‘MEET THE PARENTS’: THE IMPORTANCE OF ‘PRE-CONCEPTION’ CONDITIONS IN FACILITATING HIGH-TECHNOLOGY SPIN-OUT COMPANIES

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This Working Paper relates to work undertaken by the CBR into the incubation of high technology small firms as part of the EU STRATA Programme.

Abstract
Encouraging the spinning out of high tech companies from higher education institutes (HEIS) is now a major tenet of industrial policy in the UK and other European countries. New enterprise formation is seen as a vehicle for technology transfer and the commercialisation of research by universities, and independent and government funded research institutes. Despite the proliferation of schemes and mechanisms supporting would-be entrepreneurs and their nascent enterprises, we are still some way from identifying the factors making for success. Understanding any scheme aimed at generating new technology based firms (ntbfs) requires a holistic approach which considers the nature of the parent research organisation, the local economic context, the specific objectives of the scheme and the changing needs of new enterprises. The nature of the parent is particularly important in setting what may be seen as 'pre-conception' conditions: namely inspiration, motivation, willingness to take risk and identification of potential idea. This paper describes differences found in these pre-conception conditions in a number of research organisations in the UK.

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Introduction

The last decade of the 20th century saw increasing policy concern for the potential economic role of the academic research sector[1] in many countries. At the national level that role has become bound up with concerns for innovation, the growth of knowledge based industries, and international competitiveness (DTI 1993, 1999). In the UK there has been blurring of the boundaries between industrial, regional and science and technology policy (Wren 2001). Universities in the UK are now charged with a 'Third Arm': the mission to commercially exploit their research (DTI 1993, 2000). Equally, in Germany concern for lack of national competitiveness in biotechnology prompted the development of the 'BioRegio' initiatives[2].

There has also been growing awareness of the importance of the university sector to the local economy. Under the notion of 'technology spillover' technological advances arising from academic research are seen to be transferred to local industry through a variety of mechanisms: licenses to local firms, collaborative research, provision of expertise, contract research and the entry of graduates into the local labour market (Collins 2001; Jaffe et. al. 1993). The growth of high tech clusters in the US and to a lesser extent the UK has focussed attention on the potential impact on local employment generation by companies spun out of universities and research organisation. Such impact comprises both the direct employment in such companies and employment generated indirectly through either these companies in turn spawning other new firms or encouraging the development and growth of other activities (Saxenian 1994; Keeble 2002). Indeed in some European countries, such as France, the potential impact on employment has been made explicit in initiatives aimed at fostering the growth of research based spin-outs. [3].

The economic role of the academic research sector has also been the focus of academic interest. Some have described the adoption of the technology transfer role by universities as a 'second academic revolution'[4] and others have described the emerging state, industry,

academe relationships in terms of a 'triple helix' (Etzowitz and Leyesdorf 2000). Institutional theorists have seen variations in national institutional frameworks as underlying differences in the ability of research systems to generate radical technological advances and to encourage the embodiment of these in new spin out companies (Hage and Hollingsworth 2000; Casper 2000). This paper draws upon an institutionalist approach but is focused on the generation of spin-out companies by research organisations.[5]

It can be suggested that the local economic impact a research organisation may have through generation of spin-out companies is shaped by three highly interrelated factors. The first is the extent to which the norms, rules, conventions and values specific to the research organisation are conducive to entrepreneurship. These can be termed the 'pre-conception' conditions. The second is the extent and effectiveness of mechanisms aimed at supporting spin-out companies, that is, the support mechanisms: and the third is the extent to which the local economy in which the research organisation is embedded supports nascent high tech businesses and its own generative capacity. As suggested above policy concerns have lead to a proliferation of support mechanisms in the university sector across the EU and elsewhere. But because the factors shaping the impact of such mechanisms are so strongly interrelated caution must be exercised in evaluating the appropriateness or effectiveness of support mechanisms in the absence of appreciation of both the pre-conception conditions and the local context. Compared to universities such as Imperial College and Leeds, Cambridge appears to have relatively under-developed and uncoordinated formal mechanisms for supporting research based spin-outs [6]. This relative lack however is understandable when set against firstly, the highly entrepreneurial nature of many individuals and many departments within the university, secondly, university wide initiatives such as the Cambridge Entrepreneurship Centre which embody the University's commitment and support for entrepreneurship, and finally, the deeply supportive nature of the local economy. Within that local economy there has been both proliferation and deepening of services and

networks supporting technology intensive industry; what Amin and Thrift have described as ‘thickening’ of the local institutional environment (Amin and Thrift 1995; Keeble 2002).

This paper focuses on the pre-conception conditions: on the norms, rules, conventions and values which may foster or inhibit the formation of spin-out companies. The focus will be further restricted to spin-outs based on research.[7] Norms, rules, conventions and values specific to an organisation are components of its culture. The next section of the paper reviews work on organisational culture and entrepreneurship. The third section builds on this to suggest how the specific nature of organisational culture may foster or inhibit entrepreneurship and innovation. The final section of the paper provides empirical illustration by drawing upon a brief survey of the pre-conception conditions in a number of research organisations in the UK.

