Market-based learning, entrepreneurship and the high technology small firm

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Abstract Discusses case study and interview evidence to examine the evolution and development of entrepreneurial strategies in the high technology small firm (HTSF). Evidence from case study material suggests that a period of non high technology development can be an advantage for the entrepreneur to gain essential contacts, networks and learn to develop strategy, as well as time to acquire income and funding to permit the development of the technology-based firm. The paper discusses evidence from four rich case studies. Each of these involved a non-high tech start-up, yet this was still crucial to the entrepreneurship process and learning of the entrepreneur. Material from case evidence is also combined with interview evidence to discuss the critical factors in the learning process and the development of entrepreneurial strategies from a programme of interviews with HTSFs. It is argued that the evolution of a marketing strategy is part of the learning process involved in entrepreneurial development, we need to understand the diversity of this process if intervention is to be better informed by practitioners and by policy makers. In this paper we stress the diversity of entrepreneurial development, within HTSFs, discuss the importance of learning in entrepreneurial development for developing marketing strategies and develop policy implications for intervention.

Introduction
The distinctive nature of technology-based entrepreneurs (and HTSFs), means that it is sometimes perceived that one of their weaknesses is the lack of attention paid to marketing and the development of marketing strategies (Westhead and Jones-Evans, 1996; Jones-Evans, 1997). For example, the pre start-up source of technology-based entrepreneurs is often associated with a

Researching cases and developing case material requires a tremendous amount of patience on the part of the entrepreneurs involved and we are very grateful for their patience, tolerance and forbearance with the demands that the research has placed on them. The cases referred to in this paper are drawn from a programme of material that has been developed by the research centre over a period the last two years. This paper has only been possible through the efforts of different researchers (over a time period of three years) who have developed case material: Mark Freel, Linda Graham and Andrew Paddison.

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public sector scientific research institution or, if from the private sector, from
the R&D section of a large organisation. Therefore, the focus of such research
orientated entrepreneurs may be on the technical development of the product or
process, with insufficient attention paid to marketing. The development of early
stage entrepreneurial strategies may be seen to be relatively naive, reflecting
the novice status of such emergent technology-based entrepreneurs (Jones-
Evans, 1996). Implicit from this view, will follow policy prescriptions that
suggest intervention to provide marketing support or consultancy that should
be beneficial for overcoming barriers faced by such entrepreneurs. In this paper,
we discuss evidence that suggests that early stage development of non-
technology-based enterprises can be beneficial for the development later of
entrepreneurial strategies for such technology-based entrepreneurs. In
particular, such stages represent a valuable learning and development phase for
the (technology-based) entrepreneur. The paper begins with a brief
introduction, we discuss the relevant literature on marketing and technology-
based entrepreneurship before discussing case study and interview evidence
with technology-based entrepreneurs.

Organisational learning and the nature of market-based knowledge
Learning involves the acquisition, distribution, storage and interpretation of
information (Huber, 1996). Over the last decade, a considerable body of
literature on organisational learning and knowledge has developed, which led
some writers to develop some theories of the firm based on knowledge (Spender,
1996; Grant, 1996).

Although individual learning is at the basis of organisational learning, most
of the literature deals with large companies. Nonetheless, the literature offers
some insights which are useful for the analysis of entrepreneurial learning. One
of the useful aspects which emerges from the literature is the diversified nature
of knowledge. Many typologies have been developed (Spender, 1996; Nonaka
and Takeuchi, 1995). One distinction is between tacit knowledge or implicit
knowledge which is not codified and explicit, formal knowledge which is
codified (Polanyi, 1967; Fleck, 1996). Most writers emphasise the importance of
tacit knowledge in individual learning; moreover they suggest that individual
experience and intuition is paramount in generating knowledge (Huber, 1996).
A second distinction is between knowledge about technology and knowledge
about the market. Most of the literature neglects the importance of market-
based knowledge, yet success in the market place is necessary for the success of
new products (Cooper, 1988). Recently, some marketing scholars have attempted
to apply learning to marketing issues (Day, 1994; Sinulka, 1994). Sinulka (1994)
stressed the uniqueness of learning which is directed toward markets in five
ways. First, it is pertaining to external foci and is less visible than most
internally focused knowledge. Second, it leads to competitive advantage. Third,
it involves the observation of others. Fourth, the market information which
resides in organisational memory is more difficult to access and finally, market-
based information is more equivocal to interpret. More importantly in
agreement with other writers, he suggests that information about the market is “often unintentional and obtained as a by-product of organisational action that is taken for some other purpose”.

Day (1994) stressed that among the capabilities developed through learning is “market sensing”, which is important for products newly marketed. The question, then for the study of learning by entrepreneurs is how is market sensing developed by entrepreneurs during their experiences?

