic system" as a system of all essential, but only essential, viewpoints.

The concept of requisite holism addresses the question of whether holism is a *dichotomous* variable—that is, there is a particular class of systems that are holistic and the rest are not. *Requisite holism* suggests that holism may be a continuous variable that may be applied to all systems that may be holistic to various degrees in terms of the previous definition of requisite holism.

The implications for research methodology in NTSF case studies is whether reductionist research approaches, as used in the sciences, are acceptable or should all such research take a holistic viewpoint. Later in the authors' discussion of their case study research findings, the relevance of this requisite holism concept has been tested.

## **Entrepreneurial capacity as a resource**

Attention has also to be given to the definition and role of entrepreneurial capacity in the process of development of spin-off ventures. Hindle (2002) in exploring the differences between small-I and BIG-I innovation has pointed to the importance of entrepreneurial capacity.

The upshot of all this is that in the absence of entrepreneurial capacity the achievable value to a firm of any new knowledge will always be zero, irrespective of its inherent value or the scale of the productive opportunity it generates... *entrepreneurial capacity*. – not the quality of new knowledge – is the critical determinant of ultimate economic value (Hindle 2002 p.55).

Entrepreneurship (Lumpkin and Dess, 1996) has been described as the *act* of new entry and entrepreneurial orientation as the *process* that determines new entry performance. Entrepreneurial capacity is the *resource* that is essential for discovery to become a realised commercial opportunity. Alvarez and Busenitz (2001) have argued that in this context entrepreneurial capacity is a set of knowledge resources. This leads to consideration of knowledge as a resource and the relation between entrepreneurship and resource based theory of the firm.

The next step was to explore the relevance of resource based theory (RBT) as applied to entrepreneurial new ventures. Resource based theory derives from Penrose's (1980, 1995, 1999) theory of the firm.

It is the firm's unique bundle of resources that is different from competitor firms that are potentially valuable and contribute to a firm's competitive advantage (Alvarez and Busenitz 2001).

Alvarez and Busenitz (2001) extended resource based theory to entrepreneurship.

We use RBT to show entrepreneurship generally involves the entrepreneur's unique awareness of opportunities, the ability to acquire the resources needed, and the organizational ability to recombine homogeneous inputs into heterogeneous outputs (p.771)...As a result of taking an entrepreneurial perspective, one contribution to RBT is that we are now able to identify resources such as entrepreneurial alertness, insight, entrepreneurial knowledge, and the ability to coordinate resources, as resources in their own right (p.772).

They identified three specific knowledge resources that the entrepreneur bring to new venture development: *viz.* the founder's unique *awareness* of opportunities, ability to acquire the *resources* needed to exploit the opportunity, and *organizational* ability to recombine homogeneous inputs into heterogeneous outputs. For high-tech start-ups involved in the process of technological innovation, the knowledge resource and skills of the *technology champion* in managing technology development—together with *access to market* and particularly *competitor intelligence* coming from the surrogate entrepreneur and often from the first investor—can also be critically important. Alvarez and Busenitz's use of the word *entrepreneur* as a singular word is confusing. In the integrated model (Figure 2 later) developed by Hindle and Yencken (2003) for analysing the development of NTSFs, the knowledge resources that constitute entrepreneurial capacity have been shown to be generally contributed by more than one individual and to differ between individuals and between phases of development of the venture.