Entrepreneurship and Organisational Culture

The particular 'model' of research-based spin-outs adopted here assumes active involvement by individual researchers be they students or staff but involvement in the sense of 'championing' of an idea for potential commercialisation rather than necessarily ownership.[8] In this sense there are many parallels with work on innovation. The question is what motivates individuals towards high tech entrepreneurship. Most studies of small business formation have traditionally suggested that the primary motivation for venture creation is not pecuniary gain (Bolton 1971; Hamilton 1987). High tech entrepreneurs would appear to be no different in this respect (Roberts 1991; Whittaker 1999). Research spanning decades has demonstrated the importance of motives such as the desire for autonomy and independence, (Stanworth and Curran 1976; Cooper, 1986; Townroe and Mallalieu, 1993), for achievement in the sense of accomplishment of personally set goals (McClelland 1961) and a willingness or desire to effect change (Brockhaus 1982). Entrepreneurship involves ‘new combinations’, so by definition the

venture creation is a creative act. The popular notion of the entrepreneur driven by a need for adventure and risk is similarly unsupported by empirical research (Whittaker, 1999). Many of the aspects mentioned above, such as the role of independence and autonomy, the importance of being able to make a difference, and the notion of having a cause to commit to, have also been found to be important in fostering innovation (see Hesselbein, Goldsmith and Somerville, 2001).

A further revelation concerning entrepreneurship which is seemingly at odds with the popular notion of the heroic individualist is the finding that a significant proportion of small businesses are collaboratively founded and that collaborative founding is a particular feature of high tech small businesses (Roberts 1991, Harding 1998; Whittaker 1999; Quince 2001; Quince and Whittaker forthcoming). Indeed collaboration in terms of both the founding team and wider network involvement would appear to be a crucial factor in new high tech small firm survival (Saxenian 1994). So too in innovation, teamwork and collaboration are vital elements (Katzenbach and Smith 1998).

If these are the motives underlying entrepreneurship, what aspects of organisational culture facilitate or hinder their generation? Individual organisations will develop their own subset of the dominant norms, rules, conventions and values of the society in which they are embedded and at the level of the individual organisation these form its culture (Hage and Hollingsworth 2000). Organisational culture can be considered in terms of layers or levels, differing in their visibility and impact (Schein 1991; Hunt 1991). The outer most visible layer, Schein (1991) termed the organisation's 'constructed physical and social environment' comprising physical and spatial aspects, written and spoken language, organisation structure and modes of executing managerial functions. An organisation's prevailing 'ethos', ideologies, attitudes and ethical codes reflected the next deeper layer of culture of values (what ought to be), and beliefs (what is). The deepest layer of culture Schein saw as those 'unconfrontable' implicit

basic underlying assumptions that 'actually guide behaviour', 'tell group members how to perceive, think about and feel about things' (Schein, 1991 p 8).

These basic underlying assumptions cover the nature of human nature, the nature of human activity and of human relationships, the nature of truth and reality, and the relationship with the environment. In very general terms it is possible to suggest how the basic underlying assumptions of a research organisation's culture facilitate the development of autonomy, personal goal setting, desire to effect change, and creativity and collaboration, all of which are important in the context of entrepreneurship.

Assumptions concerning the relevance of different components in the environment may influence the evaluation and extent of contact and interaction with industry. In providing diversity of views and information, and exposure to problem sources such contact is seen as important in facilitating creativity. For example, many studies of innovation have shown that a large percentage of innovations are initiated by users (Kanter 1988). However, the nature of that contact or interaction, and in particular whether it allows for ownership of problems, may be more important in motivating entrepreneurship in allowing opportunities for personal goal setting and effecting change. Similarly assumptions concerning reality in defining the relevance of information may affect the adoption of multidisciplinary approaches and hence opportunities for cross fertilisation of ideas (Wheatley 2002).

Other basic underlying assumptions about the nature of human relationships and the nature of human nature will have a pervasive effect on reward systems and structures, on perceptions and evaluations of competence, on the nature and development of trust and on the structural arrangements regulating the contact between the research organisation and other actors in its environment. How jobs are defined in terms of breadth influences opportunities for autonomy and personal goal setting (Kanter 1988). Similarly the exercise of

autonomy, experimentation and attitudes towards failure are inextricably bound up with trust. Collaboration may be influenced by the definition and management of boundaries.

Generic Nurturing Processes

In her seminal essay on innovation Rosabeth Moss Kanter (1988) used the metaphor of 'nurturing' flowers. That metaphor can be adapted and the influence of organisational culture on entrepreneurship can be operationalised by looking at the generic processes involved in nurturing research-based spin-out companies. Figure 1 illustrates these processes. There has been much evidence to suggest that like innovation, enterprise formation is non-linear hence the overlapping nature of the processes. Despite this there is some sense of natural progression. As suggested above the pre-conception conditions, reflecting the most immediate impact of organisational culture, can be seen in the first two processes: 'generating desire' and 'perceiving opportunities'.