The nature of technology-based entrepreneurship and market-based learning
Research into the nature of the technology-based entrepreneurship has suggested that technology entrepreneurs can be classified into either scientist or technician-based entrepreneurs and commercially-based (or opportunist) entrepreneurs (Roberts, 1991). This classification has recently been extended by Jones-Evans (1995; 1996) who has suggested a similar typology of entrepreneurs in HT SFs. The implication, of an acceptance of such a typology, for intervention and policy-making, is that it should be worthwhile providing commercial expertise, where this is lacking for the technically-based scientist that is seeking to commercialise new technology, alternatively the commercially-orientated entrepreneur may require technical assistance through specialised expertise. As suggested above, however, most technology-based firms are considered to be technician/scientist entrepreneurs. For example, Oakey (1995, pp. 12-13) considers that:

While it is theoretically possible for a businessman with substantial surplus capital and no technical experience, to begin a new high technology business, most new high technology small firm founders are technical entrepreneurs.

The nature of R&D and the innovation process will obviously impact on the entrepreneurship process. In particular, the difficulty attached to risk assessment with technology-based products means that the technology-based entrepreneur will exhaust personal sources of capital, even if commercialisation is possible, and be under-funded at the critical launch stage. Oakey (1984) has modelled the problems inherent in this fundamental process, and argued that such entrepreneurs, as a result will pay insufficient attention to marketing. However, Jones-Evans (1997, p. 85) found from 38 technology-based entrepreneurs, in his interview survey, that:

... an interesting discovery of this research is that 21 of the technical entrepreneurs sampled had assumed responsibility for marketing within their businesses, although less than half had any formal marketing experience in their previous occupations.

Nevertheless, it is fair to assume that in general “high technology entrepreneurs are initially orientated toward engineering and technology, not sales and marketing, with evolution toward marketing occurring over time, if the firm survives” (Roberts, 1991, p. 165). From the strategic point of view no knowledge about the market has been acquired:
Many are entrepreneurial about their companies as to who will become the initial customers for their products and services. Some are not even sure as to exactly what their company will be doing (Roberts, 1991, p. 166).

As the firm develops, the entrepreneurial function may get diluted away from the individual to a team of entrepreneurs or management team. Roberts (1991) has suggested that the potentially autocratic style of single founder will become difficult to maintain as the firm develops and delegation of key functions becomes necessary to a management team.

**IPR, strategy and marketing**

The role of IPR, in terms of the entrepreneurial development of the HTSF, has received only scant attention, yet theoretically, at least, the process of obtaining patents will affect entrepreneurial development in a number of ways. Potential areas that the IPR process can affect include marketing, finance (through attracting venture capital), managerial strategy and risk management. We do know that entrepreneurs will value patents, but may not protect their coverage (Deakins, et al., 1997), however, we do not understand the extent to which intervention in the patent process may make a significant difference to HTSF survival and performance.

Patents may be used both as signals and to provide information in marketing, offering a signal of credibility to customers. The common statement of “patents pending”, stamped on products may be seen as signaling credibility and information to potential customers. In addition joint-venture marketing strategies, which are used by HTSFs to enter global markets, may require the commencement of the search and application procedure for patents, before the strategic partnership is acceptable to the prospective strategic partner. Theoretically, at least, the acquisition of IPR should provide important signals in strategic marketing, in a world of uncertainty and increasing pace of technological change (Spence, 1974).

**Learning about markets and technology-based entrepreneurship**

The importance of marketing in bringing technology to the marketplace has been well documented over the past 20 years (Cooper, 1988; 1994). Similarly, the role of marketing in the entrepreneurial process in general, has become part of the research agenda investigating commonalities between marketing and entrepreneurship (Hill and Laforge, 1992; Carson et al., 1995). However, both strands of the literature have limitations and weaknesses in explaining how marketing is practiced by technology based entrepreneurs. The process of learning in the market and how marketing strategies are formulated and conceived by high-tech entrepreneurs are not understood in most of the literature examined.

The problem is mostly due to the fact that what is traditionally explained by “the marketing orientation” and the concomitant traditional tools of marketing, the 4Ps offer limited application to the case of, not only, high-tech products but
Alternative marketing theories have been put forward in recent times. They include the concept of "Expeditionary marketing" by Hamel and Prahalad (1991). While the concept attempts to explain the process of bringing to the market high-tech new products, the thrust of their arguments is inappropriate for small firms or individual entrepreneurs.

A second stream of alternative marketing theories, exemplified by the network approach in industrial markets and for new product development (Hakansson, 1987; Biemans, 1992) together with "relationship marketing" (Gronroos, 1995) has emerged. While not devoted to the entrepreneur, this body of the literature is at present, the best theoretical analysis for explaining the learning process in the market by high-tech entrepreneurs.