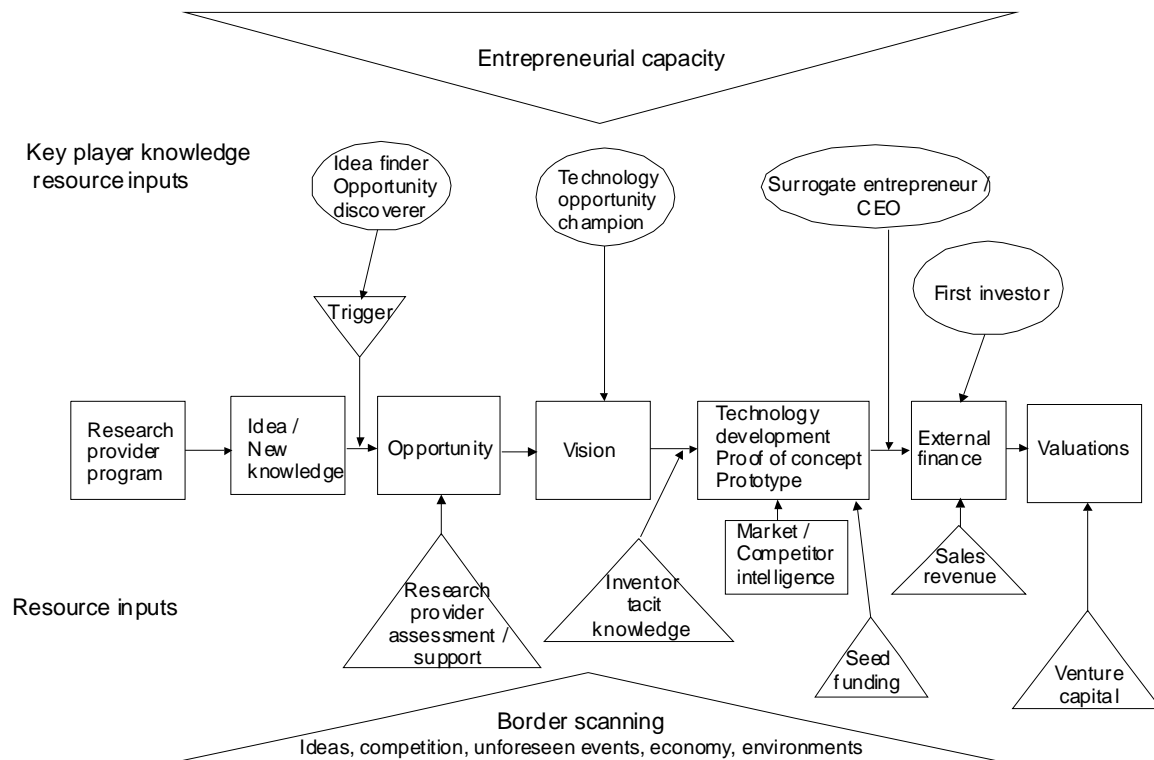
### **Cognition and discovery**

In the Discovery or Opportunity recognition phase, it will be the founder(s)' unique awareness of opportunities that will be the important resource. Venkataraman (1997) has argued that people recognise those opportunities related to information that they already possess. Scott Shane (2000) explored how such prior knowledge led different individuals to find different opportunities arising out of the one piece of new technology. He identified "three major dimensions of prior knowledge important to the process of entrepreneurial discovery: of markets, of ways to serve markets, of customer problems" (Shane op.cit.p.7).

### **An integrated model**

This definitional analysis has led to the development of a model or, better, framework — since it is not predictive — for the analysis of the spin-off company case studies. This framework, shown in Figure 2 is focussed on entrepreneurial capacity as a set of knowledge resources differing with both the players and the phases of development. The analysis will also make use of the framework developed by Vohora et al. (2002) that focuses on critical junctures between the various phases of the development of an NTSF venture that was shown as Figure 1 earlier.

Figure 2 Knowledge resource inputs in NTSF development



Source: Modified version of Hindle and Yencken(2003).

## Research methodology

Discussions with colleagues confirmed that the qualitative analysis strategy using multiple case studies—with embedded surveys to provide comparative data both between cases and over time—was better suited than quantitative survey analysis on its own for the detailed study of interactions between, inventors, entrepreneurs, parent research organisations and the external environments in the early stage of a spin-off company's development.

The research strategy was to use multiple case studies, using an embedded survey questionnaire for comparative analysis between cases and over time, and data collection by face-to-face and telephone interviews with founders, investors and CEOs, review of press articles and company documents.

The unit of analysis was an incorporated entity (company) that had been created as a new venture spun off by a public sector research agency in the period 1998-2000. The initial data collection took place in late 2001. Repeat data collection and interviews to be conducted in 2004 will further test their development, growth and survival over a six-year period.

## Hypotheses

H(1) Entrepreneurship as the act of new venture creation is a dynamic holistic process and is not suited to a reductionist research strategy (Bygrave and Hofer, 1991)

H(2) The conceptual process of venture creation is non-linear and iterative (Bhave, 1994).

H(3) Entrepreneurial capacity is a set of knowledge resources better suited to reductionist rather than holistic analysis approaches. The knowledge resource involved varies both between stages of development and key players (Yencken and Gillin, 2003a).