Generating the desire can be seen as having three components:

- inspiration, in the sense of stimulating an entrepreneurial urge
- aspiration in the sense of striving towards attainable goals and
- irritation in the sense of providing the ‘grit’ around which a pearl can form.

Inspiration

Researchers are unlikely to be inspired in organisations which do not regard entrepreneurship positively. Such evaluations can be expressed both formally and informally. Among the formal expressions are mission statements or objectives which explicitly include the commercialisation of research through new company formation. These objectives need to permeate the organisation and not remain simply espoused by the upper echelons. The researcher's perception of the regard with which the organisation holds venture formation is

most immediately reflected in performance measures, career structures and what he or she understands is regarded as 'success' by the organisation. There are a number of problems in academe with respect to performance measures such as the use of national pay scales, which often reward age and ‘time served’, which are considerably below rewards in the private sector, and which in many instances give little room for negotiation. Similarly measures of productivity or success which focus exclusively on publications and rarely take account of inventiveness or involvement in venture formation reflect the implicit message that such activities are not seen as valid for a researcher.

Among informal expressions the regard with which entrepreneurship is held by peer groups can have a significant impact. For example, in a study of research-based spin-outs from the University of Turin (Grimaldi and Grandi 2001) some academic entrepreneurs reported feeling afraid of their colleagues' hostile reactions, and felt when thinking about or planning their business that they were committing 'a crime'.

The role of research funding is also important in this context. Benner and Sanstrom (2000) suggest that two approaches to funding can be identified in most university sectors. One is a traditional research council approach controlled by academic researchers with a long-term focus on fundamental issues and evaluation by peer review, international recognition and scientific excellence. The other is a mission-oriented approach more focused on problem-oriented research controlled by practitioners with evaluation based on relevance to wider society and dissemination by user-friendly means.

Much of the work on organisational culture points to the importance of myths and stories, of heroes and villains in encapsulating and embodying dominant assumptions (Pondy et.al. 1983). Successful academic entrepreneurs as role models inspire others. Here the important questions concern the regard with which such people are held, their visibility and the explicit use made of them.

Aspiration

Stimulating aspiration is about building confidence in two areas: first the researcher's confidence in his/her own competence and secondly the confidence to take the risks involved in venture creation. There are clear overlaps with the other pre-conception process of opportunity identification.

Looking first at building competence, while role models may be inspirational, confidence is built by helping the would-be entrepreneur realize that he/she is capable of mastering the variety of tasks involved in entrepreneurship; generating a sense of accomplish ('me too/ I can do that'). Such realisation is most easily achieved through direct exposure to entrepreneurship.

There are perhaps three reasons why firms and small firms in particular beget other small firms. Firstly small firms provide exposure to the tasks involved in running a business. Flatter organization structures, greater informality and less managerial slack all help build this exposure and access to knowledge. Secondly it is easier in small firms for a potential entrepreneur to observe 'the feet of clay'. Even the most successful entrepreneur is not super-human but someone who makes mistakes, and encounters difficulties. Creating an awareness not only of 'I can do that' but 'I could do that better' may be deeply reassuring and motivating. Thirdly, it is probably easier in a small firm to provide opportunities for identifying problems and questions in which an individual can make a real contribution and develop an ownership stake.

Unless the university or research institute has programmes of placements, this kind of direct exposure is more difficult to replicate. Where programmes exist much may depend on the nature of the placement and nature of the recipient organisation. Experience in a highly functionally specialized department in a large bureaucratic organisation may help develop technical competence and may possibly provide some insight into potential opportunities but may do

little to build entrepreneurial confidence. The basic underlying assumptions of organisational culture are likely to influence both the selection of the types of business organisation the research organisation has contract with and the value it places on such contact.

But there are ways in which innovative or entrepreneurial confidence in competence can be built within a research organisation, some of which also facilitate the identification of potential opportunities. Enabling researchers to gain breadth of experience is one. External or non-institutional work in industry can provide the researcher with the type of exposure outlined above. Research organisations differ considerably in how such work is valued and managed. Rules concerning time allowances and control of external work (such as whether or not the work has to be channelled through and controlled by some technology transfer function) reflect not only how contact with industry is regarded by the organisation but also the trust placed in the individual researcher. Rules which are too harsh may deter researchers from undertaking external work or may simply encourage dishonesty.

Similarly if the nature of the external work is too strongly 'service' oriented it may not be conducive to confidence building. Ownership of a problem and generating one's own questions are important for both creativity and entrepreneurship.

Allowing people autonomy is another way of building their confidence in their own competence. Flat organisation structures allow greater autonomy to individuals. It can be argued that most UK university departments are characterised by relatively flat organisation structures and a considerable degree of autonomy is given to researchers. However the same may not be true in other types of research organisations or research organisations in other countries. For example Hollingsworth (2000) suggests that researchers in German universities are highly dependent on major professors and have low autonomy in defining the nature of the projects they work on. In the UK, research organisations, which are in, or have a recent

history of being in, certain parts of the public sector such as defence may be more hierarchical and bureaucratic.

