Three Traps Facing Knowledge Exploitation in Firms

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THREE TRAPS FACING KNOWLEDGE EXPLOITATION IN FIRMS

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ABSTRACT

We explore three mechanisms: *diversity, loosening social controls, and codification* which alleviate the well known limits to learning: *core rigidities, sloth (slow learning), and imitation by competitors*. These limits are the flip side of three centrally important generic competencies: adaptation, deepening and appropriation. We explain the difficulties posed in affecting each mechanism and how developing one generic competency leads to difficulties in managing another. We illustrate key issues surrounding these competencies and mechanisms through a study of one of Britain's leading biotechnology firms.

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"In an economy where the only certainty is uncertainty, the one sure source of lasting competitive advantage is knowledge." Nonaka (1991)

INTRODUCTION

Knowledge has long been recognised as one of the key factors in the creation of economic wealth (Hayek 1945; Marshall 1965; Penrose 1959; Stigler 1968; Teece 1977). There is a widely held belief that the organisational learning and investments in knowledge based competencies and capabilities are key value adding tasks of the firm[i] (Burgelman 1990; Drucker 1992/93; Hamel and Prahalad 1990; Levin et al 1987; Marshall 1965; Quinn 1992; Reich 1991; Toffler 1990). It is less widely appreciated that these investments are also risky. While researchers have generally considered investments in capabilities as an inherent good, a few have been more sceptical. The writings of Leonard-Barton 1992, Levinthal and March 1993, and March 1991 have all implied that the sustained integration of knowledge into the resources and capabilities of the firm does not *always* add to the value.

The contribution of this paper is to highlight these risks by unifying the discussion of three important limits to investments in learning, *Rigidities, Sloth and Imitation,* which are the flip side of three central generic competencies for the long term survival of firms, *namely Adaptation, Deepening and Appropriation.* It is these key *competencies* of the firm to which this paper addresses itself. We believe that firms who survive in the long term are those which resolve the dilemmas implicit in each of these competencies. We note that firms may choose, implicitly or explicitly, to focus on one competency at a time. Few firms can manage to be successful at all three at once. This is both because of the resource and capability expenditures that would be required and also because the mechanisms to alleviate the difficulties attached to one competency will inhibit efforts to build another.

We shall go further. We explore and examine a variety of mechanisms which are often used to manage these limits. These include: *Diversity, Loosening social controls, and Codification.* We show how each of these mechanisms works, and more seriously how they are risky and may interact negatively.

To help the reader, we begin by summarising dilemmas implicit in each of these three competencies. The first competency is *adaptation* in the face of changing markets. The dilemma implicit in the adaptive competency is how to focus the firm's resources and capabilities on the generation of a specialised knowledge base which provides superior solutions to problems for which the consumer is willing (and able) to pay, for without becoming over specialised on too small a market, or becoming too divorced from changing market needs over time.

Most firms are constrained by *core rigidities* which are the flip side of core capabilities (Leonard-Barton 1995). Core rigidities are sets of knowledge which although valuable now, are inappropriate to future needs of the organisation. (All firms make implicit or explicit choices about competing *visions* of a future world. That choice leads them to promote some capabilities over others. No firm can bet on all visions as it has a finite bundle of resources.) As the firm becomes increasingly specialised in terms of capabilities, it reduces its ability to adapt to unforeseen environmental shocks developing blind spots in its ability to understand its environment. These blind spots are an inevitable consequence of a deepening commitment to a single vision of the future. In extreme circumstances core rigidities will threaten the future survival of the organisation (Miller 1993). Overcoming adaptive threats requires strategies which encourage diversity, and include both personnel turnover and encouraging mavericks.

The second competency is to *deepen* a firm's current knowledge base, in the face of agile competitors. The dilemma implicit in the deepening competency is two fold. First, how to balance the need to generate new capabilities which may be the seeds of future success and a key plank of an adaptive competency. Second, how to deepen current capability and knowledge bases such that the firm is more capable of delivering superior service and products to the market place than its competitors.

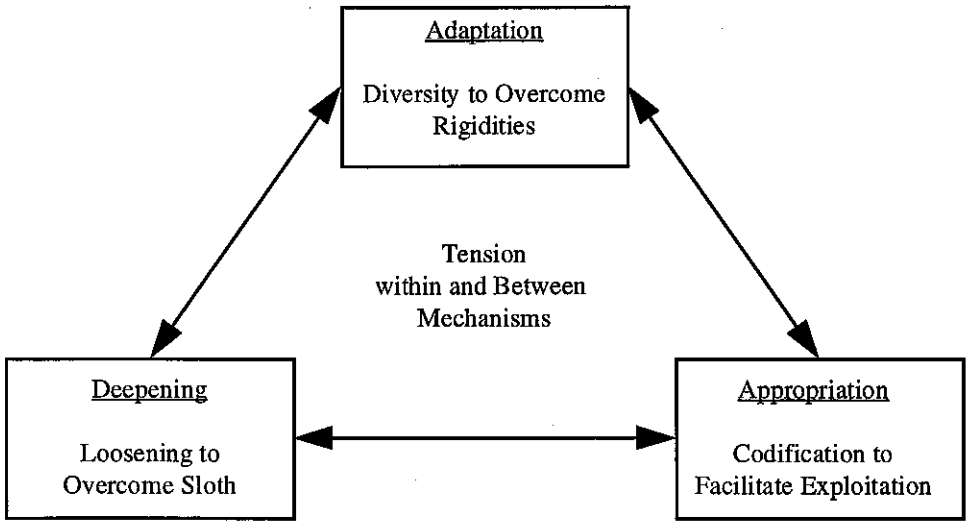
The key type of knowledge which this paper is concerned with is that which will create, maintain and expand a firms sustainable competitive advantage. The *slothful* firm moves too slowly here and is in danger of being overtaken. The loosening of controls on social interaction within the firm, especially across internal organisational boundaries, is often seen as an essential action if the organisation is to boost creativity and, hence, organisational

knowledge creation leading to deepening. Changes in the level and location of organisational slack is often seen as another essential action. In a slothful firm boosting organisational knowledge by these means may however be frustrated. The slack may be appropriated for purposes other than organisational knowledge creation and the firm runs the risk that it may reduce the efficiency and effectiveness of current capabilities.

The third competency is to *appropriate* a return from the rapid exploitation of current knowledge bases in the face of *imitators*[ii]. The dilemma implicit in the appropriation competency is that as the firm seeks to increase the return from commercial knowledge, it tends towards codification, improving the efficiency of communicating and exploiting valuable knowledge. Codification occurs across a wide span of the organisation, allowing different groups to embed this knowledge in their product/service offerings. But as a firm's commercial knowledge becomes more codified, and hence explicit, the risk rises of competitors successfully imitating this knowledge. Codification carries further risks. It may make the firm's routines, procedures, and thought processes more rigid, hence compromising an adaptive competency. It may also tighten social controls and regiment social interaction through bureaucracy, thus impairing a deepening competency.

This article is a subtle exploration of various interdependencies which firms face in the management of their knowledge bases. These are schematically shown in Figure One. The generic competencies Adaptation, Deepening and Appropriation are shown to be connected to the mechanisms of Diversity, Loosening and Codification. Each of these inner mechanisms is not only risky in of itself, but is also in tension with the other mechanisms. For *illustration* we will draw principally upon a British biotechnology firm in which we are conducting an on-going research project.

