

# EXAMINING THE EARLY DEVELOPMENT OF INTELLECTUAL ASSETS AND INTELLECTUAL PROPERTY IN NEW TECHNOLOGY BASED FIRMS

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## ABSTRACT

This paper considers how entrepreneurs in new technology-based firms (NTBFs) create, develop and exploit their knowledge assets. While the contribution of knowledge and intangible assets in generating firm value and competitive advantage is well placed in the literature, the progressive development and exploitation of intellectual capital (IC), intellectual property (IP) and intellectual property rights (IPRs) in the NTBF and the entrepreneurial function underpinning this activity have received little attention. The paper first consolidates perspectives from knowledge asset and entrepreneurship literature, theories of the firm, strategic management, social systems and socio-legal theory. The paper goes on to describe the research framework used in a current empirical study on the topic.

## INTRODUCTION

The shift towards knowledge-based industries has placed increasing importance on knowledge and intangible assets as the source of competitive advantage for firms. Literature in a variety of academic disciplines has focused on different aspects of production, appropriation, and transfer of knowledge within the firm. While some researchers have concentrated on the learning process (Levinthal and March, 1993), others have emphasized the creation of knowledge (Nonaka & Takeuchi, 1995) and the transfer and replication of knowledge (e.g. Teece, 1977, 1981; Zander and Kogut, 1995).

The centrality of knowledge as a source of productivity gain and competitiveness also places the intellectual property system at centre stage of the knowledge economy. It is argued that the knowledge economy has affected how firms generate new knowledge, with accelerated innovation and commercialisation of information goods challenging an economic, social and legal system previously developed for industrial rather than knowledge-based exploitation of intellectual property (IP) (Lessig, 2002; Fowler, 2001). Over the last decade, leading socio-legal academics have voiced concern that existing theories of IP and intellectual property rights (IPR) are falling behind a dynamic and evolving business reality of the knowledge economy (Arrow, 1999; Dam, 1993).

Literature suggests a level of complexity in identifying and measuring knowledge assets in the firm that remains central to the debate on valuing knowledge assets. Identifying, measuring and valuing knowledge assets poses methodological challenges for researchers, due in part to the general bias towards statistical and quantitative methods and static assessment of assets at specific points of time. A body of literature supports the argument that simply mapping performance drivers and outcomes of knowledge assets is unrealistic and highly flawed (Rumelt, 1984; Barney, 1991). A resource-based view suggests that assets of firms exist as a bundle and are interdependent on one another, and thus affect firm performance with causal ambiguity, making it difficult to identify where and how individual resources contribute to performance success (Penrose, 1959; Lippman and Rumelt, 1982).

Roos and Roos (1997) highlight the need for information on the transformations from one intellectual capital category into another, suggesting interdependencies between types or categories of knowledge-based assets. Spender (1996) argues that managers, in pursuit of a firm's rationale and identity, must create contextually-contingent syntheses between different "types" of knowledge. If there is more than one type of knowledge, it follows that each type may have to be measured separately (Mouritsen et al., 2002). A dynamic view of knowledge assets suggests knowledge in action, whereby the challenge lies in understanding the relationships between knowledge types and respective combinations of data, meaning, and value that contributes to business practice and bottom line.

A number of studies have focused on large corporations, and consideration of new measurement tools for identifying and measuring intellectual capital (IC) and intangible assets (OECD, 1999; PRISM, 2001-03). A key recommendation from the UK's Economic and Social Research Council (ESRC) Intellectual Property Research Programme (1996-99) is that further research be undertaken on how small firms in different sectors evaluate their intellectual assets (IA) and how they assess whether or not these assets should be covered by intellectual property rights (IPRs) (Blackburn, 2003). The need for further research to examine IP and IPR in new technology-based firms (NTBFs) is also acknowledged (Autio, 2000).

This paper provides a theoretical and conceptual basis from which to examine how the entrepreneur in the NTBF creates, develops and exploits knowledge assets. NTBFs are described as new firms established for the purpose of commercializing new technology or providing an innovative service on the basis of new technology (WIPO, 2005). Such enterprises generally have limited capital and tangible assets and largely depend on intangible assets to succeed in the marketplace. The NTBF entrepreneur is challenged not only by the successful creation, aggregation and ongoing generation of new knowledge, but often by the need to rapidly exploit knowledge assets so that they yield value (Teece, 1998). As most NTBFs do not achieve the early "home-run" high valuation, whether or not a technology yields its potential will depend on the development of further knowledge assets and firm competencies by the entrepreneur.