H(4) Prior knowledge is the trigger in opportunity identification and disclosure (Yencken and Gillin, 2003 b).

H(5) Information asymmetry between the first investor as principal and the company founders as agents can threaten the survival of the venture (Eisenhardt, 1989).

H(6) As venture development progresses, the leadership style changes from entrepreneurial orientation to start-up management (Olson, 1985).

### **Selection of cases**

The unit of analysis has been new technology based ventures, particularly those that are spin-off companies arising from universities or other public research providers where there is an ongoing intellectual property link back to the parent research provider. The research focus has been on the genesis and early stage development of recently incorporated ventures (mainly incorporated in the years 1998 to 2000) rather than on the growth and survival of such ventures.

Bhave (1994 p. 225) drew attention to the importance of selecting samples of cases on taxonomic dimensions rather than by the usual more convenient dimensions of industry, size, technology or region. The sample selected here was theoretically on taxonomic dimensions, with NTSF class and type of spin-off parent as the primary dimensions. The sample included four different classes of NTSFs:

A. *Opportunity driven entrepreneurs*, the classical domain of entrepreneurship research.

B. *Direct Research Spin-off companies* where there has been an ongoing intellectual property link with and often staff transferred across from the parent research provider (Upstill and Symington, 1999; Stankiewicz, 1994; Hindle and Yencken, 2002).

1. *Product oriented mode (PO) companies*, organised around a well developed product (or process) concept and focussed on the advanced development, production and marketing of that product (or process).
2. *Service-oriented mode companies*, similar to product oriented mode companies but developed around a well-developed service concept.
3. *Technology asset oriented mode (TA companies)*, concerned with the development of technologies which are subsequently commercialised through spinning-out new firms, licensing, joint ventures or other types of alliance rather than by manufacturing products or delivering services

There were four classes of spin-off parent research suppliers: universities with large, medium or small research profiles, Cooperative Research Centres and CSIRO as a public research agency

Data were collected from twenty such companies in Australia and from two in Scotland. From this group thirteen companies have been selected for detailed analysis. The basis of this selection was the availability of sufficient interview and other data collection involving key players to ensure proper triangulation. Data collection has continued on the other companies but in many cases key players have declined to be interviewed or there have been delays in such interviews.

The key details of this sample of companies have been summarised in Table 1.

### **Data collection and analysis**

Data collection involved a preliminary comparative data survey based on the Davidsson Klofsten (2003) Business Platform concepts with its eight cornerstones: Klofsten (1998) defined the Business platform as *is a stage reached by a new venture when it overcomes its early vulnerability and the chances for survival are increased considerably* (Klofsten, 1998). Its eight Cornerstones (Klofsten, 1998 p. 25) were Idea, Product, Market, Organizational Development, Core Group Expertise, Prime Mover and Commitment, Customer Relations and Other Firm relations. The survey instrument was

---

based on a tested questionnaire (Davidsson and Klofsten 2003). This comparative data collection was supported by up to five interviews with the “inventors”, technology champions, CEOs and first investors.

The qualitative data was analysed using NVivo text analysis software with initial coding based on the analysis framework discussed earlier (Figure 2) and supplemented by additional coding as indicated by the grounded theory analysis.

*Table 1 Cases in spin-off sample*

No. (1)	Technology source / Parent (2)	SEO (3)	Product	Opportunity type (4)	Age (5)	Business Platform score	Age First customer (months)	Age First sale (months)
<b>Opportunity driven entrepreneurs</b>								
3A	Internal	Computer software	CRM Software	Market	24	4.96	-5	-2
8A	Internal	Aluminium	Light alloy ingots	Market	72	4.30	60	Not trading
4A	University, small	Communication equipment	Wireless communication hardware and software	Problem	72	5.22	16	20
<b>Direct Research Spin-offs</b>								
<i>Product oriented companies</i>								
1A	CRC	Computer software	Encryption software	Problem	12	6.24	-18	-18
6A	University, large	Medical instrumentation	Medical instrument (glaucoma detection)	Problem	30	5.71	NA	32 (expected)
27A	University, medium	Machinery and equipment	Special filters	Problem	30	5.65	20	20
22S	University, medium	Machinery and equipment	Machinery monitoring	Problem	48	3.91	40	48
<i>Service-oriented companies</i>								
15A	University, medium	Marketing	Brain scan	Way to market	54	4.48	21	33
24A	CRC	Livestock	Pig genetic improvement	Market	42	5.15	42	40
<i>Technology asset companies</i>								
5A	University, large	Human pharmaceutical products	Pain killing drugs	Market	24	5.35	Not yet	Not yet
13A	University, large	Human pharmaceutical products	Blood clotting factor	Problem	72	4.15	Not yet	Not yet
19S	University, medium	Processed food products	Starch based food fat replacer	Market	24	4.11	Not yet	Not yet
	<i>Mean score (22 cases)</i>					4.93	Not yet	Not yet