Allowing people to exercise their autonomy in a creative setting requires tolerance of experimentation and of failure. At a general level, attitudes towards experimentation and failure prevailing in an organisation are important in building personal confidence. Tolerance of and allowance for experimentation and failure of new enterprise creation may be more difficult to achieve in many research organisations. Experimentation may be supported through a variety of mechanisms such as providing two year post graduate funding for proof of concept.

The issue of failure raises the question of the second type of confidence which needs to be built as part of generating the desire for entrepreneurship, namely the confidence to take the risk. There are two aspects of building confidence to take the risk. The first concerns the potential costs and benefits of venture formation and the second concerns collaboration. Would-be entrepreneurs need to know what potential financial resources are available to them. It was suggested earlier that the primary motivation for entrepreneurship was not pecuniary gain, however this does not mean that pecuniary returns will have no role in influencing confidence in respect of risk. The generosity or otherwise of policies which reward inventors, through either a percentage of the income generated through licenses or royalties or proportion of equity of any spin-out company, reflects the value the organisation places on commercialisation of research, and more importantly, the role of the researcher in this process.

Research organisations differ considerably in whether they reward inventors directly or indirectly and in the generosity of such rewards, reflecting differences in policies concerning the ownership of intellectual property rights. Like their counterparts in the US, most universities in the UK now own the IPR arising out of government funded research but not always out of research funded directly by industry or by charities. Some universities such as Cambridge have

only very recently (March 2001) formalised a standard policy. Even here there are still grey areas and variations. In Cambridge, for example, there is variation in respect of PhD students whose ownership of IPR arising from their work depends on whether they are sponsored and the nature of that sponsorship. This variety of situation has two implications for the building of confidence to take the risk of venture creation. Firstly, for the researcher there is a need to know quickly and easily what his/her position is, and secondly related to this, the interface organisation (the TTO) needs to develop or have good access to IPR expertise. Clarity of policy is very important and arguably will become increasingly so. To date there have been few disputes, even in the US with considerably more experience, but the potential for conflict is huge, particularly where the potential gain is commensurately large (Collins, 2001).

Understanding and developing confidence about the risks involved in venture formation also require that would-be entrepreneurs are aware of the potential costs, and in particular, their employment situation. As suggested earlier employment practices and policies reflect basic underlying assumptions about the nature of human nature and the nature of relationships. Research organisations vary in the extent to which their employment practices allow for involvement in any spin-out company, for time out to develop a potential spin-out and for return to, or protection of, their job in the event of failure.

Enterprise formation is an act of creation and organisations which do not allow the researcher to take an active part in the spin-out or force a choice very early on deny the would-entrepreneur that involvement and the associated excitement and affective commitment. Researchers will be demotivated from venture formation if the costs are seen as too high.

It was suggested earlier that experimentation is not only a fundamental part of creativity but also crucial to building confidence both in competence and in respect of risk. Enterprise formation rarely proceeds neatly in a straight line, so some flexibility in employment is

needed. For example recently Cambridge University allowed a senior researcher six months leave of absence to develop a potential business. The extent to which research organisations are able to allow such flexibility varies. In an attempt to lessen the risks involved in creating a spin-out companies some research organisations have recognised the possibility of failure and allow a buffer period in which people are guaranteed re-employment in the event of failure.

The other aspect in building the confidence of the researcher to take the risk is the opportunity for collaboration. Many businesses are collaborative ventures and this is particularly true for high technology businesses. In a recent CBR study of 237 small high tech business in the UK, less a fifth had been founded by people acting alone (Quince and Whittaker forthcoming). Much research activity involves collaboration. Collaboration in venture team formation builds confidence in two ways. Firstly, it meets what may be a fundamental psychological need namely the preference to hold another's hand in a risky situation. Secondly confidence is built because collaboration bolsters the individual's competence and broadens that of the potential venture.

This raises the important question of teams and how far they are encouraged. Within the research organisation the encouragement of teams may be helped by its degree of interconnectedness. Collaboration with organisations outside of the research organisation may depend on the rigidity or otherwise of its boundaries and its accommodation of fuzzy or what others have termed 'porous' boundaries (Saxenian 1994). An important factor in the research organisation's ability to accommodate porous boundaries might be the expertise that the organization can bring to bear on any IPR and other contractual issues arising out of such boundaries. External collaboration may facilitate entrepreneurial team formation and the perception of opportunities.

Irritation

The third component in generating the desire for entrepreneurship concerns the 'grit': the irritant around which a pearl can develop. Most high tech firms spun out of from existing firms occur not simply because of pull factors in terms of the opportunities seen by the founders, but also because of push factors. The history of founder conflict as a source of new firm spin-out has yet to be written, but anecdotal evidence suggests it plays a part (Quince 2001). It is the balance between push and pull factors which is important. One argument often used in the case of Cambridge University is the non-tenured nature of much research employment. A large proportion of those undertaking research are employed on fixed term contracts of 2, or 3, and sometimes 5 years frequently related to specific research contracts. If additional projects or funding have not been found by the end of their term then the researcher has no job. In this context it may be easy to see that while starting a company is risky, the potential gains are great and for many that may be a better option than remaining in academe where the future is only marginally more certain and the potential gains far less. Clearly, the risk involved in starting a business will also be shaped by both the support mechanisms available and the local context.