The first section of the paper consolidates knowledge asset and entrepreneurship literature, theories of the firm, strategic management, evolutionary economics, social systems and legal theory to consider how knowledge value is created, developed and exploited in the NTBF. The second section describes the research methodology that has been developed for further empirical study, based on theoretical and conceptual insights identified in section one. A case-

based research design will examine NTBFs over a two-year period that includes assessment of 1) creation, development and management of IC, IP and IPR; 2) outcomes – the extraction, utilisation, valuation and adaptation of IC, IP and IPR; 3) internal analysis factors, that include firm strategy, business performance and complementary knowledge assets; 4) external factors, that include assessment of relevant legal, business and regulatory factors influencing IC, IP and IPR; and 5) the entrepreneurial function within the NTBF.

## THEORETICAL AND CONCEPTUAL DISCUSSION

### Knowledge Assets and the Firm

The move towards a knowledge economy has been well documented in both academic and practitioner literature and has become a facet of current management orthodoxy (OECD, 2001). It is widely accepted that firm value is created primarily from knowledge generated within the firm rather than physical assets. One only needs to examine stock-market valuation of knowledge-intensive companies to realise that physical and financial assets may only be a small part of a firm's value.

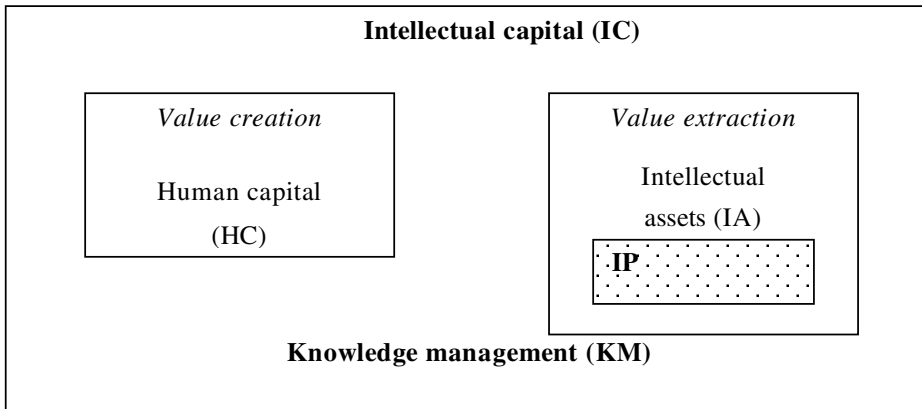
Prominent economists such as Alfred Marshall have long identified the importance of knowledge accumulation and the specialisation of knowledge, along with other “differentiated” agents of production, in realising success in the market (Marshall, 1952). Robert Solow (1956) and Nobel Laureate Kenneth Arrow (1962) identified the dynamic and accumulating nature of knowledge through the concept of “learning curves”. While neoclassical perspectives emphasise the explicit, codified aspect of knowledge as part of the production function, evolutionary and institutional economics favour the tacit aspect of knowledge embodied within human capital (Polanyi, 1962; Becker, 1985). Lev (2001) notes that knowledge assets are frequently embedded in physical assets and in labour (the tacit knowledge of employees), leading to considerable interactions between tangible and intellectual assets and value creation. Similarly, knowledge is described as an evolving interplay between information, codifiable and tacit knowledge and competence (Amin and Wilkinson, 1999).

The conceptualisation of knowledge as intellectual capital (IC) and management of knowledge (KM) are identified with creating competitive advantage in an increasingly knowledge-intensive economy (Teece, 1981; Prahalad and Hamel, 1990; Flood et al., 2002). Illustration 1 identifies the relationship of knowledge components within a firm as proposed by Harrison and Sullivan (2000). It shows that IC is created by the firm from its knowledge assets, from which value is created through the efforts of human capital, and extracted as intellectual assets (IA), that includes IP as a sub-set of the total intellectual asset value held in the firm. IC is also described as intellectual material that has been formalised, captured, and leveraged to produce a higher-valued asset (Stewart, 1997). IC may include not only traditional intangible assets, such as brand names, trademarks and goodwill, but also ‘new’ intangibles, such as knowledge, technology value and good customer relationships (WIPO, 2004).