The "marketing orientation" and the success of innovation

According to Narver and Slater (1990), market or customer orientation consists of three behavioural components: customer orientation, competitor orientation and interfunctional orientation. This implies that firms are continuously collecting and disseminating information about target customers’ needs and competitors’ capabilities in order to create continuously superior customer value (Slater and Narver, 1995). There is now a variety of studies showing the relationship between market orientation and performance (Jaworski and Kohli, 1993). The importance of “market orientation” for innovation is the result of a variety of studies which include the project SAPPHO and the numerous research conducted by Cooper (Rothwell, 1979; Cooper, 1988; 1994). The thrust of these studies has been to investigate the reasons for success and failure of new products. Many factors were highlighted, nonetheless marketing factors were identified as being the most important. Thus project SAPPHO identified the understanding of users’ needs, wants, preferences and benefits as the most critical and important success factor. In fact most studies which followed also corroborated that initial finding. Thus NEW PROD continuous study conducted by Cooper (1994) over the last 20 years, which includes a database of over 1,000 new products projects, consistently emphasized that a unique superior product in terms of benefits and superior value to the customer together with a strong marketing orientation make the difference when it comes to separating successful and unsuccessful industrial new products (Cooper, 1994).

The managerial implications from all these studies is that marketing is an important function for the success of new product. More specifically, marketing intelligence, using conventional marketing research tools like surveys, focus groups, conjoint analysis, is paramount for assessing customers’ needs and wants. Once these have been identified, segmentation and targeting should follow. In fact marketing activities should be incorporated throughout the whole process of new product development from the idea to the launch (Cooper,
Therefore, most studies advocate strategic models which include a step by step approach incorporated into a formal plan in order to achieve success.

A number of criticisms have been made concerning the effectiveness of the market orientation for high-tech products and technologies: first, the fact that so many products are failing shows that the process of understanding the market for innovation is not yet fully understood or as one writer put it:

Many management scholars assert that innovators ought to understand the market, yet they fail to explain why innovators do not carry out this seemingly obvious advice. Improvements in both the theory and practice of product innovation will be limited until the problem with understanding new markets are clarified and solved (Dougherty, 1990, p. 59).

Indeed, most studies examined are not confined to high-tech new products, but include relatively low technology products. Cooper’s studies, for instance, take the newness of product to include already existing products which are modified.

This point is also made forcibly by Workman (1993), Tidd et al. (1997) and Jolly (1997) who point out that complex technology, products and systems are a special case in marketing because, among other things, markets are not well defined or understood. At the strategic level, the implication is that those studies shed no light on strategic marketing i.e. the decision to enter new markets, but merely deal with tactical marketing which is concerned with differentiating and extending existing products. Therefore, “in the specific case of complex or novel products and services, many of the standard marketing tools and techniques are of limited help in the development and commercialization” (Tidd et al., 1997, p. 164). The second point of criticism directly linked to this paper is the fact that most of the studies examined are concerned with already established and mostly large companies, where the marketing function is carried by a marketing department which links with other departments. Practically, very few studies deal with innovation involving the set up of a new venture. Even the study by Jolly (1998) which deals with new technology, is about already established firms. In fact Cooper (1988), who metaphorically compares the process of a new product development to a game played by different players and stars, omits to mention entrepreneurs as players.

Alternative marketing theories have been put forward dealing with the process of understanding customer needs for high-tech innovations and will be examined following the second strand of the literature dealing with the interface between marketing and entrepreneurship.

Marketing and entrepreneurship interface
Murray (1981) postulated that marketing is the logical home for the entrepreneurial process in organizations, similarly, Foxal and Minks (1996) attribute the locus of entrepreneurship to marketing. However their analysis pertained to established and in the latter case to large firms. That marketing is inherently entrepreneurship in small firms and start up businesses has also received considerable attention in recent times and culminated in a vast body of the literature (Hills and Laforge, 1992; Carson et al., 1995; Romano and
Ratnatunga, 1995; Morris and Lewis, 1996). In fact Carson even went further and proclaimed the discipline as a new paradigm (Carson, 1995).

The initial aim was to investigate “just how well do existing marketing models and the traditional marketing paradigm fit the environment, behaviour and processes found in entrepreneurial organizations?” (Muzyka and Hill, 1993).

The main approach used by many writers was then to take the main concepts used by marketing (the process of planning and executing the conception, pricing, promotion and distribution of ideas, goods and services to create exchange that satisfy individual and organizational objectives, AAM) and compare them to the entrepreneurial process. This modus-operandi led many writers to identify various common points (Hills and Laforge, 1992; Carson et al., 1995).

Thus it was found that the marketing culture, that is the belief about the central importance of the customer prevailed in many small firms. Similarly, market segmentation, targeting and positioning and defining how the firm is going to compete in its chosen market, were also widely used. Finally, the use of the elements of the marketing mix, that is the 4 Ps, is adopted by most firms. (Hills and Laforge, 1992).