Notes: (1) Suffix A indicates Australian origin, suffix S indicates Scottish origin company.  
(2) For universities, size relates to research profile not student numbers  
(3) Based on ABS Standard Research Classification Cat. No.  
(4) Based on Shane (2000) definitions.  
(5) Age in months since incorporation.  
(6) Customer identification and first sale date may precede incorporation resulting in a negative number of months in relation to incorporation date.

## Research findings

*H(1) Entrepreneurship as the act of new venture creation is a dynamic holistic process and is not suited to a reductionist research strategy (Bygrave and Hofer, 1991)*

The analysis of the case studies suggest that the cases differ significantly in the holistic nature of the entrepreneurship act of new entry and hence the relevance of a holistic as opposed to a reductionist research strategy. The first group of cases in the first class (3A, 4A and 8A in Table 1), the opportunity driven entrepreneurs, were the least amenable to reductionist analysis. They each involved an entrepreneur who identified an opportunity, mobilised the resources, including the necessary technology — algorithms, GSM and GPS, light alloy metallurgy — and created an organisation to exploit that opportunity. The entrepreneur retained leadership throughout and in one case identified new opportunities when the technology was not available to exploit the first opportunity. In all these cases the opportunity came first. This was followed by the search for technological and other resources. In the early stages of their development (even though one of them failed), the effective research strategy was holistic rather than reductionist.

At the other extreme, the cases in the classes, Product Oriented (1A, 6A, 27A and 22S) and Service Oriented (15A and 24A), the development process was much more complex with many more players and knowledge resource inputs. The most difficult question to answer was who was the entrepreneur and who was the driving force in each different development phase. A holistic research strategy was difficult to conceive. A reductionist approach was much more relevant to explore separately, rather than as a whole, the various processes and inputs during the disparate phases of the venture's development and in relation to the different players involved, particularly at the critical junctures between these phases (Vohora et al., 2002).

In between these two extremes lay the technology asset companies (5A, 13A and 19S). The opportunity for these was identified out of ongoing research activity, either as a potential market or as a potential solution to a problem. The product in all three cases would be a licence to a third party existing company for the IP developed, in these cases pharmaceutical or processed food manufacturers and distributors. These ventures were technology driven. The identification of the entrepreneur was not as clear as for the opportunity driven ventures. They were however more amenable to a holistic research strategy than the Product and Service Oriented companies and benefited from a greater degree of reductionist analysis than the more traditional Opportunity Driven Entrepreneurs.

These findings well support the concept of requisite holism developed by Rubernik and Mulej (2000) that “suggests that holism may be a continuous variable that may be applied to all systems that may be holistic to various degrees in terms of the previous definition of requisite holism”

*These findings do not support the hypothesis that entrepreneurship is always a fully holistic process. They do support the proposition that research strategies to explore technological innovation through new spin-off ventures will require varying mixes of holistic and reductionist research strategies according to the class of company involved.*

*H(2) The conceptual process of venture creation is non-linear and iterative (Bhave, 1994).*

For two of the opportunity driven entrepreneurs (Companies 3A and 4A) the conceptual development process was clearly non-linear and iterative. When one opportunity was put aside because the technology was not available or yet developed, another was quickly identified and the development cycle was re-started. For all the other companies the venture development in its early phases closely followed the linear framework developed by Vohora et al. (2002).

*H(3) Entrepreneurial capacity is a set of knowledge resources better suited to reductionist rather than holistic analysis approaches. The knowledge resource involved varies between both stages of development and key players.*

The knowledge resources that generated entrepreneurial capacity for the spin-off companies studied, have been shown in Table 2. They showed considerable variation between key players, stages of development and companies. There was also evidence of the importance of recognising when a knowl-

edge source was not available internally and out sourcing was necessary. For Company 6A, involved with medical instrumentation, a consultant, experienced in rebate negotiations with Medibank and Medicare, the Australian medical insurance and medical fee recovery agencies, was successfully employed to obtain better rebates for fees paid by doctors' patients from the use of their glaucoma scanning equipment.