Both value creation and value extraction processes can be formally managed in the firm through a knowledge management (KM) system, as shown in Illustration 1. Formal KM activities are identified with established firms who deliberately organise, strategise, renew and maximise the firm-wide value of knowledge assets (Wiig, 1997). By definition, human capital focuses on the individual, whereas KM is concerned with groups, communities, and networks. Nevertheless,

KM builds on human capital ideas and has, as one of its tasks, to continue making the value of human capital clear to decision makers in the firm while developing tools and techniques for investing and reaping value from it (Harrison and Sullivan, 2000).

**Illustration 1: Key Components of Knowledge in the Firm (Harrison and Sullivan, 2000: p. 35)**



While it is suggested that KM is becoming more concerned with group knowledge and processes of social capital that underpin group knowledge (Cohen and Prusak, 2001), KM is also described according to use of knowledge. Tannembaum and Alliger (2000) suggest four KM processes: 1) knowledge creation and acquisition; 2) knowledge organisation and storage; 3) knowledge sharing and distribution; and 4) knowledge interpretation and application.

A resource-based perspective suggests that a crucial determinant of a firm's ability to generate sustainable competitive advantage from knowledge assets rests in the firm's ability to transfer and utilize those assets, particularly within the firm (Barney, 1986). Teece's work on the transfer of knowledge emphasise that processes that effectively integrate knowledge within the firm must be designed with an understanding of the properties that can impede knowledge transfer. Specifically, four factors have been identified in previous research (Szulanski, 1996; Teece, 1977) including: 1) properties of the knowledge being transferred, 2) characteristics of the knowledge-supplying source, 3) characteristics of the knowledge recipient, and 4) context in which the knowledge transfer takes place. An important element of Teece's argument (1977) is the need to increase the stock of useful knowledge and extend its applications to both external use and to internal firm activities.

### **Creation, Development and Exploitation of Knowledge Assets**

Literature describes a knowledge-based view of the enterprise in which competitive advantage resides in its ability to integrate knowledge of different individuals in the production process of goods and services (Ghoshal and Moran, 1996; Grant, 1996). This view suggests that competitive advantage can be traced to the knowledge integrating processes that enable the enterprise to coordinate, transfer, and/or apply the knowledge of different individuals to support its production function. Combining and integrating diverse knowledge is identified as a pre-condition for successful high technology enterprises within successful high technology regions (Lawson and Lorenz, 1999).

Nonaka and Takeuchi (1995) emphasise the importance of individuals in creating knowledge, and at the same time, presume the interchangeability of explicit (or codified) and tacit knowledge. They view firm knowledge creation as a process that organizationally amplifies the knowledge created by individuals and crystallizes it and identify four knowledge creation processes:

1. *Socialization* is the process that transfers tacit knowledge from one person to tacit knowledge in another person.
2. *Externalization* is the process for making tacit knowledge explicit among individuals within a group.
3. *Combination* refers to the knowledge transfer once knowledge is explicit.
4. *Internalization* is the process of understanding and absorbing explicit knowledge into tacit knowledge held by the individual.

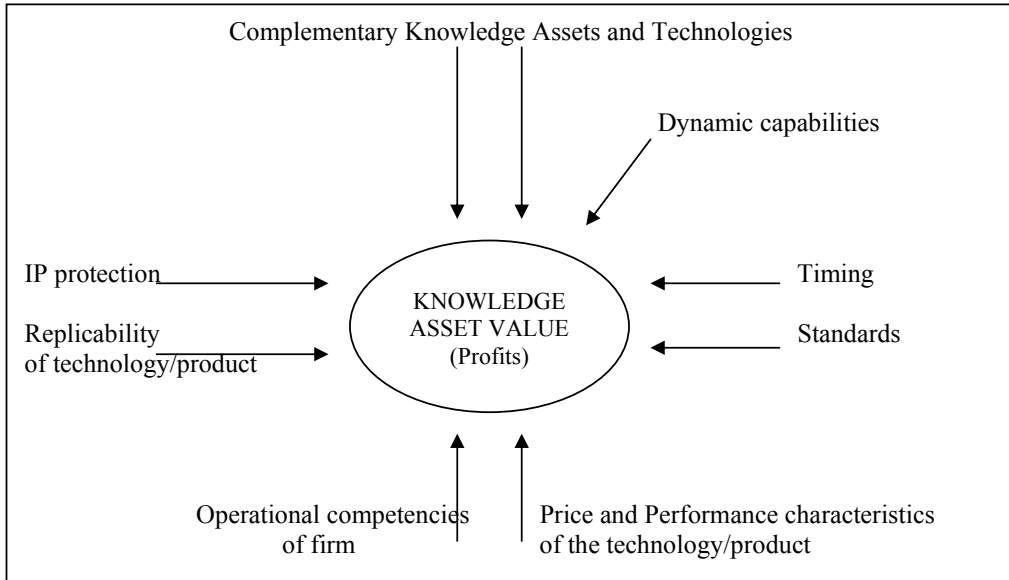
Evolutionary economics describes the ongoing development of new knowledge in terms of a collective view of the firm (e.g. Penrose, 1959; Nelson and Winter, 1982; Lundvall, 1992, 1994) where the consolidation of new knowledge may lead to new capabilities by the firm that are captured in firm routines and may be distinct from IP or IPR (Keeble and Wilkinson, 1999). Knowledge focused only on IP may in fact be compromised or put on hold as new diverse and complementary knowledge to further develop the firm as an entity is developed. Knowledge directly related to the technology may be codified, and therefore more economically shared and transferred within the firm (Teece, 1981). Knowledge that is codified may be more conducive to protection by IPR, although different knowledge mediums will qualify for different types of IP protection (Teece, 1998).