It is quite clear, however that the weaknesses of such studies lies in the fact that they deal mainly with the use of marketing after the firm is already in existence. There is little insight about the process of identifying customer needs prior to the creation of the firm. The only studies devoted to high-tech firms like the study by Peterson (1991) deals with product innovation after the firm's existence that is at the growth stage.

Some of the criticism levelled previously against the success and failure literature is valid here also. Thus although many studies conclude the use of segmentation, positioning and targeting of consumer segment is strategic, when it comes to high-tech products, this is merely tactical. Furthermore, most of the studies do not focus on the strategic process per se. Or as Siu and Kirby (1998) put it:

Much of the literature on marketing in small business, however, has ignored the strategic and competitive dimension and confined marketing to the management function (Siu and Kirby, 1998 p. 52).

Perhaps the most significant aspect concerning strategy formulation process was provided by Carson et al. (1995) who indicated that most entrepreneurs do not use formal planning nor strategy. From the learning point of view, knowledge acquisition is also formal, explicit and takes place well after the birth of the firm.

On the whole, the evidence from these studies contains little relevance to high-tech products and services, and as with the literature on new product development, the traditional marketing models provide little information about appraising the customers' needs in high-tech markets. To address these criticisms and limitations two strands of analysis emerged: "expeditionary
marketing” (Hamel and Prahalad, 1991) and the network approach to innovation (Hakanson, 1987; Biemans, 1992).

**Alternative theories of marketing and innovation**

**Expeditionary marketing**

Hamel and Prahalad (1991) argue that the traditional marketing concepts are suitable for existing, well defined markets. For new emerging markets, corporate imagination and “expeditionary marketing” are the key to unlocking these markets. Their arguments contain four components: escaping the “tyranny” of served markets, searching for innovative product concepts, overturning the traditional assumption about price/performance and leading the customers rather than leading them. Current business boundaries limit the company to focus on only expressed needs of customers, such “tyranny” makes companies miss new opportunities.

Searching for innovative concepts means that standard approaches to market analysis are not likely to lead to innovations, indeed, market research, and segmentation are unlikely to reveal new opportunities. Indeed they cite the examples of Toshiba life styles research institute, and Sony’s exploration of “human science” as new ways of “listening to the market”. Those methods will enable companies to push customers “into where they want to go before they know it”.

Expeditionary marketing means that companies should create markets ahead of competitors: “sometimes the hoped market for does not exist”. Obviously companies take a great risk of failure, but the “hits” in the market might be greater than the “misses” and failure takes a different dimension because the innovation is not completely abandoned but put on the shelf for eventual future use.

Taking high risks in this way in the markets is seen as entrepreneurial (Narver and Slater, 1995), and constitutes a major shift from traditional marketing. But its relevance is limited to large companies, because in order to pursue such strategy, firms need to possess core capabilities and many technologies on the shelf as the example of Japanese firms showed. In the case of entrepreneurs with a single innovation, the risk of failure has different consequences.

**The network approach to innovation**

The traditional concepts of marketing have also been criticized in another strand of the literature, namely “relationship” marketing.

Basically, the argument is that transactional marketing is better suited to consumer packaged goods in a market setting like the USA where there is a sophisticated distribution system. Also the customer is seen as a passive player in the market.

In industrial and service marketing, the argument runs, marketing is interactive and based on long term relationship. Moreover the process of marketing is more important than the structure (Gronroos, 1994). The findings
of these studies follow an earlier approach by the IMP group (Hakansson, 1982) which considers industrial markets as networks between buyers and sellers. The network approach has been extended to innovation (Hakansson, 1987; Biemans, 1992). The gist of the argument is that traditional models of innovation see new product development as the sole domain of the manufacturer, an internal process where the customer is not active. Moreover, the process is linear in its progression.

Research by Von Hippel (1988) showed that in some industries, users play a dominant role in the development of the innovation process. The research was an important step in showing how the users’ needs are taken into account for new products. This led Von Hippel to hypothesize that there are two different paradigms describing the idea generation stage of the new development stage: the manufacturer active paradigm (MAP) and the customer active paradigm (CAP).

Hakansson (1987) combined the two paradigms by bringing manufacturers and users and other actors into a network which he called the interaction approach. Innovation, he argues takes place in a network of actors who might include the government’s agencies, research institutions’ banks, and so on. Cooperation between different actors leads to product development. The theory is an advance on the work of Von Hippel because the parties involved are no longer confined to the buying and selling firms (Biemans, 1992). There are also indirect relationships in the network, and from the strategic point of view, the position within the network is a “strategic position”.

On the whole this theory is very useful for the process of how needs and wants are assessed. The shortcoming of this approach is that there is a slight bias against the role of the individual entrepreneur. The network takes the preponderant place in the analysis. Entrepreneurs are seen as the exception rather than the rule. That may be correct for some markets, but in many markets the individual entrepreneur is very important.