On the other hand, Company 8A in the light alloy casting business did not recognise in time the need for specialist consultant support for its large START industrial research grant funding application. These two examples show that entrepreneurial capacity can include both internal and externally sourced knowledge resources.

Entrepreneurial capacity consists of a set of resources differing between players and phases of development. The mix of resources involved varied significantly between the various cases. *This hypothesis is supported.*

*Table 2 Technology capacity as a set of knowledge resources*

No. (1)	Technology source / Parent (2)	SEO (3)	Inventor / Opportunity finder	Technology source / champion	Technology transfer office	Surrogate entrepreneur / CEO	First investor
<b>Opportunity driven entrepreneurs</b>							
3A	Internal	CRM Software	Internet service provider needs	Previous software development		Software development and OEM contacts	Internet service provider operations. Business environment.
8A	Internal	Light alloy ingots	Light alloy casting market	Light alloy metallurgy		Light alloy ingot suppliers / market	Venture capital contacts
4A	University, small	Wireless communication hardware and software	Opportunity for wireless tracking devices	GSM modem and GPS technology	Access to technology park	Initial: Business development Current: management	Limited local knowledge
<b>Direct Research Spin-offs</b>							
<i>Product oriented companies</i>							
1A	CRC	Encryption software	Mathematical skills / Java language encryption	Awareness of IT OEM interest		IT startup experience in Silicon Valley	Knowledge of CRC IP development. IT industry knowledge.
6A	University, large	Medical instrument (glaucoma detection)	Clinical ophthalmology	Applied mathematics and computer science	Initial advice /support. IP protection. VC availability	Previous startup experience in similar field.	Strong business experience and mentoring competence
27A	University, medium	Special filters	Waste water treatment and chemical engineering	Filter design	Mentoring and support		
22S	University, medium	Machinery monitoring	Engineering and machine monitoring		Spin-off experience. Finding first investor.	Operations in related maintenance field	Corporate management of engineering company. User contacts.
<i>Service-oriented companies</i>							
15A	University, medium	Brain scan for advertisement assessment	Brain scanning science		Market advice and IT protection.	Advertising industry	Venture capital access
24A	CRC	Pig genetic improvement	Animal genetics	Understanding of pig industry needs	IP protection	Startup management	Private equity investment
<i>Technology asset companies</i>							
5A	University, large	Pain killing drugs	Australian venoms and bioactive compounds	Venom chemistry and human pathology. Clinical trial needs. Industry contacts.	IP protection. Market assessment.	Pharmaceutical industry experience	
13A	University, large	Blood clotting factor	Clinical haematology	Understanding of blood clotting factors	Market assessment and IP protection	Pharmaceutical industry	Venture capital and economic environment
19S	University, medium	Starch based food fat replacer	Starch biochemistry. Processed food technology and markets		Mentoring and support	Startup management experience	

H(3) Prior knowledge is the trigger in opportunity identification and disclosure.

In all thirteen cases (Table3), the prior knowledge of the discoverer—who was not always the “inventor” or generator of the new knowledge—was the trigger that lead to the exploitation of a perceived commercial opportunity *This hypothesis is supported.*