Intellectual property (IP) and the legal rights afforded to protect IP (IPR) encapsulate knowledge assets and IC and make it possible for the firm to sell and buy ideas (David and Olsen, 1992; Teece, 1998) and to develop favourable partnerships and licensing relationships (Teece, 1986). The traditional economic perspective identifies IPR as the reward for entrepreneurial judgement and risk, providing the knowledge creator and innovator with monopoly power and guaranteeing first-advantage (Casson, 1990), allowing entrepreneurs to control the introduction of new knowledge to potential consumers and secure profits (Howells et al., 1998). The legal perspective for protecting IP is that innovations are hard to produce but easier to copy (Chidamber and Kon, 1994). In the knowledge economy, many research-based companies rely on licensing revenues derived directly from their IP rights (e.g. royalties) as their main (or even as the sole) source of income, becoming producers of knowledge, which is shared via licensing agreements with a number of other companies for its commercial exploitation (WIPO, 2005).

Illustration 2 identifies factors that contribute to capturing value from knowledge assets (Teece, 1998). It includes the complementary knowledge assets around the technology/product, knowledge involving the operational competencies of the firm, IPR affording the technology/product and market factors, that include industry standards, price/performance of technology/product in market and its replicability. Teece (1998) argues that a key factor in value capture is the capacity to sense opportunities, reconfigure knowledge assets, competencies and complementary assets and technologies to achieve sustainable competitive advantage, which he describes as dynamic capabilities. For the NTBF to exhibit dynamic capabilities, the entrepreneur must sense

the initial opportunity and establish a basis framework from which dynamic capabilities can be developed. Whether the NTBF can leverage early value from a superior technology may depend on the strength of one or more of the elements identified in Illustration 2.

**Illustration 2: Capturing Value from Knowledge Assets (Teece, 1998: p. 73)**



The notion of dynamic capabilities identifies the importance for a firm to reconsider and re-evaluate its competencies as they accumulate over time, emphasising the role of strategic management in adapting and reconfiguring knowledge assets to match the requirements of a changing internal and external environment (Teece et al., 1997; Teece 1996, 1998). Accumulating new assets is not enough to create or sustain competitive advantage, according to Teece. Firms that can respond quickly and flexibly to changing conditions will be more successful, suggesting the particular importance of dynamic capabilities for NTBFs in dynamic and competitive sectors.

Social system perspectives suggest that knowledge develops through a complex social structure, or “*through the accretion of numerous institutional, resource and proprietary events that co-produce each other over an extend period*” (Van de Ven, 1993: 212). This perspective suggests that development of new knowledge and new firm capabilities requires that the entrepreneur consider given external factors, i.e. business, sectoral, regulatory and policy effects that will affect knowledge acquisition and exploitation possibilities. Research identifies the importance of social capital for gaining access to new knowledge, developing intra and inter-organisational ties or bonds and creating a collective benefit perspective (Granovetter, 1985; Brooking, 1997). The importance of the external environment to knowledge assets of the firm is suggested in regional and national systems of innovation perspectives, which emphasise how innovative and competitive capabilities of the firm depend on local supporting institutions, networks and knowledge spillovers from competitors (Lundvall, 1992; Molina, 1997, 1998).