Empirical Evidence

In order to assess the relevance of the concepts of inspiration, asperation and irritation in understanding the varying nature of preconception conditions in different public research organizations in Britain, a number of research organisations in the UK were surveyed using a combination of extended telephone and face to face interviews. This survey formed part of a larger EU study of support mechanisms for research based spin-out companies. The study, conducted under the EU STRATA programme, covered the UK, the Netherlands, Belgium, France, Germany, Italy, Ireland, Sweden and Israel.

The nine organisations taking part in the UK survey are set out in Table 1. Those interviewed in each organisation were either directly responsible for new venture formation or were effectively the CEO, depending on the nature of the research organisation. The survey instrument, a semi-structured questionnaire, covered the following issues:

- primary objectives of the organisation and the nature of the body responsible for setting those objectives
- the research activities undertaken and the overall orientation as between basic or fundamental and applied research
- human resource management practices and policies including criteria determining remuneration, progression and evaluation of 'success', employment flexibility, restrictiveness of the employment contract in respect of external (non institutional work)
- nature of commercialisation activities including management of contract research for commercial organisations
- new venture creation, experience of and mechanisms for supporting and activities directed at heightening awareness of these and of entrepreneurship in general.

The two research council research institutes (RCI 1 and RCI 2) differed in their focus, one being medical, the other animal health, and in their experience of spin-out companies. The former, recognised as a centre of excellence with many Nobel prize laureates among its staff, has a long history of spinning out successful ventures. The latter by contrast has only recently embarked on active encouragement of new ventures. The 'engineering' research institute EI recently moved from charitable status to a membership organisation. Despite more than half a century of extensive contact with industry virtually no spin-outs had been created on the basis of its own patents[9]. The 'ex government organisation' (GRE) was a recently privatised part of a defence research establishment. Commercialisation of research and the development of spin-out companies had become imperative for this organisation. The two technical consultancies were both, combining contract and in-house research and development although GA was more involved in manufacturing. These differed markedly in

their structure, ownership, and mode of new venture creation. Technical consultancy GA although a plc was three quarters owned by its staff, had a flat egalitarian structure and tended to set up new ventures as independent and autonomous units within the protective umbrella of its group. It resembled a Portuguese-Man-of-War, a colony of independent organisms. New ventures are eventually 'spun out' or in the company's terminology 'de-merged', but at this stage the new firm may employ more than 100 and may go immediately to IPO. Technical consultancy GE had a major external shareholder and ran its two activities of contract research and development and new venture creation in parallel. It followed a more traditional mode of relatively early new venture spin-out. In addition to the University of Cambridge interviews were also conducted with those responsible for technology transfer in two other organisations in the university sector. The large metropolitan university (MU) had a large and well developed technology transfer function and a good track record in generating new ventures. The Medical School was located in a peripheral region and by contrast its technology transfer function was limited, although in relation to the rest of the region in which it was located it was relatively successful in spinning out research-based companies. The shaded section in Table 1 indicates those research organisations located in the Cambridge sub-region.

Inspiration

There were clear differences RCI1 and the engineering institute (EI) in the extent to which commercialisation through spin-out companies was held as an objective.

RCI1 *Absolutely clearly the primary objective is to do long term research into the basis mechanisms of molecular biology. ...So that's our main goal. But alongside that we do a variety of their things,.... technology transfer and training young people.* (We) *have had a policy for about 15-20 years of encouraging the essentially government employed scientists to spend a bit of their time to encourage spin-outs.*

EI *Our primary objective is in supplying world class services in joining materials, engineering and allied technologies. We are a membership based organisation and work to meet the needs and requirements of our members, and that's our primary objective. We also undertake core research into joining technologies. Spin-outs is an option but it is not our first choice.*

The strong service orientation of EI, which is discussed later, is also evident. Both technical consultancies, EI and the ex government research establishment (GRE) all used rewards systems based on annual individual target setting and appraisal, but there were differences in whether these included any capacity for rewarding inventiveness. Only in GRE would patent applications be taken into account, but the most important factor influencing an individual researcher's progression was his/her deployability

GRE *'In an organisation like ours which is really a contract research activity where we sell people's time to customers you require people to be deployable. .... Deployability is the most important factor'*

In EI patents would not be considered but publications, conference papers and citation would. Both EI and GRE had what can be called a 'service orientation' under which the client or customer's needs or demands appeared to shape their internal reward structure (and was also likely to shape the nature of the external contact.)

EI *...we continuously monitor customer satisfaction by asking the client to rate the contact when the job is completed. Where clients are very satisfied people are given a three E star rating. A successful researcher would be one who exceeded their 'smart' objectives, had good client rating (stars) and exceeded publications targets.*

Undertaking a high level of research on a contract basis for other organisations did not necessarily appear to lead to the sort of service orientation reflected above. By definition this type of work was significant for both technical consultancies. Neither took patents into

account in their reward systems but both viewed contract work in terms of the potential for commercialisation it offered to them and both emphasised the importance of 'champions', be they individuals or teams, in progressing such opportunities.