FIGURE ONE:
Competencies and Mechanisms for Facilitating Greater Learning



METHODS AND INDUSTRY CONTEXT

The Method

This paper is part of a wider research project at CUBS and the University of Bath. The study focuses on the management of financial, technical, entrepreneurial and market risks in the biotechnology sector. Part of this study is an exploration of the management knowledge within and across organisational boundaries. The research within the firm used for illustrative purposes in this paper represents a pilot study where problem definition and initial exploration is being undertaken. Further studies are currently been undertaken in the UK biotech sector, with a comparative US study being considered.

The method employed is that of the case study. There are three primary sources of data to date. The first is interviews inside our case company, the second is a search of public domain data on that firm, and the third is a

search for public domain data on six other biotechnology firms in the UK who are all listed on the London Stock Exchange.

At present we do not wish to revel the identity of the case firm, hence we will refer to it by the fictious name 'Bio'. Interviews were conducted in 'Bio' by a team of three researchers. One is a professor of chemical engineering who has experience in both technical and managerial research. Another is a professor of strategy, who has extensive experience in research across a wide range of industries and firm sizes. The third is a PhD student, who is specialising in the area of knowledge management. The creation of a case study on 'Bio' specifically, and the LSE biotech firms generally, was written through a process of iterative rewrites which sought to incorporate a shared understanding by the researchers of the firm's story. Further enriching of the document is currently underway with a review by 'Bio' executives of the case study document, after which a final rewrite will be undertaken with the goal of releasing it into the public domain.

Four senior managers were interviewed for between one and two hours each. These were the Chief Executive of the group, the Director of Research, the Director of Development and the Chief Executive of the Development and Research firm. Each executive has at least ten years experience in the industry. All have PhD's in science and all have previously worked in the pharmaceuticals sector. These four were pivotal in the re-orientation of 'Bio's' strategy in the 1990s. As the research was exploratory the researchers first interviewed the group Chief Executive following a broad interview schedule. This interview fleshed out the principle story of the firm and at that stage a new set of interview questions were developed for the remaining three interviews. During each interview issues arose which were unexpected, to which follow up questions were applied. Across interviews issues arose which were subsequently followed up in the next interview. By the end of the four interviews, the interviewers felt that they had obtained a basic understanding of the firm. In a future follow-up study further interviews may be undertaken at 'Bio'.

The focus of interviews was on successful innovative drug R&D projects. The interviews centred around one project which had been identified as critical by the professor of chemical engineering, and had been confirmed as such by each of the interviewees. Such a programme involves two broad phases. The first is drug discovery, where compounds are identified, or generated, and shown to have potential as a drug. The second phase involves going though a series of three, or more, clinical trials where it is proved to regulators that the drug is both safe for public use and is of clear therapeutic benefit. Phase one clinical trials study the effects of the drug on a small number of, usually, healthy volunteers to establish its safety. Phase two trials test if the drug is of therapeutic benefit, that is does it result in an improvement in the patients condition. It also tests the range of dosages and their effects. Phase three clinical trials seek to establish whether the drug has a clear clinical benefit relative to another drug on the market place, or the standard treatment. Only after success in phase three can a drug seek regulatory approval for marketing. In this paper success is defined as a drug which reaches phase III clinical trials. This is because it is the pivotal stage in drug development, many drugs will have fallen out of the running at this stage. At present no UK biotech drug has passed phase III, though several phase III trial results will be reported during 1997.

Further data was collected on 'Bio' through an analysis of the last ten years of annual reports. Background information on the history of the firm was obtained by a search of the general news media since the early 1990s. This was done using the CD-ROM database McCarthy, which contains much of the UK's leading news media articles, from 1994 to 1996, and via manual searches. Additional general data on the biotech industry was obtained by a search of the Economist on CD-ROM from 1987 to 1996.

These media searches also offered data on other UK biotech firms, seven of which we have looked at in more depth. The last two years company reports of each of these firms were also analysed. These firms lead the UK biotech sector in terms of raising capital, establishing competent managerial and scientific teams with a proven track record, collaborating with leading pharmaceutical firms, and all bar one has at least two products at phase II or beyond. Their combined market capitalisation exceeds 2,700 million pounds. They have cash reserves of about 465 million pounds. Their R&D spend is about 90 million pounds per year. Their combined research portfolio includes 38 drugs in clinical trials, six of which are in phase III. The data from this study supports and enriches much of that reported in this paper. Follow-up field studies are currently being planned in some of these firms.

Context

The Biotechnology Industry

Biotechnology is a very knowledge intensive industry, as illustrated by its R&D spends. It also represents an important frontier of global competition. Of the top 10 pharmaceutical firms in the world six come from the USA and four from Europe (Fortune 1996). Four of these firms are in the top 50 most profitable companies in the world. Britain leads the way in this $255.32 billion industry with Glaxo Welcome as the largest seller of pharmaceuticals in the world (Evans 1996). Unfortunately 40 % of its sales come from two products the patents of which are soon to expire. The patent on Zantac, which generated sales of almost two billion pounds in 1996 and $27 billion since 1981, will expire in July 1997. Glaxo Welcome's CEO believes that a worst case scenario could be an 80% reduction in Zantac sales (Lister 1997). The future of the industry is dependant on a new stream of drugs, which are likely to increasingly come from advances in biotechnology rather than traditional organic chemistry. The USA took an early lead in biotechnology, however the industry is developing fast in the EU, lead by innovative British firms.

Biotechnology is based on three core technologies namely, recombinant DNA, monoclonal antibodies, and protein engineering (Liebeskind et al 1994). Alternative definitions of biotechnology do exist, but are not explored in this paper. Biotechnology has exciting applications in the areas of health care, food production, crop protection, and environmental clean-up and management. In the USA industry sales stood at $10.8 bn in 1994, with the 1992 President's Commission predicting a $50 bn global market by the year 2000 (BIO 1995; Green 1996).

The industry only emerged in the 1970s. The USA continues to be its centre with about 1,300 firms, two thirds of which employ less than 135 people (BIO 1996). These firms spent $ 7.9 billion on R&D, had a market capitalisation of $ 77 billion, and employed about 118,000 (BIO 1996; Green 1996). In the UK there are about 890 biotech firms, many of which are academic institutions, biotech suppliers, or divisions of large pharmaceutical firms (Crafts-Lightly et al 1996). There are only sixteen biotech firms listed on the London Stock Exchange. The market capitalisation of the UK sector is over 4 billion pounds (Green 1996)

The focus of our interest is firms engaging in drug discovery and development. The pharmaceutical industry is populated by giant firms who find the creation of new innovative drugs to be difficult. They are turning to smaller, more innovative biotechnology firms as a source of future products (Whittaker and Bower 1994; interviews with case firm executives). The success of these firms is in part due to their small size which fosters innovative research. More fundamentally Powel et al 1996 note that

> 'Biotechnology represents a competence-destroying innovation because it builds on a scientific basis (immunology and molecular biology) that differs significantly from the knowledge base (organic chemistry) of the more established pharmaceutical industry. Consequently, biotech provides enhanced research productivity ..... '

As yet this is an industry largely devoid of products. The time to market for drugs can range from eight to twelve years. To date there are 32 biotechnology drugs approved by the FDA, with over 300 in clinical trials. New drugs are expected to come to market in increasing numbers from biotech sources as the research efforts of this, the most research intensive industry in the world come to fruition. In 1995 US biotech firms spent $71,000 per employee on R&D (or $7.9 billion) compared to $56,000 for US pharmaceutical firms (BIO 1996).