Table 3 Opportunity discovery triggers and prior knowledge

No.	Product / service	Source of opportunity		Trigger	Prior knowledge		Individual Involvement		Trigger location
		Supply side	Demand side			Type	Inventor	Idea finder	
<b>Opportunity driven entrepreneurs</b>									
3	Integrated customer relations management	Programming competence	Awareness of need for integrated CRM software	"Productisation" of profitable consultancy package.	Consultancy on use of Internet for CRM	Ways to serve markets	Entrepreneur	Entrepreneur	Internal
4A	Cellular telecommunications between devices	Marriage of GSM and GPS research skills	Need to be able to track people with dementia	Possible use of wireless to monitor people and devices	Working in dementia nursing homes	Ways to serve markets	Researchers	Entrepreneur	External
8A	Direct chill casting process for aluminium alloys	Successful light alloy casting consultancy	Demand for small diameter light alloy feedstock	Turning time based consultancy into Product / process package	Light alloy casting processes and equipment	Markets	Entrepreneur / consultant	Entrepreneur / consultant	Internal
<b>Direct research spin-offs</b>									
<b>Product oriented companies</b>									
1A	Java encryption algorithms	Research based on theory of numbers	Dissatisfaction with available Java encryption	Website log in evidence of large player interest	Existing Java encryption and theory of numbers	Customer problem	Researcher	CRC web master	Internal
6A	Instrument for early glaucoma detection	Opportunity to use electrical signals in the eye to detect glaucoma	Need for early glaucoma detection	Access to mathematical and software skills applied eye signal processing	Clinical ophthalmology	Customer problem	Researcher	Researcher	Internal
27	Waste water filter to remove solid contaminants before further processing	Research on filtration systems	Need to remove solid contaminants in waste water before further processing (egg with membranes)	No suitable continuous counter flow equipment available	Waste water filtration process potential	Customer problems	Researcher	Researcher	Internal
22	Ultrasound monitor for pumps and other rotating machinery	Research on ultra sound monitoring.	Need for advanced warning of failure of rotating equipment	An identified need but no suitable process or equipment		Ways to serve markets	Researcher	Researcher	Internal
<b>Service oriented companies</b>									
15A	Brain response scanning		Application advertisement assessment	Media interest	Brain science	Way to serve market	Inventor	Inventor	Internal

24A	Measurement of growth factors as predictors of growth performance	Knowledge of growth factors and their markers in humans and animals	Better genetic selection of pigs for growth performance	Interest of major intensive pig farmer	Needs of the pig industry	Customer problems	Researcher	CRC Director	External
<i>Technology asset companies</i>									
5A	Bio active compounds, such as pain killers	Research on bioactive compounds in venoms	Ongoing markets for new pharmaceuticals	Discovery of a family of interesting compounds	Australian venoms and their sources	Markets	Researcher	Researcher	Internal
13A	Blood anti-clotting factor	Hospital haematologist clinician	Need for improved anti-clotting agents	University technology company interest and support	Clinical haematology	Customer problems	Researcher	University technology company executive	Internal
19S	Fat replacer derived from egg whites	Research on fat replacers	Market for fat replacers in processed foods	Perceptions of large potential market	Food processing applied research in a similar area	Markets	Researcher	Researcher	Internal

*H(4) Information asymmetry between the first investor as principal and the company founders as agents can threaten the survival of the venture.*

Eisenhardt (1989b) has described agency theory as having to solve two problems, goal conflicts between the agent and principal and risk sharing. For all except one of the cases, first investors as principals were personally known to, close geographically and closely involved (at least weekly, but often daily) with their agents, the entrepreneurs and others in the new spin-off companies. The exception was a situation (Case 3A) where the first investor principal knew the entrepreneur agent personally but was located 1000 km. distant from him. The investor primarily relied on monthly board meetings for his information. The result was information asymmetry leading to a last minute realisation that the company was running out of cash and that there was little possibility (about the time of the *techwreck*) of raising additional equity. The result was a very late decision to cut staff from 30 to two and the company only just survived through the refusal of the entrepreneur to give up. In other cases, an important issue in information asymmetry was the distance between first investors and start-up managers. One expressed the view that they, the management group, needed an investor who was less than three hours' drive away. *This hypothesis is supported.*

*H(5) As venture development progresses, the leadership style changes from entrepreneurial orientation to start-up management.*

The change in management style from entrepreneurial to managerial (Solow, 1956) was seen in six of the thirteen companies (Companies 1A, 6A, 15A, 24A, 5A, 13A) by the need to recruit after a few years a CEO with more formal management experience and competence. This most commonly related to the timing of seeking and obtaining new equity investment. There was contemporaneously a change in strategy from a focus on doing more research to reduce uncertainty (the scientific viewpoint) to a focus on getting the first product and the first customer (the more commercial viewpoint). *This hypothesis was supported.*

## Conclusions

The selected case studies and the reported analysis of them have suggested important differences between the opportunity driven entrepreneur companies in the sample, the classical subject of entrepreneurship research, and the spin-off companies that had been developed as commercialisation channels leading to technological innovation from university and other public research provider outcomes. The spin-off companies showed a much lesser degree of requisite holism and were thus more amenable to reductionist research strategies. The early phases of the development of the spin-off companies' ap-

peared to be generally linear, while for the opportunity driven entrepreneur companies such development appeared to be non-linear and more iterative, as reported in the literature.