Apart from rewards associated with intellectual property rights (discussed below) in the university sector there may be limited scope for positively gearing the reward structure towards involvement in spin-outs but it is not impossible and there was evidence of change:

Medical school *Holding a patent that would or could be licensed would be seen as being successful whereas a few years ago it wouldn't. As for involvement in a spin-out it would not really advance their career with the college, but if the company was a major success then it would become a factor in promotion.*

The use of role models also varied. Several research organisations had well developed programmes aimed at increasing researchers' awareness of the need for, and methods of, commercialisation of their work. Such programmes included lectures, workshops, presentations, new letters and web sites. With a focus on 'instruction' rather than 'inspiration' in some cases these events primarily involved only the staff responsible for commercialization: what appeared to be lacking was the use of role models. By contrast RCI1 not only had a highly informative web site but also made use of its own highly successful entrepreneurs, both those holding active managerial roles and those who had left the organisation.

RCI1 …..*one (*member of the board) *has started two companies and he'll probably have a third before he retires. He is our most successful and richest entrepreneur*.....we get….*some of our more successful entrepreneurs who have left and become very wealthy to come back and give talk.*

In the Cambridge sub-region there are many network opportunities and initiatives which provide opportunities for researchers to hear and interact with some of its many successful entrepreneurs[10].

Aspiration: Confidence in Competence

Involvement in external work may heighten the individual researcher's confidence by broadening his/her job, may increase creativity through exposure to diverse perspectives and potential ownership of problems, and may also help in the perception of opportunities for entrepreneurship. The rules the research organisation adopts in order to govern and manage such work are therefore important. It is perhaps how the interface is managed and the nature of the experience so derived that is more important than any specific time[11] or pecuniary limits. There were large differences between the organisations in their management of external work.

MU *The university does not discourage academics from doing consultancy, far from it, the university encourages it. It is just how that consultancy is managed. The university would discourage private consultancy: it has to be channelled through us (our consultancy division).*
Medical school ..*as long as it is in line with their research were are more than happy for them to do that* (external work)

RCI1 undertook no contract work for other organisations but its approach to its researchers being involved in external work stands in stark contrast to that of GRE. The latter's previous role as a defence research establishment is all too apparent.

RCI1 '*People who are on a full-time salary were previously encouraged to spend up to 5 or 6 hours a week teaching in the university, that scheme which has existed for 50 years has now been broadened. They would have to declare other work and they could be told they're not allowed to do it, if it is not relevant to what they are*

doing here and ***it does not help them.*** *They could still do it in their own time, Saturdays and at night. The 5 or 6 hours we'd allow them to take out of their time paid by us would mean that* ***whatever they learnt there would broaden their interests and help them in their work here.'***
GRE *Part of their contract with the organisation is that they only work for us. Unless they have specific permission to do so and I cannot think of any circumstance where I would feel comfortable if a member of our staff actually worked for someone else.*

Giving autonomy and providing opportunities for experimentation were also seen as factors likely develop the researcher's confidence in his/her own competence.

RCI1 *….we believe that younger people should be group leaders and heads of divisions. New independent group leaders are given complete autonomy and told to be imaginative and aim to do revolutionary research:, of course they're much better in their area at doing that than anybody more senior. So they are encouraged to be independent, somewhat anarchic and to make leaps into new uncharted areas.*
Technical consultancy GA … *the* (organisation) *structure is as flat as we can possibly make it. We give people space (time, financial and physical) to enable them to explore things, ...the accounting is very loose, the individual or group can really explore the possibilities. There are limits on this 'space' but it is not written down, it's just understood, you get a feeling if someone is spending too much time on a harebrained scheme.*

Aspiration: Confidence to Take the Risk

The potential costs and benefits to the researcher of involvement in a spin-out are defined in the first instance by the research organisation's IPR and employment policies. Most universities in the UK own the IPR in respect of publicly funded research and most have some form of rewards to inventors scheme for any income arising from this IPR.

The most common 'share' to the researcher in respect of significant inventions is 33%. Some universities such as Cambridge have a sliding scale under which virtually all of small amounts of income will go to the researcher. Within the university sector there are differences in how PhD students are treated. In Cambridge and the Medical School PhD's were a 'grey area' as the IP policies did not apply to them. Further in Cambridge the researcher although an employee would own the IPR arising out of personal research, that is, research not related to any external funding. The situation for research institutes is more variable. EI for example does not always own the IP, frequently it rests with the client organisation for which EI is working. Again differences in particular between the GRE and RCI1 highlight fundamental differences in their cultures. The latter has a sliding scale under which the least the researcher can receive is 10% but

RCI1 … *And at £15 million* (net income) *it drops to 10%. It never goes below 10% but at 10% we are talking about really large sums….there are quite a few people who have actually reached this.*

GRE *If a person works for us then any intellectual property they generate would be owned by the company even if they think about it in the bath. There have been cases where people have gone home and patented and to be honest, we take them to court.*

Not only does the extent to which employment practices also allow for involvement in the spin out vary but so also does the attitude towards such involvement. RCI1 was deeply supportive and its flexibility in respect of employment illustrated both its recognition that venture creation can be a protracted and iterative process, and its understanding of the potential benefits.