The case firm: 'Bio'

'Bio' is one of the more established firms in the sector. It has three basic historical phases. For the first decade of its existence two separate strands of the business were grown: contract research and in-house research and development. The dominant focus by the end of the decade was on contract research, requiring a strong technological capability. The goal was to cover the costs of developing in-house drugs with revenues generated by doing contract research on behalf of other firms.

The second phase commenced when a new CEO entered the firm with a new perspective. He saw the future as being in the development of innovative new drugs in which 'Bio' had a slice of the action. As he puts it 'The winners have to be the companies that are therapeutic because the value added is so huge'. The firm re-focused its efforts around developing a capability in the creation of innovative drugs, up to phase III trials, based around the areas of immunomodulation, oncology and inflammation. This required a shift in core capabilities away from technology and towards inter-disciplinary research. This makes 'Bio' an interesting study in the competency of *adaptation*. Contract research was made into a separate company. Recently the contract research element of the firm was divested and 'Bio' pinned its flag firmly to the mast of R&D of drugs based on biotechnology within its three areas.

'Bio' has a market capitalisation of greater than 400 million pounds, making it one of Britain's largest biotech firms. It invests over 17 million pounds p.a. in R&D, or close to 100,000 pounds per employee, which is far higher than the US average. With over 150 employees it is large, even by US standards. It has a strategy of collaboration with large pharmaceutical firms in the development of its drugs. Current collaborators include some of the leading pharmaceutical firms in the USA and EU. Its portfolio of collaborators, in terms of pedigree, compares most favourably with others quoted on the London Stock Exchange. The number of drugs it has in both clinical trials and in discovery projects, or pre-clinical trials, compares favourably with these firms. This makes it an interesting study of knowledge *deepening* and transfer. This strategy also enables 'Bio' to exploit its knowledge base before going to the end market, via milestone payments from collaborators, but without selling a full interest in the downstream property rights. Milestone payments and collaboration is not unusual in this sector, however 'Bio' is one of the oldest hands in this sector in the management of collaboration. This makes it an interesting case in studying the *exploitation* of knowledge.

We focused our interviews around a TNF anti-body based drug discovery and development programme in collaboration with a leading EU pharmaceutical firm. The drug offers therapeutic solutions in rheumatoid arthritis, septic shock and inflammatory bowel disorders. The results from a pivotal phase III clinical trial will be known in 1997. If successful then the firm's drug could be on the market in 1998. The rough market size for these illnesses are as follows: severe rheumatoid arthritis 800,000 patients, inflammatory bowel disorders 500,000, and septic shock 500,000 p.a. (annual report). Given the severity of these illnesses the monetary value of products which provide enhanced therapies is likely to be considerable. The collaborators have established a strong patent position around TNF antibodies with few other major competitors. The principle competitor is a US biotech firm which has followed a go-it-alone strategy. The extent of risk and uncertainty attached to this project can be seen in the fact that nine US biotech firms have tried to develop septic shock drugs, but all have failed in clinical trials (Lister 1996), while other firms in the past have failed to convert therapeutic potential of TNF antibodies into marketable drugs. We shall now turn to an analysis of the three competencies.

1. ADAPTATION: CORE (KNOWLEDGE) RIGIDITIES AND BLIND SPOTS

The first generic competency which we focus on is that of adaptation. Adaptive competency requires a dynamic change in a firm's capabilities over time. The existence of core rigidities impedes such a change. Leonard-Barton (1995) notes that the flip side of core (knowledge) capabilities is the existence of core rigidities; core capabilities can, over time, turn in upon themselves and become liabilities. As Peteraf (1993) puts it: "current capabilities may both impel and constrain future learning and investment activity".

The key reasoning is as follows. Development of core capabilities tends to be path dependent (Cohen and Levinthal 1990 & 1994; Collis 1991; Mahoney 1995). The capability grows over time reinforcing behaviours that have lead to past success embedding these deeper in the organisation. This enables the firm to refine its organisational routines and procedures in knowledge integration to such a point that it knows more than any other firm about how to efficiently and effectively deliver value added to a particular market. But as market needs change over time, other knowledge bases may emerge to deliver superior value added. This shift may 'maroon' established "mature" firms leaving them with core capabilities that are no longer appropriate (Herriott et al. 1985; Miller 1993). The resulting rigidities are due to the high switching costs involved in changing core capabilities (Kogut and Zander 1992); inertia within the organisation, and the high level of uncertainty (and hence cost) attached to investments in exploration of new knowledge (Levinthal and March 1993; March 1991; Huff et al 1992). These factors may

encourage members of the firm to continue to apply and expand their current knowledge base to the problems the firm faces, rather than developing alternative, more effective knowledge bases. In short, we suggest that:

> *As firms focus upon the exclusive development of a capability the risk arises that the capability will evolve into a core rigidity. The more the firm learns about a capability the more it builds rigidities and blind spots in its ability to adapt to unforeseen shocks. Shifts in industry dynamics may place heavy demands on the firm. To overcome rigidities, it may encourage mavericks and personnel turnover, strategies which themselves bring further risks.*

There is now emerging a substantial body of evidence on the existence of core rigidities. Unfortunately, much of the work is based on a firm perspective without reference to clear industry analysis. Without recourse to industry analysis it is difficult to establish whether a rigidity within a firm is mirrored by paradigmatic change across the industry. For many firms, failure to adapt may only represent a failure to catch-up relative to general rules of competition within the industry. In other cases, the industry undergoes paradigmatic change driven by 'new rules' set by incumbent or new firms.

Studies which look at both firms and sectors to analyse core rigidities and paradigmatic shifts are relatively few. Documentation of such events is best for automobiles (for example: Hounshell 1984; Womak et al. 1990), but also exists for other sectors such as insurance and publishing (Pettigrew and Whipp 1991) cutlery, textiles, appliances, fibres and pumps (Baden-Fuller and Stopford 1994). The scientific methods and strategies employed by biotech firms may be evolving into a key paradigmatic shift within the pharmaceutical sector (Powel et al 1996). All these studies suggest that adaptation to industry shifts is rare, but do occasionally take place, usually with difficulty.