In other words, while the premise that no firm is an “island” is true due to the social embeddedness, there is no reason why networks have to be formal; entrepreneurs can use the social relationship, and informal networks and remain independent. This point is very important for entrepreneurs when they embark on strategic alliances.

So to sum up this literature review on marketing and innovation, traditional tools of marketing are inadequate for the process of discovering customers’ needs in high tech sectors, expeditionary marketing is suitable for large firms only, while the network approach is suitable but not sufficient for unravelling how the process of understanding markets is achieved by high-tech entrepreneurs.

This review of different strands of the literature concerning technology-based firms and entrepreneurship suggests that learning and evolution of successful strategies will be affected by the following factors:
Marked-based learning

- dealing with customers and marketing strategies adopted;
- developing suitable networks/contacts and strategies dependent on new product development;
- the extent to which customers and markets are understood (or the degree of market orientation) of the technology-based entrepreneur.

The remainder of the paper discusses methodology and data sources before discussing the evidence in the light of the literature and the importance of different critical factors in learning by technology-based entrepreneurs.

**Research methods and data sources**

The cases, that form the focus of the paper, have been developed and tracked over a time period of up to two years. Each case involved five to six interviews with the entrepreneurs concerned. The cases concern different technologies involving direct involvement in R&D, with the inclusion of one case where the firm was applying new technology to engineering. The case interviews began with a semi-structured interview designed to illicit general development issues around motivation, formation and later development. This initial interview served to highlight potential critical incidents and issues to be taken up with subsequent open-ended interviews. These critical incidents were then used to encourage the entrepreneur to expand on the process that led to the incident, how it was resolved and, more important, what was learned from the incident. The cases involved considerable time spent alongside the entrepreneur understanding the nature of the firm, the innovation or technology process and discussion in addition to the formal and informal interviews.

This paper supplements the rich case material with further interview evidence with technology-based entrepreneurs to examine the development of marketing and entrepreneurial strategies for HTSFs. From a database of 300 HTSFs in Scotland (Deakins and Paddison, 1995), an interview sample was generated, based on responses to a brief postal questionnaire designed to illicit the extent of R&D in HTSFs. This survey generated a sample of HTSFs engaged in R&D, that were willing to take part in an interview.

The case material is complemented by material from 23 “one-off”, face to face interviews. We have both transcripts and questionnaire material from the programme of interviews. A semi-structured interview guide has been used which has the advantage of maintaining some structure to the interview, providing categories and coding for the transcripts, permitting some tabular information to be derived and reducing bias from different members of the team, as well as permitting more open-ended questions to be pursued. Given the diversity of HTSFs, the transcripts have been used to provide an additional source of data and to allow the scope for the entrepreneur to express in their ‘own words’, the importance of different issues in the development of strategy.

Some initial findings from these interviews are reported in this paper on the specific issue of critical factors in the learning process to supplement the case study evidence.
Discussion of findings

Due to the bi-lateral research strategy, we have organised the discussion of evidence under two headings. First, evidence from case material on critical factors on the processes of entrepreneurship, innovation and learning and second some limited evidence drawn from the programme of the more systematic interviews. Space limitations preclude a fuller discussion of interview evidence.

Evidence from case material
In all of our case study firms, the entrepreneurs were concerned with what would be considered as standard start-ups in sectors that were classified as non high technology sectors. These non high technology start-ups were used as a method of generating income and capital which would later finance the R&D concerned with the development of new and applied technology. In all the cases, the original start-up business/operations are still continuing and still being used to provide income and capital to fund the technology-related development. This strategy has been pursued, not by accident, but as a deliberate start-up approach by the entrepreneurs concerned. It had advantages in generating seed capital (for the new technology), in obtaining track records for bank and venture finance development capital funding, in diverting attention of potential competitors away from the main long term (technology-related) development of the firm and, not least, for the entrepreneurial learning experience and knowledge gained.

The cases: start-up, technology and marketing strategy
In case A, the start-up consisted of a general publishing bureau which was used to accumulate capital for three years, before embarking on new IT developments and R&D development of software, requiring an 18 month development of new imaging system. In case B, the start-up was involved with general business services consultancy before the development of new technology in computer-aided engineering. Case C represented a mature engineering firm, which was launched, after a long period of stability, into a significant growth curve of development following the application of new technology. Finally case D, involved a start-up as a retail design service for five years before the launch of a video technology business involving leading edge technical development and computer animation.

The development, technology sectors and strategies of the four case study firms are summarised and shown in Table I.