RCI1, *a few people have had complete leave of absence, a couple took leave of absence for two years and started ….. A couple of others have done 50% of their time receiving 50% of their salary for 2 or 3 years. There are no hard and fast rules, but there are guidelines on*

our website. There is a degree of discretion. ...If the company was potentially worth a lot of money we would be more encouraging

RCI2 was in the process of setting up a 'buffer' period of 2 years during which time researchers who had left to found a research-based business would be guaranteed employment with the institute in the event of failure. GRE's rather hostile approach may not only deter individual researchers from championing potential spin-out activities but also implies a restricted and constraining view of the abilities of researchers.

GRE *We would rather people did not go into the company….If people do go into a spin-off then we would normally not expect those people to run it.* ***Our expectations are that anyone who is good at the technology would be unlikely to be good at the business side as well.*** *It can happen but it is probably very rare.*

It was also suggested that collaboration in research facilitates confidence to take the risk by providing potential partners for venture formation. As suggested earlier the nature of the interface with external organisations will shape the degree to which it develops the researcher's confidence but it will also influence the opportunities for collaboration. It was not possible to investigate fully the organisation structure of the research organisations and in this context the need would be to study individual departments. Comment can only be made on the research institutes and technical consultancies. Reflecting both its size and history of defence work GRE was the most hierarchical organisation. Both RCI 1 and 2 were more like university departments with an emphasis on project teams. The differences in the organisational structure of the two technical consultancies were outlined earlier: GA had a more fluid structure.

GA '*One of the advantages of this company, one of the realities of the business is that the whole thing is a team venture. Everything we do requires a team of people, not just a team of technical people but everybody else. We try to structure the environment here so that*

serendipity has a chance, it's very flat, very egalitarian. We have a wide range of different objectives: commercial objectives, social objectives. Our social objectives are to the community outside and to ourselves as a community; people should have fun.

Irritation

In the organisations in the university sector the majority of full time researchers were non-tenured employees. Similarly in both RCI1 and 2 half of the employees are on some form of time period contract and mobility on the part of researchers was seen as 'healthy'.

RCI1 *..the earlier part of scientific career is generally thought to be healthier if people are moving around.*

In the other organisations researchers were largely permanent employees. For these lack of security of employment would not provide the grit around which the pearl of the new venture could form, but in all organisations frustrations can develop.

Conclusions

This paper has sought to highlight differences in research organisations which may foster or inhibit the development of new spin-out ventures. These differences in missions or goals, in approaches to external (non-institutional) work, in employment policies and practices and in IPR policies are seen to reflect and express organisational culture. Organisational culture sets what has been termed the 'pre-conception' conditions in the process of nurturing research-based spin-outs. It can be suggested that organisations seeking to encourage research-based new ventures need to be aware of these pre-conception conditions and reflect on the extent to which their culture is supportive or inhibitive. This may be particularly true for research organisations moving out of parts of the

public sector such as defence, which may possess cultures in which concerns for security have resulted in hierarchical structures and controlling approaches to personnel policies and practices.

Although very few organisations were studied, the results of the empirical survey question some of the myths about factors facilitating the generation of research-based firms. It does not appear to be the case that applied as opposed to fundamental research necessarily generates more opportunities for new venture formation. Nor does undertaking contract work for commercial clients. Rather it is the nature and management of such external contact which is important.

The importance of flat organisation structures, team work, individual autonomy, ownership of problems and of fuzzy or porous external boundaries is well understood in the context of innovation. This paper suggests that these are equally important in the context of research-based new ventures. The crucial economic role seen for new technology-based firms throughout Europe and elsewhere has encouraged the widespread growth of initiatives aimed at their generation. This growth has largely been in terms of a proliferation of support mechanisms. However a more holistic approach, which takes account of the pre-conception conditions prevailing in the parent organisation, the support mechanisms in relation to these and the local context, is needed. While it may be relatively easy to set up support mechanisms, organisational culture is more enduring and may be more difficult to change.

Notes

[1] The universities and public research institutes.

[2] A federally funded scheme started in 1995 aimed at facilitating the spin out of biotechnology companies from universities.

[3] In 1999 the French government announced the setting up of 31 'regional' incubators many of which had the specific objective of employment generation.

[4] The first academic revolution being the expansion from a purely teaching role to include research.

[5] It is acknowledged that there are many other forms of technology transfer.

[6] Leeds e.g. Leeds Innovations Limited, Imperial College: IC Innovations and IC Company Maker.

[7] As opposed to consultancy and technical service type spin out companies.

[8] There are other 'models' under which potential ideas for commercialisation are championed by external actors.