'Bio' provides an illustrative example of the adaptation dilemma. In the 1980s it built up a formidable capability in the technology of protein production. This enabled it to create a profitable contract business which had a positive cash-flow and many large clients including Merck and American Cyanamid. There was a high level of *inertia* to change within some elements of management as they were committed publicly to a strategy of balancing expenditures on in-house research against revenues from contract research. By continuing to invest in this capability cash could be immediately brought in to fund in-house research which had time horizons of over a decade to market. *Switching cost* were going to be quite high, thus reinforcing attempts to rely on current capabilities, rather than switching. When the new CEO decided to develop a new strategy of greater emphasis on in-house R&D restructuring costs came to about five million pounds. The firm had a cash burn of approximately two years at the time (cash and near cash reserves divided by pre tax losses of the firm) and only two drugs in early stages of clinical trials. This made it very likely that the firm would need to return to capital markets for the cash needed to tide it over until cashflows would be generated from their drug portfolio. Pressures from the capital markets were reinforced by the fact that 'Bio's' largest shareholder was in administration. Long term investments in inter-disciplinary teams, which fundamentally changed the organisation of the firm, added to the costs and risks.

Inertia, reinforced by switching costs, was only overcome via a series of shocks, in this case financial and managerial changes. Huff et al. (1992) note that rarely is a single shock to a managerial system sufficient to overcome the organisational inertia which has built up slowly over time. A single shock can be rationalised away as an aberration, or a temporary occurrence. Ordinarily, as in the case of 'Bio', a radical departure from the status quo is only triggered by a series of significant shocks to the system, which are bunched closely together.

The old capability took key resources and capabilities from in-house R&D. Such R&D was viewed by new management as the engine to drive 'Bio' towards its ultimate goal of becoming a large drug company. The old capability and organisational structure inhibited the development of this engine, therefore this issue was tackled in the early days of the change. To change capabilities the firm engaged in a restructuring of staff away from an organisation structure based around clearly demarcated functional scientific disciplines and towards a structure centred around multi-disciplinary teams. These teams were made collectively responsible for developing drug candidates within three broad therapeutic areas, which were defined by senior management. This change involved resource reallocations and was driven by a change in management and a sense of crisis. It also involved an unlearning of past recipes of success and personnel turnover, issues to which we now turn.

Unlearning

As noted above, it is widely recognised that organisational inertia inhibits change, and that every successful firm faces extreme difficulties in adjustment, especially to industry paradigm shifts. The challenge for firms is to recognise that the capabilities (and the knowledge bases on which they are based) which presently yield success may be the future architects of decline or failure. As capability development is path dependant, the removal of core rigidities takes time. Behaviours can become deeply embedded and inhibit, rather than promote, actions which add value. Unlearning is defined by Hedberg (1981) "as a process through which learners discard knowledge" which is "obsolete and misleading .... " This process of unlearning has been equated by Imai et al (1985) with Schumpeter's process of creative destruction. That unlearning is critical to the broader issue of organisational learning processes has been noted by Bettis and Prahalad (1995) and Huber (1991). New organisations are less disadvantaged than established firms because they have less to discard. Hamel and Prahalad (1994) support this view noting that:

> " Although much in vogue, creating a 'learning organisation' is only half the solution. Just as important is creating an unlearning organisation. Why do children learn new skills faster than adults ? Partly because they have less to unlearn "

The task of 'unlearning' can be viewed as a considerable organisational challenge, because the effort and *risks* involved in switching from one capability to another can be substantial. The interplay between bundles of resources and capabilities necessary to create a new capability will, at the outset, be poorly understood since the creation of organisational knowledge is by definition a complex and uncertain process. Kogut and Zander (1992) articulate this risk in their study when they note that:

> "Switching to new capabilities is difficult as neither the knowledge embedded in the current relationships and principles is well understood, nor the social fabric required to support the new learning known"

In the case of 'Bio' the switch from technological capability to a more therapeutic based capability was a considerable challenge. The technological capability in part moved into the new contract research firm, with 60 redundancies. Research was re-organised with teams focusing around three therapeutic targets selected by the new management. Biologists of differing specialities were put in teams to work towards a common goal. Previously they worked within functional groupings. Now scientists of differing functional expertise worked together within specific projects. Each project had a goal of bring a drug to clinical trials, thus improving the firms research productivity. Additionally thirty five medicinal chemists were hired, and dispersed across the projects as required. The skills which these scientists brought to 'Bio' enlarged its skill base from biotechnology and into the more traditional medicinal chemistry skills of pharmaceutical firms.

Mixing old and new functions within common projects required scientists to learn about issues outside their previous speciality. To do this they had to focus more on these skills and less on their specialist skills which had been their sole previous focus, thus facilitating unlearning. This process of socialisation, a new challenge and vision of the future, and a narrowly defined focus of work (three therapeutic areas with individual teams looking at narrower issues) enabled a shift in capability to occur. The success of this strategy, in terms of research productivity and acceptance by stakeholders, cumulated in the divestment of the contract research firm.

Mature firms face a dilemma. Without unlearning, they may die. Yet, unlearning is risky for the strategies are not secure, and actions to stimulate unlearning may also destroy other dimensions of the learning organisation, a point we take up later. [iii]

Mavericks

It is widely argued that the process of exploration of alternative capabilities is more likely to occur in a firm which contains several different perspectives. These could be diverse knowledge bases on how to conduct specific tasks (e.g. production of a product) or differing perspectives on the more general issues of both what business the firm is in and what business opportunities it is capable of exploiting in the future. This diversity will highlight ways in which the knowledge embedded in the organisational code is 'incorrect'. Diversity of perspectives and individual knowledge bases may suggest novel combinations of the firm's current resources, capabilities and organisational knowledge, thus avoiding stagnation (Herriott et al 1985; Levinthal and March 1981). March (1991) even suggests that the organisation code can only change through the diversity of individuals.

Diversity of views can be created in two generic ways: through mavericks and through personnel turnover. Mavericks are slow to learn "the company way" from the experiences embedded in the organisational code. Such people it is argued, promote diversity of thought within the organisation. In so doing they will increase the likelihood that alternative capabilities will begin to take root in the organisation. These can be accentuated and developed when the central core capability evolves into a core rigidity.

Mavericks *complement* individuals who learn the organisational code quickly, 'fit' into the organisation and do things 'the company way'. Quick learners integrate current organisational knowledge into their jobs more efficiently than slow learners, who expend time questioning. 'Fast learners' may be less effective as catalysts to organisational change than 'slow learners'. Change is more likely to occur if managers notice a gap between the knowledge which the firm employs and that needed to effectively deliver value to customers. Mavericks are good at this. Questions which highlight value adding dilemmas or incongruities are more likely to come from the questioning minds of mavericks rather than 'company people'.

Encouraging mavericks brings direct and obvious risks. They get in the way, they do not promote efficiency and they may be 'wrong' in what they want to do. In the eyes of some, the costs may not be worth the benefits.

Personnel Turnover

An alternative method of creating diversity is through injection of new ideas by hiring new staff (Carley 1992; Simon 1991). Rapidly growing firms are constantly recruiting and do not face any difficulty in getting new ideas. Mature firms which want to become more adept, can only increase diversity through some current personnel exiting the organisation and being replaced by new staff[iv]. The mature firm is forced into employee turnover, and this strategy requires a careful management of knowledge stocks, such that valuable knowledge stored in departing personnel is substituted through the process of new personnel entering the organisation. Some of the disruptive effects can be avoided if the knowledge is transferred and stored in retrievable fashion within the organisation's routines or remaining personnel. Use of turnover strategies also requires awareness of the possibility that the departing staff during the 'hand over' period may indoctrinate new staff in knowledge, or behaviours, which the firm's management would prefer extinguished (Javanovic and Nyarko 1995).