Dynamics of innovation, learning and strategy
The interaction between innovation and entrepreneurship is crucial to successful development, the entrepreneur will need to acquire skills that concern both the development of the technology and the business development process. The process, because of the nature of innovation, incorporates learning in a number of different areas, this could be in marketing, acquiring resources, managing people,
acquiring IPR and obtaining different forms of funding. Our case material revealed the complexity and interaction of this process. Given the nature of the early stage process, which was in areas not directly related to technology, some commercial skills had been acquired, but not always in areas that could be used in later development. For example, in local markets rather than exporting to world-wide markets, in dealing with the local bank manager rather than dealing with venture capitalists, in controlling a small operation rather than managing a fast growth firm. This experience could leave such entrepreneurs unprepared for the decision-making required with fast growth technology firms, trading in world-wide markets, situations where intervention could make a difference to coping and managing such firms. Early strategies of the case study entrepreneurs were ad hoc, as one case study entrepreneur commented:

To begin with our early strategy was ad hoc, but now we have moved to a more formalised strategy, we have moved premises to cope with an expanded workforce and the logistics of supplying to a wider market (Case A).

Coping with this transfer is an important part of development of HTSFs and while intervention may not make a dramatic impact on survival rates, since evidence suggests that HTSFs have lower failure rates than other small firms, they are still high enough to cause concern (Westhead and Jones-Evans, 1996); intervention at such critical points can often make a dramatic difference to performance and the learning experience.

Transfer to technology-based development
How innovation occurs and how opportunities were exploited were also often ad hoc in nature. Developing and exploiting new technology and new market

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Table I. The cases: start-up, technology, and marketing strategy
opportunities were often the result of chance occurrences rather than planned strategy, although strategies might well be subsequently developed to exploit these opportunities. One entrepreneur spoke of “stumbling over new ideas”, another spoke of seeing opportunity through a belief that “we could do that (process) better”. This, of course, gives support to the view that technical change occurs only in small incremental changes rather than major innovations. Change also occurs through applying technology that has been developed elsewhere, but the entrepreneur is able to apply the technology in a new way. The entrepreneurs in case B were able to apply knowledge gained in electronic engineering to a new process in fish farming, one entrepreneur in case C, had been able to apply new computing technology to his area of expertise in steel processing.

One entrepreneur from Case D recognised the limitations of their strategy but was unable to do little about it until a later stage. For example she commented during a discussion of their early stage development:

90% of our turnover was with XXX (major utility), we enjoyed an exclusivity contract, where no-one else could carry out work for them, but we were crippling dependent on XXX, who were an incredibly difficult customer – we had only one brochure designed in 1989, that by 1993 was beginning to look distinctly jaded (Case D).

However, later, the entrepreneur comments on development of the multi-media business:

We benefited from our experience before, although we were on a very steep learning curve. I knew that I had to control the business, we had the technical expertise, but that creativity needs to be controlled and channelled, we now have a Marketing Director and marketing strategy built into our business planning (Case D).

Case C, involved a longer first stage non-technical development of 12 years before a significant investment in new technology involving a move into manufacturing and the new application of technology. The investment was funded through the negotiation of a large (unsecured) overdraft with the bank, which was granted by the bank due to a good track record, but previous experience also provided the basis for the development of a growth strategy. Previous growth had been steady but unspectacular, a period of sustained growth and breakthrough into new markets was achieved through key personnel recruitment:

We needed an individual who could be capable of assuming responsibility for human resource management and development issues, who could restructure the organisation of the firm to enable growth to increase - we also investigated and researched new markets and identified a firm for takeover who already had network in the new markets (Case C).

Thus evidence from the case study material on the entrepreneurship process suggests that learning may occur from non technology-based activities such as dealing with customers, the bank manager, but also from product development while other activities are progressing. The impact of outside agencies on this process was relatively marginal. The significance for intervention lies in helping such entrepreneurs to maximise a strategy of diversification, such
technology-based entrepreneurs, where they did seek support, sought help from those who understood the technological process, but were not necessarily technical specialists.

The role of serendipity

To the casual observer, the entrepreneurial and marketing strategies developed in each of the case study firms may appear to contain a strong element of chance, yet the precursor, non high technology development before the technology-related development, in each case, was an important preparation for the development of entrepreneurial and marketing strategies concerned with the technology-based ventures. The role of serendipity has scarcely been acknowledged, let alone researched, in entrepreneurial development and strategies (Martello, 1994), yet the case study evidence demonstrates that chance is only one element, the technology-based entrepreneur must be prepared to exploit opportunities and be able to recognise and take advantage of opportunities. Thus, the importance of the non technology phase of development lay in learning to deal with customers, to deal with suppliers, to deal with bank managers and in gaining general business experience. A feature which, we will see is confirmed by the interview evidence.

This is commented on by one of the case study entrepreneurs, who had first established a general business services consultancy concerned with providing a range of business services. The start-up stage provided experience in raising finance and dealing with the bank manager:

We have had to bootstrap the finance – (through the) – development of the service products – in order to develop our technology (Case B)

The same entrepreneur commented on the strategy as helping to:

... hide the invention as part of a wider system, referring to the continued operation of both ventures.