Another perspective identifies knowledge as both a process and product among the *untraded interdependencies that “take the form of conventions, informal rules, and habits that coordinate economic actors under conditions of uncertainty”* (Storper, 1997: 5). In this context, both the value creation and value extraction processes, as identified in Illustration 1, will be affected by untraded interdependencies existing within the enterprise and between the enterprise and its external environment (Dosi, 1988; Teece, 1986, 1996; Teece et al., 1997) that may enable or constrain IA creation and use. Untraded interdependencies to extract value from IP may be affected not only by characteristics of IP but also by the efficiency of the legal mechanisms of protection (Teece, 1986; 2000). Leading from Teece’s work, actor network theory (Callon, 1987, 1992; Latour, 1987) and Molina’s (1995, 1997, 1998) concept of *sociotechnical constituencies* suggest the need to examine IP given sectoral conditions, the regional context and legal regulations that determine opportunities and boundaries for the enterprise’s use of its IP (Molina and Gregson, 2002).

### **The Entrepreneurial Function**

The entrepreneurial function in new knowledge creation is implicit in Schumpeter’s theories (1934, 1939), with the entrepreneurial effort embedded in the human capital that generates new novel combinations of resources and processes of technological change and innovation. While Schumpeter identifies the entrepreneur as the original source for human capital and value creation, the role of the entrepreneur in the ongoing production of knowledge is assumed. The firm’s production function is used by neoclassical economists to account for value creation without explicitly acknowledging either the entrepreneur or the social division of human capital that generates value while treating technology as a given (Anderson and Corley, 2003). While organisational theorists such as Nonaka (1991, 1994) argue that appropriating tacit and explicit or codified knowledge requires a learning and sharing organisational culture, the emphasis remains on the firm as an entity fulfilling this function, rather than any notion of an entrepreneurial function.

Initial knowledge assets in the NTBF are likely generated by a combination of the entrepreneur’s “general” intellectual capabilities directed to the market opportunity being pursued and tacit and articulated knowledge specific to the new product or technology (Lawson and Lorenz, 1999). Knowledge possessed by the entrepreneur at this stage may or may not fit with the definition of IC, whereby value can be identified and extracted (Harrison and Sullivan, 2000). The innovative idea is usually the main asset of the NTBF during its start-up phase and the basis on which it will seek investors to take the product or service to market.

The nature of knowledge required by the entrepreneur in the early stage development of the NTBF may be rather more commercial than technical. Competences to manage knowledge assets may develop into routines, such as those firm-level processes fundamental to operations that include product design, customer service, quality control (Teece, 1998). One question is whether or not the entrepreneur develops firm routines that are tacit in nature, although it is conceded that knowledge assets are difficult to replicate (Nelson and Winter, 1982; Teece, 1982). Some sources of knowledge may be so complex that even the firm does not understand them (Lippman and Rumelt, 1992). Tacit knowledge is slower and more costly to exchange (Teece, 1998) and will represent much of the “productive knowledge” required to commercialise a technology or product (Teece, 1977).

Although the creation of an initial bundle of knowledge assets within the NTBF can be traced to the experience, skills and expertise of the entrepreneur, proper structures, incentives and management will be required to develop and shape knowledge into firm competences (Teece, 1996, 1998). If knowledge and experience remain personal and are not somehow shared, then the firm can at best expect to achieve a constant return to scale (Teece, 1998: 60). Teece (1998) argues that the creation of new knowledge need not require a complex organisation, as high-value knowledge in the possession of a few individuals can produce valuable knowledge outcomes. However, Teece emphasises that it is the commercialisation of new knowledge through a new technology that is increasingly the domain of a more complex organisation.

While it is assumed that reliance on IPRs for a competitive edge is critically important for the NTBF, the difficulty involved in valuation of intellectual property assets is identified as an important reason as to why such intangible assets cannot be used effectively as collateral by young technology companies in the European context (European Commission, 2001). Nevertheless, the focus for many new technology-based entrepreneurs is to file for an intellectual property right based on a minimum knowledge threshold to fulfil filing criteria in order to present an IPR to potential investors.

Although the system of intellectual property rights (IPR) creates a mechanism to resolve the “appropriability” problem of knowledge and its transferability, there are a number of identified barriers for the NTBF to protect IP (WIPO, 2005). Some NTBFs may lack the inventive step to be protectable under the patent system (in such cases utility models, where such protection is available, or industrial designs may be suitable alternatives), possess process innovations or innovations in certain low-technology sectors are less likely to be patented, or not be able to meet the cost of IPR filing particularly for patents. NTBFs may use alternative means of appropriating their innovations. Some of the alternatives to patenting include secrecy, exploitation of lead-time advantages, moving rapidly down the learning curve, use of complementary sales and service capabilities, technical complexity, on-going innovation, relationships based on trust and use of trademarks to differentiate their products from those of imitators (Levin et al., 1987; Cohen et al., 2000).