Intellectual diversity was essential to 'Bio's' change in capability. New senior management recruited from outside 'Bio' brought with them a different perspective on how the firm could achieve success. No longer was the focus on two balls. Now the drive was to be a targeted in-house research organisation. The new team brought a new vision and also new skills, including knowledge of asthma therapies, which had not previously been a focus at 'Bio'. New people in the area of medicinal chemistry were hired, a necessary ingredient in the new strategy. These were mixed in with old 'Bio' staff and also with the previously segmented disciplines of biology. We see turnover occurring in 'Bio' both from within and through 'new blood'. This enabled further stimulation of a new direction and capability. But all this change was risky. Old employees might not have adapted to the new change. New teams might not have 'gelled'. Research results would have initially slowed and momentum might not have been regained. Capability change is an uncertain path.

Staff turnover and mavericks bring other problems. Not only do they have direct costs and risks, but their attitude may threaten other dimensions of learning inside organisations. One of these is the discouragement of learning by doing, and another is effective exploitation. To appreciate these issues we examine the limits further.

2. AVOIDING SLOTH: SPEEDING UP LEARNING AND KNOWLEDGE DEEPENING

Whereas core rigidities threaten the firm which needs to leverage an adaptive competency in shifting competitive paradigms, more straightforward competitive pressures threaten the firm which is too slow at learning. Most at risk are well established organisations which are threatened by younger rivals (e.g. pharmaceutical firms Vs biotech start ups). It is often noted that successful newer firms show a generic competency to deepen knowledge more quickly. As population ecologists often note, age can be a real disadvantage in the survival race.

Many have noted that a firm's social system plays an important role in determining the speed and path of learning (Brown and Duguid 1989; Imai et al 1985; Kay 1993; Orr 1990; Simon 1991). Changes in the levels of control of social interaction over the structure of communication flows within firms can increase shared understanding, through increases in organisational slack (Blacker 1995; Cyert and March 1963; Huber 1991; Nonaka 1991).

Nonaka's work indicates the central role of social processes in the 'spiral' of knowledge creation, which he views as a key to the success of firms (Nonaka 1994; Nonaka and Takeuchi 1995). In Nonaka's view the development (and deepening) of capabilities (and the knowledge on which they are based) within firms involves a process of conversions of tacit knowledge into explicit knowledge, explicit knowledge into tacit, and from one form of explicit or tacit knowledge to another. For Nonaka the driving forces for these transfers between forms of knowledge are attempts to create new knowledge and to improve the efficiency of integration of existing knowledge into the firm. Nonaka sees movements to or from tacit knowledge as involving a high degree of social interaction.

Sometimes small changes in social interactions can result in considerable changes in the efficiency and effectiveness of deepening a capability. This is due to the often causally ambiguous interconnections between bundles of resources, capabilities and human factors which lead to success (Badaracco 1992; Hall 1992; Itami and Roehl 1987). Put simply, capabilities can evolve and be successfully deployed in a black box environment. Management may have a reasonable understanding of the inputs dedicated to the capability and the broad outputs it produces but it remains largely unable to decipher the causal relationships between the inputs which determine the successful delivery of the outputs. There are socially complex interactions and high degrees of tacit knowledge involved in the creation of a complex capability. We suggest

> *Learning in of itself is an uncertain process and the competency of knowledge deepening requires looser social control mechanisms and more organisational slack, particularly in terms of knowledge overlaps and redundancy. The outputs of loosening are uncertain and can result in a substantial risk that both the efficiency and effectiveness of our current capabilities is reduced. There is also a risk that slack maybe appropriated for purposes other than organisational knowledge creation.*

Slack

It is commonly recognised that increased rates of learning and knowledge deepening can be achieve by increasing slack. More slack permits a higher degree of interaction between people, involving higher levels of communication, greater flexibility and experimentation (Huber 1991; Inkpen 1995; Kogut and Zander 1992; Mc Gill and Slocum 1993; Nonaka and Takeuchi 1995). Increasing information redundancy or organisational slack by creating overlaps of information and knowledge is another learning stimulant (Cyert and March 1963; Nonaka 1991). Slack is also necessary for job rotation, another way of creating knowledge and a complementary strategy to personnel turnover (Cohen and Levinthal 1990; Nonaka and Takeuchi 1995). Ghemawat (1991), notes that slack may need to be carefully managed as it can be subject to misappropriation especially by employees. Slack is an investment, it has a high cost and the returns may not come for some time and are uncertain.

The risks of slack being misappropriate are obvious. Some of the risks can be curtailed. In knowledge terms slack can be offered as a freedom to experiment, uncontrolled social interaction across functional groups and development of overlapping knowledge bases through access to common data bases. Such freedoms do not need to be equally applied to all members of the organisation, nor does slack necessarily have to be unquantified. For example, it is reputed that 3M have allowed research staff 15% of their time to engage in such activities. It is believed that prudent usage of slack can increase the creation of commercialisable knowledge. 'Bio' once had a scheme similar to 3M, but found it did not work. 'Bio's' approach is different. As the Director of Research put it:

> 'It just doesn't produce good results [the 3M system]. I don't think that people can partition their time. All this is driven by needs. Some of the time you are at a particular stage of the programme and you are working on it all of the time, but at other times you can spend more time doing other things. This idea that you can spend 5% of your time doing something else is just not real - at least not in our environment, it doesn't work.'

'Bio' provide objectives for staff on each research programme. During troughs researchers are encouraged to experiment on ideas which fall within the three broad therapeutic areas. These ideas can and do feed into future

research candidates through a process of bubbling up of ideas and formal strategic reviews as large research projects wind down, freeing up resources.

Whether controlling slack formally as in the case of 3M, or through culture as in 'Bio', the provision of slack seems important in the process of deepening. Equally control is important. For 'Bio' the close proximity of senior management to researchers enables tight control through project objectives and informal understandings - this is not the case in a large firm. Close proximity is enabled because all staff are located on one small site in southern England. Compare this to one of 'Bio's' principle collaborators who has over 8,000 products, a market presence in 140 countries, and over 2,000 R&D staff in its central research division alone and one can see the proximity issue at a practical level.

Creating slack is consistent with policies encouraging mavericks and employee turnover. Mavericks and new comers need space in which to operate and freedom to experiment. Thus, at first, it seems that the three mechanisms for encouraging the learning organisation are consonant. However, other mechanisms widely advocated are potentially in conflict.

Common Codes and Shared Language

For knowledge to be created there needs to be investment in a shared language amongst the individuals involved (Blacker 1995; Cohen and Levinthal 1990; DeGeus 1996; Nonaka and Takeuchi 1995). Just as academics develop precise codes to facilitate the transfer of ideas among themselves, so people in organisations generally need to express their ideas in terms that others understand. Given the central role of individuals in knowledge creation, without the transfer of knowledge across individuals organisational knowledge would be unlikely to develop to a commercial level, if at all.

The creation and development of a basic common language is a costly and uncertain task. When creating and integrating complex knowledge into organisational routines and directions, it is likely that the opportunity for misunderstandings will develop. This integration of knowledge occurs across several functions, and the problem of shared knowledge becomes more pronounced.