[9] EI had collaborated with another organisation in the formation of a spin-out company.

[10] These include The Cambridge Network, Eastern Region Biotech Initiative, Cambridge High Tech Association of Small Enterprises, Cambridge University Local Industry Links, Local Industry Network, Cambridge Europe and Technology Club, Cambridge Entrepreneurship Centre, and Cambridge–MIT Programme.

[11] The prevailing norm in most UK universities is 25 days external work per year and in most some form of prior 'permission' to undertake such work must be obtained.

FIGURES AND TABLES

FIGURE 1: GENERIC VENTURE NURTURING PROCESSES

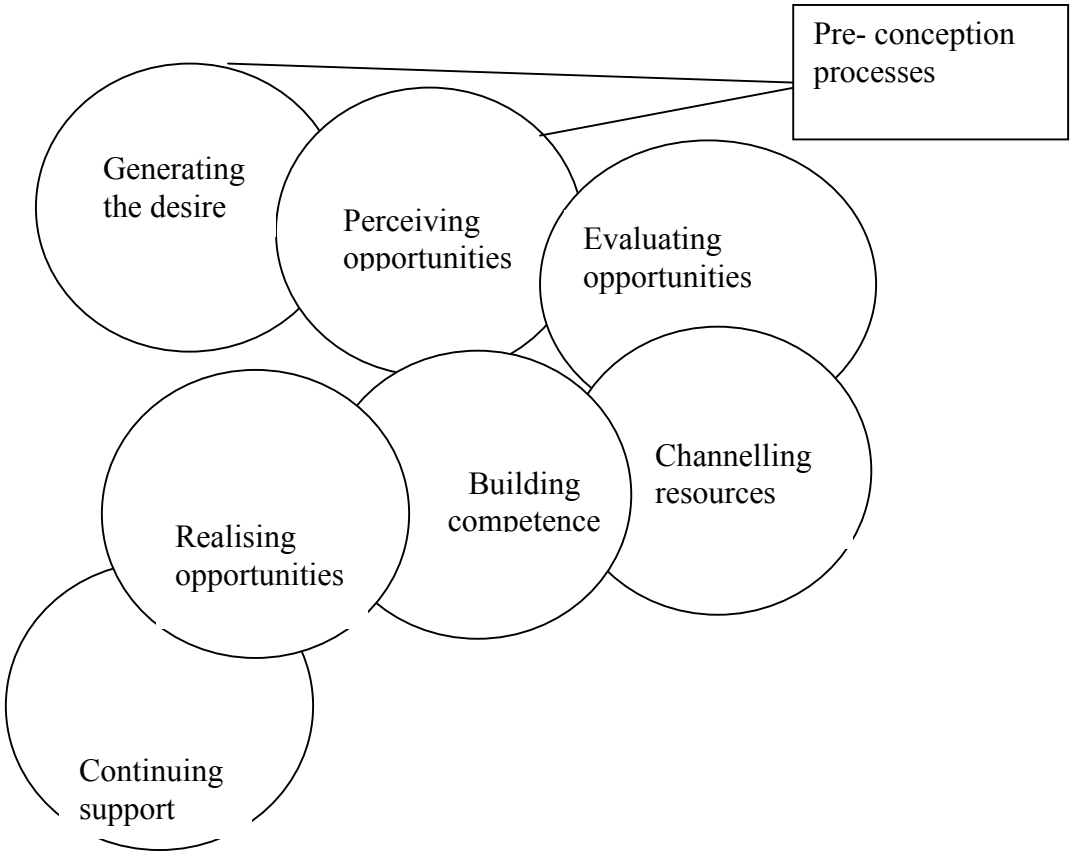

TABLE 1: CHARACTERISTICS OF RESEARCH ORGANISATIONS INTERVIEWED

Organisation	No. of researchers	Area of technology noted for	Orientation	Percentage of commercial contract work (non gov't)	Spin-outs (p.a.)
University of Cambridge	2,000*	Life sciences computer sciences,	All	5%	5-6
Research council institute 1 (RCI 1)	350	Life sciences	Fundamental	0	2
Research council institute 2 (RCI 2)	320	Life sciences	Fundamental	10%	(1)
Engineering (EI)	420	Materials, joining technologies	Applied	60%	0
Tech consultancy 1 (GA)	400	Electronics, communications, software, life sciences	Applied	50%	1.33
Tech consultancy 2 (GE)	250	Life sciences, electronics, communications, materials	Applied	85%	1.33
Metropolitan University (MU)	1,800*	Geology/geophysics, food sciences, pharmaceuticals	All	4%	4
Medical School	1,500	Infecto-immunity, cardio vascular, cancer	50/50	15%	1
Ex. Gov't Research Est. (GRE)	1,500	Sensors, electronics	Largely applied	20%	(1)

Notes

Orientation of research: basic research – applied research

Percentage of total turnover undertaken on a contract basis for commercial organisations and excluding contract work for government.

(1) Indicates only one spin out company to date.

* figures for those employed wholly on research, i.e .excludes those holding teaching posts and involved in research.

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