## EMPIRICAL RESEARCH

Three integrated themes are identified in the literature that confirms the need for further empirical study. First, literature suggests the dynamic and evolving nature of knowledge assets, interdependencies between types or categories of knowledge assets and the need to further understand the relationships between knowledge types and their meaning and value to business practice (Spender, 1996; Roos and Roos, 1997; Mouritsen et al., 2002). In considering the NTBF, there is a need to firstly understand the internal drivers that lead to knowledge creation and knowledge extraction activities that identify an entrepreneurial function (Harrison and Sullivan, 2000). This includes examining the dynamic relationship and presence of identifiable boundaries between IC, IP and IPR elements as the firm develops, assessing the extent to which IC, IP and IPR are strategic objectives and examining pre-commercial expectations and perceptions of knowledge asset value by the entrepreneur.

Second, although the identification, integration, consolidation, management and exploitation of knowledge assets to create new value in the market by the entrepreneur reflects an

entrepreneurial function, few studies have examined *knowledge integrating processes* performed in the NTBF by the entrepreneur. Literature identifies the need for a knowledge-integrating function in the firm that includes KM activities and generation of firm routines (Ghoshal and Moran, 1996; Grant, 1996; Teece, 1998) and highlights the role of individuals in knowledge creation (Nonaka and Takeuchi, 1995). However, there is a need to examine the underlying processes and decision-making activities undertaken by the NTBF entrepreneur, including the integration of early-stage technical, commercial and 'productive' knowledge, its evolution to identifiable IC, IP and IPR and the incentives to invent, disclose, commercialise, design-around and invest in knowledge assets.

Third, literature identifies various internal and external factors and barriers that affect IC, IP and IPR creation, development and usage by NTBFs (Teece, 1998; OECD, 1999). There is a need to examine internal competencies and dynamic capabilities of the firm that may complement or constrain use and value of IC (Teece, 1998) and influence IP and IPR activities and appropriability (Autio, 2000; Blackburn, 2003). This level of analysis would also examine costs and benefits of IP protection for the NTBF that takes into account sectoral, regulatory and legal influences. Examination of a cross-section of NTBFs would also inform the debate as to whether or not new knowledge commercialisation through a new technology is increasingly the domain of a more complex firm (Teece, 1998).

### Research Design

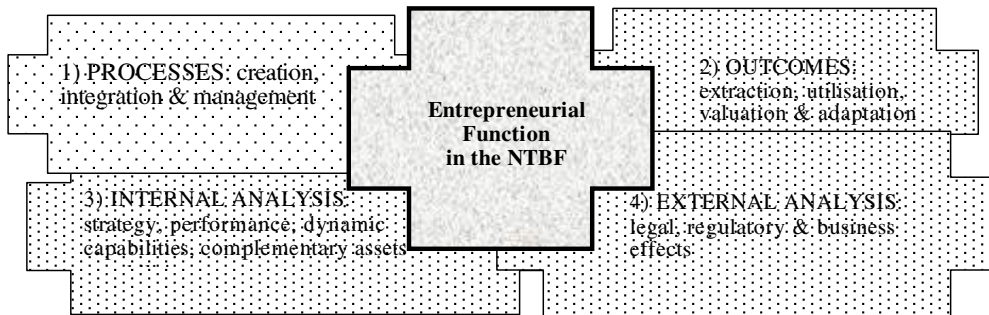
The research design is driven by the need to examine in-depth the early development of knowledge assets – intellectual capital, intellectual property and intellectual property rights – in new technology based firms and the role of the entrepreneurial function. The integrated themes identified in the literature suggest the need for an appropriate number of case studies of early-stage NTBFs (less than 5 years old) that represent a cross-section of sectors, possess identifiable IP and can be studied over time. Four technology sectors are identified that characterise early stage UK-based NTBFs with identifiable IP: 1) software; 2) electronics; 3) bioscience and biomedical; and 4) information systems and technologies. Yin (1989) suggests the need for four to six cases when attempting to generalise on the character of any particular phenomenon. This study identifies the need for four cases that represent each of the four sectors or a total of 16 cases and the need for a longitudinal but realistic time period which is identified by the authors as 24 months.