In the case of 'Bio' when it changed from a discipline/technology based capability to a therapeutic capability chemists were thrust together with biologists leading to differences in common understandings. This required colleagues to train each other up in the basics of their discipline. In so doing knowledge overlaps and redundancies were created. An understanding of the language and mind sets of other disciplines facilitated a deeper understanding of the problems facing the firm. Triggers for innovative solutions were set off through this process of developing shared understanding. This challenge has also been faced by the firm in its collaborative efforts. 'Bio' have found that its collaborators tend to think differently. This makes communications across firm boundaries a slow process of learning, where firms learn to talk to each other, learn the meaning of their objectives, mind sets, and systems, thus slowing transferring the knowledge needed to collaborate. This process can also help the firm to recognise and learn gaps in its own knowledge bases stimulating both the competencies of adaptation and deepening.

The creation of a shared code of language creates other risks. The first is that it makes it much more difficult for mavericks and outsiders to operate. The common code is a typical feature of a strong culture, that is one that resists outsiders and non-conformists. Mavericks and new comers are effectively excluded from organisation debates, or if included find themselves in difficulties in making their new ideas felt.

The second problem which shared language can create is that of imitation. Paradoxically, whilst shared language may discourage outsiders who want to change the course of the firm, the existence of a shared language which is understood by exiting personnel will increase the firm's transparency. Thus, a strategy which is designed to help learning along one dimension may cause problems along another. To understand this more fully we have to explore the issues of appropriation.

Loosening of social controls does not imply anarchy. In 'Bio' its reorganisation of staff into inter-disciplinary teams created social change. This was reinforced by the creation of knowledge overlaps and redundancies. Simultaneously control over research focus was tightened with research teams working to defined milestones and within three defined therapeutic areas. Review processes of research are in place, in addition to broader strategic reviews of research direction in the firm as a whole. 'Bio's' change involved loosening control in some areas to stimulate creation of commercialisable knowledge, while maintaining and strengthening other control systems. It is not enough to deepen knowledge, a firm needs to embed this in its products and services from which the knowledge base can be exploited. It is important for firms to balance exploration and deepening of knowledge against exploitation, which has its own challenges to which we now turn.

3. IMITATION THREATS AND APPROPRIATING LEARNING BENEFITS

The third generic competency is the need to achieve exploitation without imitation. Every firm which grows commercial knowledge about a specific issue faces imitation by its competitors. Moreover, the greater the level of valuable knowledge, the greater the imitation risk. Several authors have noted that for firms to appropriate the greatest return from its knowledge it needs to make that knowledge available to a wide audience within the firm (Kogut and Zander 1992; Nonaka and Takeuchi 1995). This typically involves moves to make tacit knowledge more explicit, thus facilitating a more efficient integration of such knowledge across an enlarged group of people within the firm. However, as it becomes easier for knowledge to diffuse within the firm, so the risk of diffusion of valuable knowledge to competitors increases.

> *Greater rates of commercial learning across the organisation requires more organisational knowledge to become codified, or, replicable. As firms commercial knowledge becomes more explicit the risk of external imitation becomes larger, thus placing greater challenges on the appropriation of rents.*

Nonaka and Takeuchi (1995), comment that unless shared knowledge becomes explicit, or codified, then it cannot be easily leveraged by the organisation as whole in the creation of value added. Kay (1993) probably goes too far when he says that if the firm is to appropriate return for itself then every member of the firm must be replaceable. However, effective exploitation requires much of the technical and organisational knowledge of the firm to be stored explicitly, or in detailed organisational routines and procedures. Attaining these goals efficiently pressures the organisation towards codification of its knowledge base.

Here lies the heart of the problem of knowledge management and exploitation. To efficiently integrate knowledge into the product/service offerings of the firm it will tend towards the codification (including efforts to create routines and procedures) of such knowledge. In so doing it increases the risk that its knowledge will leak out of the firm and be imitated and improved upon by competitors. It is possible for management to slow, or channel the process of knowledge migration to varying degrees. It is not possible for them to halt the leakage of valuable knowledge from the firm. To understand this, we need to explore the issues further.

Codification and imitation risk

There are three key forms of knowledge that flow across firm boundaries, namely, explicit knowledge (e.g. product designs), knowledge embodied in products, and knowledge embedded in the organisational routines and processes of the firm (Blacker 1995; Geroski 1991; Grant and Baden-Fuller 1995; Inkpen 1995; Teece 1977). Migration of explicit knowledge and embodied (product) knowledge is much more rapid than embedded knowledge (Badaracco 1991).

Firms cannot necessarily rely on intellectual property rights for protection. For example, writing down knowledge in a detailed patent offers legal protection. On the other hand, the patent can be read by other firms. Given the explicit nature of a written legal procedure, patents provide other firms with a considerable insight into the nature of a product or process. They can work their way around the legal protection offered by a patent and imitate the product or procedure (Mansfield et al 1981).

Avoiding intellectual property right issues by commercial secrets poses difficulties too. The problem with a commercial secret is a basic one. If a secret is shared with some one else, for example a joint venture partner, a

supplier, or a customer, then its unlikely to remain a secret for long (Von Hippel 1988). To gain maximum value, the knowledge must be leveraged across the organisation, yet this risks revealing the secret.

Secrecy is always uncertain. Complex social interactions are not limited to the boundaries of the firm. Employees have social outlets other than the firm through which knowledge may flow, including professional circles and private social networks. Modern communication technologies, and managerial systems which encourage closer interaction with actors outside the boundaries of the firm, such as just in time supply chains and inter-organisational collaborative initiatives may accelerate such interactions and, thus, diffuse key bundles of knowledge beyond firm boundaries and into the hands of competitors.

The protection mechanism of casual ambiguity is a third possibility. If the actions and relationships which lead to successful completion of a set of tasks are 'inside' the black box, that is if they are causally ambiguous, then it will be difficult for competitors to successfully imitate the capability (Peteraf 1993). But causal ambiguity brings risks. Collis (1994) points out it may make it difficult for firms to detect that some minor changes between resources and capabilities are destroying the core capability itself. As the complexity of a capability increases, then the likelihood of such destruction will also increase over time. Over the long term in an environment of high causal ambiguity the firm is likely to engage in as much capability destruction as creation. The dilemma facing the organisation is to balance attempts at reducing imitation by increasing causal ambiguity with the risks of increased imitation from competitors spurred on by codification of capabilities inside the firm.

'Bio' seeks to bring knowledge exploitation forward by collaborations with major pharmaceutical firms who provide milestone payments. In the drug discovery and development project which we researched 'Bio' and its partner have tried to lock out competitors via strong patent positions. Each firm has a slice of the other's patents in the project. In this case knowledge flows across organisational boundaries in the pursuit of end products, but at the price of final rights. This involves negotiation skills, and a deep knowledge of the underlying science and competitor positions - a valuable capability !

Researchers are part of a wider community. Interaction with colleagues from other firms through conferences etc. does occur. These interactions provide stimulation for 'Bio's' research but this is a two way process which is reinforced by staff turnover. Much of the present senior management come from other firms within the industry. They brought with them different perspectives on research direction and organisation. Of course this influx does not reduce the risk of an industry wide core rigidity being reinforced inside 'Bio'.