Another case entrepreneur was able to comment on the preparation of the first phase for the accumulation of seed capital through an alternative operation:

We paid ourselves minimal wages, in order to re-invest and build capital that could be used for our new (R&D) development (Case A).

In summary the case evidence indicated all the entrepreneurs had gained a valuable learning experience from the early stage non technical development, a period when such novice entrepreneurs may be naive about strategy, ill equipped to develop more sophisticated marketing and entrepreneurial strategies. During this period the case study entrepreneurs learned importantly the significance of marketing strategies, from dealing with customers, the bank and other stakeholders, this period provided valuable preparation, or a serendipity process that meant they were better prepared for the technology-based phase of development. We consider next whether this case evidence is supported by initial findings from our programme of interviews.
Interview evidence
Evidence on precursor developments
The preceding discussion suggests that early stage business development, in
HTSFs may not be concerned with the main form of technology which will
become the underlying focus of later development. The research programme of
interviews confirmed the extent to which this occurs, which is probably more
common than realised. The following example, taken from our current
interviews with entrepreneurs, is typical:

XXX Technology ran for about 8 years by developing and selling XXX as a normal
commercial company (glass products) - (Then) developed a new product (a new family of
glasses) and I felt that there was substantial potential there - so then I formed a new firm with
XXX - That's what I had used in that intervening period to develop the glass (Tech1).

Here, the entrepreneur is referring to the first trading firm development of
eight years to finance the later development of a new product (although a
SMART award was won towards this development but this was seen as small
scale compared to the funding required to fully develop and launch the new
product).

Another engineering firm has been able to develop new products only after
trading for a number of years. The entrepreneur concerned commented:

We have never had an innovation award - (over ten years of development), - (but) - we have
actually developed a product - which is called an XXX agitator; we are now looking to see if
anyone can sell it, put it on the market, we developed it, something that we have always
wanted as our main product (Tech2).

Evidence on critical factors in development
Table II gives some results on the importance of critical factors for learning
and entrepreneurial development, some of these factors have been derived
from evidence suggested by the case material and discussed above. Also, we
might hypothesise, from issues discussed in the introduction, that factors that
influence experiential learning would be important, these should include
factors such as dealing with customers, developing products and dealing with
other “stakeholders” in the entrepreneurs’ environment such as the bank
manager or insurance broker (Gibb, 1997). The table shows that expert-led
advice, which is often available from part-funded consultancy, was less critical
than factors associated with the entrepreneurship process in technology-based
firms. Perhaps surprisingly, advice from the bank manager and accountant
rated above that of public sector advisers, less surprisingly it was also rated
above the value of seminars and short courses.

These results confirm the nature and process of learning by technology-
based entrepreneurs suggested by the case material. That is, that such learning
critically depends on knowledge gained from dealing with customers, from
dealing with suppliers and with dealing with other stakeholders such as
accountants and bank managers. Also important are product development and
the research and design process. We argue that such entrepreneurs will benefit
more from a support system that allows intervention to be flexible, largely non-specialist, but with an understanding of the innovation process.

Evidence on the importance of developing marketing strategies
The importance attached to dealing with the customer signifies the importance of marketing and developing a marketing strategy for the HTSF. The importance of marketing, for the technology-based entrepreneur, was also reflected in the significance attached to different business problems or issues faced by such entrepreneurs. Table III provides the rank order of important problems or issues faced by such entrepreneurs. Scores are not shown, but breaking into new markets was rated significantly above that of all other issues (at the 5 per cent level of significance), including raising finance and obtaining patents, issues that might be expected to be equally as important.

Tables II and III show that strategies are formulated from dealing with customers and that developing new markets are critically important for the success of strategies in technology-based firms. The interaction of dealing with customers and developing marketing strategies reflect issues that were discussed in the review of different strands in the literature. Three factors were listed at the end of that review as likely to be particularly important, which included the most important factors in Tables II and III; that is, dealing with customers, developing products and developing new markets. The case study evidence demonstrated that the entrepreneurs all had a period to learn about the importance of these factors (such as the importance of an appropriate marketing strategy for new technical products). This enables us to conclude with some observations on the policy implications of these findings.