### **Future research**

The next stage of the research reported here will be to explore further the findings reported here. The survey instrument has also been designed for longitudinal application. It is planned to revisit each of these companies after two years to obtain data over a total six-year time span.

## **References**

- Alvarez, S. and Busenitz, L. (2001) The entrepreneurship of resource based theory. *Journal of Management* **27**, 655-676.
- Bhave, M.P. (1994) A process model of entrepreneurial venture creation. *Journal of Business Venturing* **9**, 223-242.
- Bygrave, W.D. (1989) The entrepreneurship Paradigm (I): a philosophical look at its research methodologies. *Entrepreneurship: Theory and Practice* **14**, 20
- Bygrave William D. and Hofer Charles W.. (1991) Theorizing About Entrepreneurship. . *Entrepreneurship Theory and Practice* **6**, 13-22.
- Davidsson, P. and Klofsten, M. (2003) The Business Platform: Developing an Instrument to Gauge and to assist the Development of Young Firms. *Journal of Small Business Management* **41**, 1-26.
- Drucker, P.F. (2002) The Discipline of Innovation. *Harvard Business Review - The Innovating Enterprise*
- Eisenhardt, K.M. (1989) Agency theory: An assessment and review. *Academy of Management Review* **14**, 57-74.
- Hindle, K. (2002) How entrepreneurial capacity transforms 'small-i' into 'Big-I' innovation: implications for national policy. *Telecommunications Journal of Australia* **52**, 51
- Hindle, K. and Yencken, J. (2003) Public Research Commercialisation, Entrepreneurship and New Technology Based Firms: An Integrated Model . *Technovation*
- Klofsten, M. (1998) *The Business Platform: Entrepreneurship and management in the early stages of a firm's development.*, edn. Luxembourg: TII - European Association for the Transfer of Technologies, Innovation and Industrial Information.
- Lumpkin, G.T. and Dess, G.G. (1996) Clarifying the Entrepreneurial Orientation Construct and Linking to Performance. *Academy of Management Review* **21**, 135-172.
- Olson, P.D. (1985) Entrepreneurship: Process and Abilities. *American Journal of Small Business* **10**, 25-32.
- Penrose, F. (1995-1999) *The Theory of the Growth of the Firm. First edition.* edn. Oxford: Basil Blackwell and New York: John Wiley & Sons. Second edition, 1980, Oxford: Basil Blackwell .
- Rebernik, M. and Mulej, M. (2000) Requisite holism, isolating mechanisms and entrepreneurship. *Kybernetes* **29**, 9/10, 1126-1140.
- Shane, S. (2000) Prior Knowledge and the Discovery of Entrepreneurial Opportunities. *Organisation Science: a Journal of the Institute of Management* **11**, 448
- Stankiewicz, R. (1994) University firms: spin-off companies from universities. *Science and Public Policy* **21**, 99-107.

- Upstill, G. and Symington, D. (1999) *Generating New Companies from CSIRO Technology*. Canberra: CSIRO.
- Venkataraman, S. (1997) The distinctive domain of entrepreneurship research: an editor's perspective. In: Katz, J. and Brockhaus, R., (Eds.) *Advances in Entrepreneurship, Firm Emergence and Growth*, Greenwich, CT, USA.: JAI Press]
- Vohora, A., Lockett, A. and Wright, M. (2002) *Critical Junctures in the Growth in University High-Tech Spin-out Companies*. Nottingham. Presented at Babson Kauffman 2002 Entrepreneurship Research Conference, Boulder, Colorado: Nottingham University Business School Jubilee Campus.
- Yencken, J. and Gillin, M. (2003a) *Entrepreneurship, Holism and Technological Innovation: Towards an Integrated Model*. Paper presented at High-Tech Small Firms (HTSF) Conference, Manchester Business School, June 2003. Manchester: Manchester University.
- Yencken, J. and Gillin, M. (2003b) *Entrepreneurial Capacity and Resource Based Theory: Prior Knowledge, Skills And Motivation In The Opportunity Discovery Process*. Paper presented at Babson Kauffman Entrepreneurship Research Conference, Babson. June 2003: Babson Kauffman Foundation.