As knowledge flows from the industry to 'Bio' some knowledge flows the other way. The competitive game is to manage serious losses via confidentiality clauses and organise to more efficiently embed knowledge which flows across the industry into commercialisable research projects than can the competition. This is where 'Bio's' complex capabilities in the management of inter-disciplinary research teams, collaboration and the financial community comes into play. This success can be seen in 'Bio's' continued survival and progress in clinical trials, which compares favourable with other biotech firm's on the London Stock Exchange. The experience of the biotechnology sector is reinforced by Mansfield (1985) who found that knowledge about new product developments and understanding of new processes leaked to competitors between six and eighteen months. This data tends to indicate that relying solely on gaining superior value added relative to competitors via *once-off* efforts to obtain greater knowledge about a product, or process, may lead to a quite short term advantage.

Finally, and most critically, we reinforce an earlier message. Codification, like other mechanisms, brings additional risks. The process requires greater degrees of social control and more organisation codes. These threaten the critical processes of adaptation, and put the firm at danger from excessive rigidities. Thus, an action to alleviate limits to learning in one dimension hazards those along another.

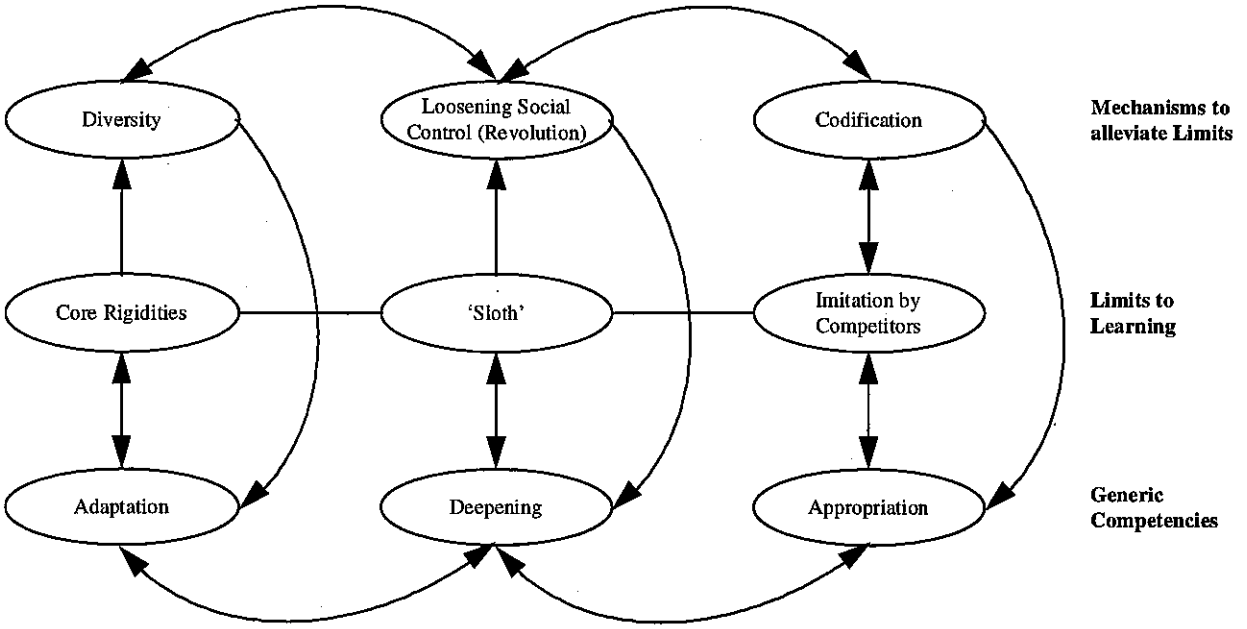
DISCUSSION

In this section we will discuss two issues. First, the interconnections across each of the competencies, the traps and mechanisms to elevate them. Second, some very tentative comments on the interconnections between firm behaviour and industry behaviour. This is a focus of on-going research and shall be presented in later papers.

Figure two illustrates the complexity of the problem. The paper thus far has explained the vertical interactions in figure two of how each individual competency relates to its limit and the relationship between the limit and the mechanism by which it is elevated. We have also alluded to interactions between the competencies. Interactions also exist across the mechanisms to elevate the limits, while each limit can reinforce, or trigger another. These interactions are represented by the horizontal interactions in figure two.

There is a classic conflict between the competencies of adaptation, deepening and appropriation. It is a struggle which all businesses in the long term face in varying guises. The challenge for mangers is to creatively, and profitability, manage the overall balance between these three competencies, deciding when to focus on one, or two over another. The reasoning for these conflicts is basically as follows. Adaptation seeks to increase flexibility and overcome the negative effects of specialisation caused by core rigidities. Deepening seeks to reinforce the gains from specialisation in capabilities. Appropriation seeks to increase returns from specialisation via internal imitation which is designed to increase exploitation but risks external imitation.

FIGURE TWO
Interactions between Learning Limits and Generic Competencies



The competency of adaptation includes an exploration for new knowledge, or competencies, over time to avoid the onset of corporate wide core ridgities. This conflicts with the deepening competency, which seeks to deepen commercialisable knowledge about a single set of current knowledge in the face of agile competitors. In a firm with finite resources and capabilities there is a conflict between managers who wish to invest in the exploration of new competencies versus the deepening of new knowledge. In the context of 'Bio' this can be seen in the tensions between increased investment in the development of a current portfolio of drugs (currently about five), versus the drive to discover new drugs which can be pumped into future development (currently also about five) and the tension for discovery to move outside the present three broad therapeutic areas within which current research is limited by a general management policy. These conflicts are at present contained through formal mechanisms such as annual and strategic reviews of investments in discovery and development, as well as a high degree of contact

and co-operation between staff in both the research and development wings. The fact that the research wing of the firm is larger, in terms of staff, by several orders of magnitude is also a natural limit on over focus on development, while pressures to appropriate a return are a counter balance on over focus on adaptation, or exploration.

The competency of adaptation is also in conflict with that of appropriation. In an industry beset by negative long term cash flows, there is considerable pressure to get products and services out to the market quickly, potentially at the cost of long term exploration projects. This may have occurred in 'Bio' towards the turn of the decade. It had deepened its technological capabilities to the extent that pharmaceutical firms were willing to contract out certain technical tasks to 'Bio'. 'Bio' was in fact making a profit overall based on this contract business, however this was at the cost of developing a substantial pipeline of its own drugs. The entry of new management lead to a sea change where investment in the research side of the business was given priority relative to the contract side. Slowly over time adaptation occurred and a substantial portfolio of drug candidates was developed. The deepening competency refocused on deepening skills in the research and development of drug candidates, leading to a portfolio of five drugs in development and about five more clearly identified drug discovery projects. Innovations in appropriation, through alliances with pharmaceutical firms in R&D, coupled with innovative capital financing, enabled the balance between adaptation, deepening, and appropriation to be redressed. Temporarily 'Bio' seem to be successfully managing, and thriving on, the tension between the process of adaptation, the search for new knowledge, and the drive to appropriate a return from current knowledge bases.