The case method is highly appropriate for examining knowledge assets given the integrated themes described above, as it "*investigates a contemporary phenomenon within its real life context, ... is most relevant when the boundaries between phenomenon and context are not clearly evident, and when multiple sources of evidence can be used in support of research questions*" (Yin, 1989: 14). A case methodology allows research to go beyond evidence-collection to illustrate or explain the decisions and motivations that underlie observed processes (Sarantakos, 1993) and to identify and understand those detailed interactive processes crucial to understanding a complex business context (Bryman, 1988; Remenyi et al., 1998).

Case study analysis is also expected to lead to the identification of relevant sectoral, business and legal factors to qualify the *external factors* influencing knowledge asset processes and outcomes. A participant observer approach is also suggested to gain access to knowledge,

perceptions and other insights as the NTBF and its knowledge assets evolve over time. This approach will explore the often ‘tacit’ component of knowledge that resides in the entrepreneur and those people directly or indirectly involved with the knowledge assets generated within each NTBF (Vincenti, 1990). Illustration 3 identifies the levels of analysis for each case study that will drive the data collection process.

**Illustration 3: A Framework for Examining Knowledge Assets and Entrepreneurial Function in the NTBF**



Each element of the research framework is briefly described below:

- *Knowledge Creation, Integration and Management Process Continuum (element 1)*: IC, IP, IPR characteristics for each case study will be examined using a process continuum to examine creation, development and management processes within the enterprise.
- *Knowledge Extraction and Outcome Analysis (element 2)*: This element examines IC, IP and IPR extraction, utilisation, valuation and ongoing adaptation of IP for the NTBF over time.
- *NTBF Analysis (element 3)*: Characteristics of the NTBF are examined (origins, profile of entrepreneur and firm, characteristics of original technology, operational competencies, complementary assets/technologies, dynamic capabilities, firm strategy and performance) that also link back and inform insights from elements 1&2.
- *External Analysis (element 4)*: This element examines business, legal and regulatory environments that directly or indirectly affect IC, IP and IPR generation in each case. Case study data are complemented by use of secondary data, legal, business and practitioner documents/reports and insights and feedback from approximately 6-8 external experts who will be identified and engaged during the study. Experts will be leaders in NTBF research, knowledge intensive business and law who will provide a credible, relevant and up-to-date regulatory, theoretical and conceptual knowledge resource.

As identified in Illustration 3, a central element within the four described levels of analysis is the role of the *entrepreneurial function* affecting the creation, development and utilisation of knowledge assets within the NTBF. The entrepreneurial function is identified as that capability which identifies and integrates novel combinations of technical knowledge with commercial knowledge unique to each NTBF and includes original opportunity identification and firm creation activities. This capability may derive from a single individual, a few individuals or a

team, but is likely to change over time. The key interest within this study is to identify the original source of the entrepreneurial function and how this develops over time and affects knowledge assets within the firm.

As case selection is critical, cases will be selected in cooperation with a credible industrial partner, Technology Transfer and Innovation Ltd (TTI). TTI is involved with the UK government in supporting knowledge transfer partnerships (KTPs) between universities and industry and in supporting technology-based industries in association with the Department of Trade and Industry (DTI).

TTI will assist in case selection using their database of over 1,000 companies) using guidelines below:

- Satisfies definition of NTBF;
- Clear entrepreneur as champion, or identified entrepreneurial driver to firm;
- Commitment to study, accessibility over life of project;
- Appropriate IC (identifiable IP used by firm as a 'key competitive asset' (potential for patent. Copyright or trademark protection);
- Cross-section of sectors within sample;
- 2-3 cases 'in reserve' to counter potential early drop-outs or closures.

For each of the 16 cases, data will be collected through a regular schedule of monthly meetings with the entrepreneur and other key actors of the knowledge asset constituency. Case study data would be complemented by use of relevant documents and reports. Semi-structured meetings and interviews will identify and capture evolving knowledge within the NTBF from people who may assume more than one of the roles below:

- entrepreneur, knowledge creator(s) and contributors;
- Company owner(s), entrepreneur(s), CEO, Managing Director(s);
- Legal staff and/or legal service provider(s);
- Technical staff working with IP;
- End-customers or intermediate customers;
- Collaborative partners (e.g. joint IP ownership, shared IP);
- Competitors.

All data will be categorised according to the framework described in Illustration 3. Some information will be historical in nature, depending on the age and development of the company, and therefore require some degree of reflection and reference back to previous firm processes, activities and events. However, the intention is to position the researcher within the early stage of firm development to reveal new insights into knowledge asset development, processes and outcomes that can be examined in the context of evolving internal and external influences and conditions.