<table>
<thead>
<tr>
<th>Importancea</th>
<th>Dealing with customers</th>
<th>2.45</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Developing products</td>
<td>2.31</td>
</tr>
<tr>
<td></td>
<td>Design</td>
<td>2.22</td>
</tr>
<tr>
<td></td>
<td>Dealing with suppliers</td>
<td>1.90</td>
</tr>
<tr>
<td></td>
<td>Dealing with employees</td>
<td>1.72</td>
</tr>
<tr>
<td></td>
<td>Research</td>
<td>1.68</td>
</tr>
<tr>
<td></td>
<td>Training</td>
<td>1.64</td>
</tr>
<tr>
<td></td>
<td>Advice from bank manager</td>
<td>1.50</td>
</tr>
<tr>
<td></td>
<td>Advice from accountant</td>
<td>1.45</td>
</tr>
<tr>
<td></td>
<td>Short courses/seminars</td>
<td>1.41</td>
</tr>
<tr>
<td></td>
<td>Trade association/firms in same sector</td>
<td>1.05</td>
</tr>
<tr>
<td></td>
<td>Using consultants</td>
<td>1.00</td>
</tr>
<tr>
<td></td>
<td>Applying for patents</td>
<td>0.73</td>
</tr>
<tr>
<td></td>
<td>Public sector advisers</td>
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</tr>
<tr>
<td></td>
<td>Advice from insurance broker</td>
<td>0.73</td>
</tr>
<tr>
<td></td>
<td>Other</td>
<td>0.72</td>
</tr>
<tr>
<td></td>
<td>Total number of entrepreneurs</td>
<td>23</td>
</tr>
</tbody>
</table>

Note: a Likert scale derived from subjective perceived scale of critical importance to no importance.
Conclusions and implications

This paper has examined qualitative evidence from a programme of interviews and development of case studies with high technology entrepreneurs. We have argued that the traditional model of the development of the HTSF (as spin out from research in a public sector institution or private sector large firm) may not, in many cases, be typical of the development of the HTSF. Our case study evidence suggests that high technology development can occur after an initial non-technical start-up. The non-technical start-up provides an important preparation for the entrepreneur through the learning experience, providing the basis for the development of more advanced marketing strategies for the technology-based development. The importance of this preparation should not be underestimated, it provides the naive and novice entrepreneur a valuable window of development when potential mistakes can be overcome, when lessons can be learned and when contacts and networking can be developed. The entrepreneur, during this period, learns to recognise the importance of marketing strategies, moving away from ad hoc developments to more appropriate marketing policies. The traditional view, normally sees the technology-based entrepreneur, in high technology environments, as a technical expert, lacking commercial expertise. We have argued, that this is too simplistic; the background of such entrepreneurs is also very diverse, such entrepreneurs do not necessarily lack commercial skills; for example, in some cases they have been acquired through the start-up process; however, what can be crucial is the contacts and marketing power brought in by additional members or expertise at a later date.

Our interview evidence, provides further material on the nature of the exploitation of technical opportunities, often stemming from activities that are not directly related. The combination of case study and interview evidence leads to the following conclusions. First, that non-technical start-ups can be a useful nursery stage development and precursor for technology-related
entrepreneurial development, acting on the serendipity process that can be important in the creative process of entrepreneurship. Second, that critical incidents and learning occur from the experience of dealing with customers/suppliers and other stakeholders as well as from product development. Thus it is important that novice or early stage entrepreneurs have opportunities to learn from customers in the development of marketing strategies, such a period provides valuable feedback in the shaping and development of entrepreneurial strategies. Third, it is argued that the performance and development of HTSFs depend on critical incident decision-making, that financial schemes to overcome seed capital or equity constraints actually make little difference to overall development. More crucial has been the ability to market and to take advantage of nicheing opportunities. Fourth, the timing of development, and hence of intervention, was often crucial, with the role of serendipity (preparation from previous experience) an important catalyst for change and for the development of strategy.

The evidence presented in this paper would suggest that intervention, at critical stages, has an important role. In none of our cases, however, was intervention through advice, counselling or other forms of help thought to be particularly helpful or worthwhile. This was because, in the majority of cases, it was expert-led, consultancy driven and short term. For example, part-funded consultancy helps to produce a business plan to attempt to secure development funding. In none of our cases, was there any attempt to build a longer relationship, to develop an understanding of the position of the firm and the nature of the relationship with the entrepreneur(s). When this is combined with findings from the programme of interviews, we find that critical factors in learning centred on product development, research and dealing with “stakeholders”. This evidence, we argue, suggests that support should be on a flexible, long term and non-expert basis, although such advisers should have an understanding of the nature of the important constraints in the innovation process for HTSFs. Support that has been provided has often been the opposite; short term and expert-led.

There are the beginnings of developments, in the UK, which will lead to the development of longer term, less expert-driven relationships that can be harnessed to the benefit of high technology-based entrepreneurs. It is important, however, to ensure that these developments complement each other; these developments, we suggest should include:

- The development of mentoring/advising relationships during the early stage entrepreneurship process (the present technology counsellor network offers some scope for development, but business links, where such counsellors are based, still target support at existing firms employing more than ten employees; missing the majority of high technology small firm entrepreneurs).
- Linking mentors/advisors to networks of high technology business angels, business angels who themselves have good networking contacts
- Using the educating role of business angels to greater effect.
References


Further reading


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