There also exist conflicts across the mechanisms to elevate limits, as illustrated in figure two. In general one can view the mechanisms of diversity and loosening social control as complementary. Unlearning, mavericks and personnel turnover can all be fostered in an environment where there is a managed level of slack. With slack mavericks can be free, within boundaries, to explore their alternative views of the firm and what its function is. Slack can also enable unlearning to occur, giving people time to develop new ways to work, without being forced to rely to heavily on the crutch of old ways that excessive pressure to deliver results in a short time period can bring. Slack may also aid in personnel turnover, enabling current staff to rotate jobs, and new staff to be added. Shared language may liberate people, enabling them to talk across disciplines as in the case of 'Bio', however, it may also impede diversity. Common codes, may be a cultural barrier to new personnel entering the firm, much like an emigrant entering a country the language of which he has learned in school but never spoken amongst natives. The natives may embrace him, teaching him their colloquialisms, rejoicing in his new perspective and accent, on the other hand they may not.

The real conflict is between diversity and loosening on the one hand and codification on the other. Codification seeks to enable knowledge to flow across the organisation more quickly and uniformly, however this occurs at some compromise to the ideal of diversity. Codes require some degree of co-ordination and conformity, while diversity requires some degree of tolerance of non-conformity. Should either mechanism meet the extreme of the other, then considerable conflict will arise. In communities where scientific individuality is sacrosanct, such as some universities, then the codification versus diversity dilemma can become a cornerstone of the organisation. Similarly so in 'Bio' which at the turn of the decade was viewed by some managers as akin to a cultural relative of the university system.

Finally in figure two, we turn to the complementary nature of the limits. A core ridgity may develop from sustained deepening and be reinforced by sloth. When faced with an agile competitor the temptation may be to dig deeper into the old ways of doing business. This is the classic problem of doing what we do better, being more efficient at delivering products and services employing current techniques, rather than doing what we do differently, incorporating new techniques, and thus becoming both more effective *and* efficient. In the face of reduced returns brought on by imitation we may sink further into a core ridgity response.

The vertical effects of figure two challenge managers to maintain adaptive, deepening and/or appropriation competencies in the face of serious limits, core ridgities, sloth and imitation. The horizontal effects which we explored above challenge managers further by raising the important concern that efforts to nurture one competency may come at the cost of another. We will close the discussion by briefly alluding to the vertical challenges which can be faced at an industry wide level. This is the subject of current research efforts.

It has been reported that it is a goal of about 40% of UK biotechnology firms to become fully integrated companies engaged in the full value chain from drug discovery, through to development, manufacture and eventually marketing through their own marketing network (Arthur Anderson 1994). This raises and interesting issue at the industry level. In the 1990s UK biotech firms used innovations in appropriation to fund long terms discovery and development projects. One of the innovations was to engage in long term R&D alliances with major pharmaceutical firms where the biotech firm obtained milestone payments for achieving certain research milestones, while at the cost of splitting the eventual royalties. 'Bio' has been one of the leaders in this area with an estimated 25 to 45% of final net profits (in the event of drug sales) accruing to 'Bio' from its various alliance deals.

The limit for the biotech firms may be that the much larger pharmaceutical firms may learn more from their vast network of alliances with biotech firms than individual biotech firms learn from their own ('Bio' has five major alliances). The majors may be able over time to imitate the capabilities of the biotech firms, thus squeezing the biotech firms' future returns. On the other hand this phenomena may also enable biotech firms to learn key development and marketing skills which they are presently weak in. If 'Bio' and other such firms were to have success in an alliance with a product of $ 500m plus then they may gradually develop the financial resources to deepen their current drug discovery capabilities but to also adapt and grow their development and marketing skills. Over time this could enable them to compete directly with the major pharmaceutical firms in the total adaptation-deepening-appropriation value chain.

This is a phenomena has occurred before, for example in the automobile industry. Badaracco (1991), outlines the fascinating knowledge based competition between GM and its alliance partners. In the beginning Toyota was a small and not successful car manufacturer, by learning from GM it adapted and deepened its competencies, for example in engine design, over time it rose to challenge GM globally. Similarly GM responded with innovative use of knowledge based alliances to attach its Japanese competitors/alliance partners. We recognise that there exists considerably greater homogeneity amongst automobile products than in the pharmaceutical sector, and that the sector is somewhat less concentrated in terms of number of large dominant firms. Not withstanding the above caveat, this is a phenomena which may also be in its infancy in the story of biotechnology and pharmaceuticals. David and Goliath stories may lurk as much in the world of biotech today as they did in the automotive industry in the 1970s and 80s.

CONCLUSION

The three competencies *adaptation, deepening and appropriation* are well known. Although their flip side the three limits to learning: *core rigidities, sloth and imitation* have been discussed by many, the exploration of the mechanisms which overcome these limitations has received much less attention. A critical contribution of this paper is that mechanisms which alleviate one limit are likely to be risky and aggravate a difficulty elsewhere

The discussion of knowledge management within the overall strategic management conversation is an emerging and exciting debate. The simplistic view that the learning organisation is a reverential goal belies the existence of the many traps which exist for the unwary and the serious risks for firms which seek to attain this goal. For the debate on learning to develop and mature into powerful contributions to both academia and industry there is a need for an overarching view. There is a need to balance the claims that knowledge management can act as the central driving force of economic growth in the twenty-first century against the genuine challenges and dilemmas that the strategic management of commercialisable knowledge bases poses to firms. This paper is a modest contribution to the powerful contributions of Grant, Kogut and Zander, Leonard-Barton, Nonaka and others in the framing of a balanced debate.

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[i] *Capabilities* can be defined as ' information based, tangible or intangible processes that are firm specific and are developed over time through complex interactions among firm's resources .. unlike resources, capabilities are based on developing, carrying and exchanging information through the firm's human capital.' (Amit and Schoemaker 1993). An example is 'Bio's' ability to engineer innovative therapeutic drugs using its knowledge of antibodies.

We view *organisational learning* as a process of creation, development, maintenance, expansion, contraction and decline of knowledge based competencies.

[ii] Imitation does not imply just copying another firm's knowledge bases, but involves taking some of the best concepts of a pioneer's ideas and improving upon them (Kogut and Zander 1992; Schnaars 1994). Imitation is a complex capability which may be an important element of a firm's overall strategy to success !

[iii] In addressing the challenge of core rigidities the firm is faced with three primary strategies. **First,** take a population ecology world view, accepting the onset of organisational decline that core rigidities will eventually

imply as the firm becomes increasingly divorced from its environment, and hence organisational death. **Second,** invest in unlearning capabilities either provocatively, or as and when the need arises. **Third,** invest in the promotion of intellectual diversity. A firm's overall response to core rigidities is likely to involve a blending of each these three strategies based on organisational context. When addressing the creation of an overall strategic response to core rigidities the firm needs to consider do the costs, and by implication the risks attached to each of the three options combined, or individually, exceed the potential benefits (Dorroh et al 1994).

[iv]Downsizing, prevalent in mature organisations since the 1980s, may provide an opportunity and a barrier to turnover strategies. Exiting personnel offer the opportunity to inject new blood into the firm. Equally, introduction of new personnel may encounter considerable resistance, being viewed as inconsistent with the downsizing goals of cost reduction and improved efficiency.