## Pilot Study

An initial 6-month pilot study is underway (January-June 2006) to further develop the integrated case analysis framework described in Illustration 3. Two NTBFs are being examined in the pilot, one from software and the other from bioscience. Each of the four levels of analysis is created from an initial *diagnostic* assessment of each NTBF by the researcher. The researcher will also generate an initial mock-up of the *process continuum* of each case that identifies historical and current creation, development and management processes of knowledge assets within the NTBF since inception. Obvious distinctions between intellectual capital, intellectual property and intellectual property rights as usable categories of knowledge assets will be identified and examined. Should these distinctions clearly exist, as suggested by those within the firm and/or identified by the researcher, then it is expected that IC, IP and IPR extraction, utilisation and valuation activities may be underway and will be examined by the researcher. Identifying and potentially categorising *dynamic capabilities* as articulated by David Teece will also be explored within these case studies, for consideration within the framework of the main study.

Characteristics of each firm will be established upon arrival of the researcher, along with legal, regulatory and sectoral effects. These may be articulated to the researchers by those within the firm and will also become more evident to the researcher as he gains more knowledge of the firm and business context over time.

Another important objective of the pilot study is to 'operationalise' the definition of the entrepreneurial function for the larger study. Identifying and qualifying the *capability* which identifies and integrates novel combinations of technical knowledge with commercial knowledge will be informed by the researcher retracing the original technical and commercial knowledge assets upon which the NTBF was founded and related integration processes and activities. Original knowledge creators may no longer be with the firm, but will be identified and contacted for interviews. It is expected over the two-year study that entrepreneurial, general management and knowledge management functions will evolve and become more formalised. A critical question is how this affects knowledge asset development and utilisation and where and how the entrepreneurial function plays a role in a more complex and knowledge asset-rich firm environment.

A final objective of the pilot study is to develop the panel of 6-8 external experts from NTBF research, knowledge intensive business and law who will provide a credible, relevant and up-to-date regulatory, theoretical and conceptual knowledge resource that assists in informing and qualifying case results. An initial panel list has been generated, and those individuals have been contacted; the objective is that this panel will be active prior to commencement of the main study. These individuals will be associates with the Centre for Entrepreneurship Research and the AHRC Centre for Studies in Intellectual Property and Technology Law, both based at the University of Edinburgh.

## CONCLUDING REMARKS

The research draws upon a breadth of literature that integrates the creation, development and utilisation of intellectual capital, intellectual property and intellectual property rights and the entrepreneurial function in the NTBF. This approach acknowledges that any ability to generalize from case studies depends upon the adequacy of the underlying theory and related knowledge and qualified by relevant contextual conditions. Examining in-depth the evolutionary development and use of IC, IP and IPR in the 16 case studies is expected to establish empirical evidence of where business, economic and legal justifications for knowledge assets, IP and IPRs are in conflict with practice. Data derived from these case studies and the integrated levels of analysis is also expected to provide multiple sources of evidence to offer a broader spectrum of analysis and higher construct validity.

The research design described in this paper identifies the importance of examining integrated elements of knowledge of particular relevance in the NTBF, while accommodating other competencies and capabilities affecting knowledge asset development, including firm strategy, knowledge management activities and IP characteristics. The external context is accommodated in the proposed research by considering market and sectoral conditions and legal and regulatory environments and qualifying insights through an expert panel. Development of the expert panel of academics and practitioners is expected to contribute to qualifying interesting case study insights as they emerge and enriching the research process rather than simply a post-mortem reflection on consolidated and final research results.

The research will provide a number of important intellectual contributions: 1) to clarify the conditions under which NTBFs create, develop and exploit, IA, IP and IPRs; 2) to examine how knowledge assets are affected by the entrepreneurial function within the NTBFs and how this evolves over time; 3) to examine evolving processes and outcomes of IA, IP and IPR development in the context of internal (i.e. entrepreneurial, managerial and knowledge management functions) and external influences (legal, sectoral and business environment factors); 4) to provide insights on where legal regimes are compatible or compromise the needs of NTBFs to leverage their IPRs, in particular, patents; and 5) to contribute to, modify or refute existing theories and perspectives. Finally, the research will create a cross-disciplinary academic-practitioner network to generate new knowledge and facilitate discussion on IA, IP, IPR and entrepreneurship of particular relevance to the NTBF. This network will remain active after completion of this study as part of a commitment by the authors to this research project.

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