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Key words

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ABSTRACT

This paper aims to identify how entrepreneurial responses to 'barriers' can give rise to opportunities for new firms. The poor predictive record of studies analysing success attributes and favourable initial factors as determinants of new firm growth reflects the diversity of entrepreneurial responses to problems of growth, as illustrated by three case studies of new companies which were able to overcome adverse initial conditions despite the lack of early 'success attributes'. They did so by finding alternative opportunities and by achieving resource economy, resource leverage and resource creation, aided by strategic relationships formed with other players. Spurred by the problems they encounter, entrepreneurial firms revise their business conjecture and engage in innovative activities, their business model evolving through trial and error. Creative responses to unexpected developments by entrepreneurial decision makers have implications for research methodology and business support.

1 INTRODUCTION

That new firms are a source of innovation and economic renewal is now widely recognized. Because a small minority of firms achieving major growth have a disproportionate impact, the determinants of differential growth have attracted increasing attention (Storey 1994; Harris and Robinson 2001). Many attempts have been made to identify successful attributes and favourable conditions for the growth of new firms and to specify factors inhibiting growth. In this paper, we show that factors often classed as obstacles to the growth of new firms can be turned to advantage through entrepreneurial problem-solving. This has implications for research methodology and the explanation of new firm growth.

We begin by outlining perspectives on new venture growth. We go on to apply Penrosean concepts to the early growth of the new firm and develop the argument using three examples of new firms in which apparently adverse circumstances were turned to advantage. The case analysis enables us to identify some of the processes through which entrepreneurial responses to 'barriers' can give rise to opportunities for new firms. We suggest that the poor predictive record of analysis that views 'success attributes' as determinants of new firm growth is related not only to methodological weaknesses but also to the unpredictable effects of feedback processes set off by entrepreneurial problem-solving.

2 VIEWS OF NEW FIRM GROWTH

To understand growth in firms it is not enough to average out measures of attributes and performance removed from their context. The more we aggregate, the more we hide of the micro-diversity underlying change (Metcalfe 2000). To understand growth at the level where it occurs, it is necessary to trace the unfolding process of new firm development at the unit level and identify mechanisms of change. Thus the new firm's growth must be viewed as a process (Van de Ven 1992). But process perspectives on firm growth are rare, partly because of the difficulties of generalizing from them. Penrose's analysis of

growth in established firms was exemplary in identifying interconnections, change mechanisms and feedback effects of growth, her concepts informed by detailed case evidence. Her mode of analysis can also be applied to new firms. First we examine dominant approaches to new firm growth in terms of three approaches: (1) attributes and conditions affecting new firm growth identified in cross-sectional analysis at a point in time, (2) attributes and conditions affecting new firm growth over time and (3) developmental (processual) approaches.

2.1 Explaining growth in terms of cross-sectional measures of key factors

There is a relatively simple conceptualisation of the nature of growth in many cross sectional studies using a survey methodology. Firms exhibiting a variety of attributes are represented as passing through a series of time frames during each of which there is exposure to an array of conditions. These factors determine the size of the firm at that point in time or subsequently (Storey 1994, p. 123). Attributes and the conditions in which firms operate are not always distinguished; in some studies they are characterised together as negative or positive factors affecting growth (Harris and Robinson 2001). The conceptual scheme is often presented in terms of 'barriers to growth' or 'success factors' (Tether 1997, p. 91). Claims to robustness can be made for some findings that come up repeatedly in different studies. For example, firms with a growth record tend to be founded by larger teams, not by sole entrepreneurs (Eisenhardt and Schoonhoven 1990; Reynolds and White 1997, p. 94).[i] Insofar as evidence of this kind is supported by common sense and experience, it is used by investors and business support agencies. But statistical studies of SME growth have not achieved the predictive power they have sought. Critics point out that as much as 80% of sample variance is left unexplained in some of these studies. (Curran and Blackburn 2001, p. 44; Woo et al. 1994, p. 507). Many of the studies produce contradictory or inconclusive results.[ii] Since these studies compare firms that differ in their age, business cycle timing, and sector experience, these inconsistencies are not surprising. Some studies do not effectively separate determinants of success (e.g. capacity to market innovative products)

and measures of success (e.g. sales performance). This criticism has been levelled at other resource-based approaches (Peteraf and Barney 2003). The bias involved in generalizing from survivors has been criticised (Penrose 1995, p.7). Keasey and Watson point out that even where significant differences can be identified between high growth and other types of firms 'none of these studies is able to show that failed firms do not also exhibit these same characteristics' because they only include survivors (Keasey and Watson 1993 p. 113). This is a telling argument, discussed further in the conclusion. Adherents of the success attribute approach grant that prediction of performance based on measures at start up is limited, but argue that once businesses are in operation 'forecasting improves somewhat' (Storey 1994. p.159).

Prediction is not the only rationale for systematic analysis. A more serious objection is that focussing on measurable variables at a specific point in time cannot explain the mechanisms and operation of growth in new firms nor the way in which they build a resource base and increase their competence and dynamic capability.[iii] A cross sectional success attribute approach does not provide an account of prior influences, of linkages between and sequences of development . The studies in this group use 'theoretical frameworks' that consist of lists of factors, such as that provided by Storey (1994, p. 123). Despite the comprehensiveness of the lists of factors identified, some authorities have expressed reservations about calling such lists a 'theoretical framework' at all (Brüderl and Preisendörfer 2000, p. 51, Woo et al. 1994; Cardozo et al. 1995, p. 5)

2.2 Explaining growth over time

Time series approaches that examine attributes and conditions at several points in time adopt a less limited perspective on firm growth, recognizing that different factors become important over time. [iv] But aggregate findings on groups of firms are, by convention, averaged out in longitudinal studies, which tend to conceal such evidence as might be available on paths of growth over time (Delmar and

Davidsson 1998; Heirman et al. 2003). Econometric panel studies providing industry-wide analysis of entries and survival rates examine processes such as incumbent turnover that relate to populations of firms, not of individual units. These studies are useful in pointing to the renewal role of new entrants and sectoral differences in growth rates (Baldwin 1995; Caves 2003). Dramatic growth occurs for the few ventures that are able to dominate emerging niches and expand as these grow (Baldwin 1995). Penrose pointed out that what start out as interstices could become growth industries (Penrose 1995 p. 224). The methodological implication is that to analyse growth it is necessary to compare cohorts of new firms in the same sector over the same business cycles to take into account external conditions (Eisenhardt and Schoonhoven 1990).

Concern with endogenous growth is found in life cycle studies, of which the most common are stage growth models (e.g., Steinmetz 1969; Churchill and Lewis 1983; Scott and Bruce 1987). However, these have been heavily criticised on empirical and conceptual grounds (Storey 1994, p. 122; Bhidé 2000, p. 245; Stanworth and Curran 1986, pp. 81-83).[v] These studies do not provide measurable attributes associated with firm growth, nor distinguish conceptually between phases of activity, stages of development and processes of growth. Drawing on Penrose, we can see that communalities in the way firms develop in a market economy do follow from the common need to select business opportunities, mobilize resources to build a productive base, and create and capture value. Efforts to solve these problems may result in identifiable phases of activity (sometimes called stages of growth) if these problems are faced sequentially, but this is by no means universal (Garnsey 1998).

2.3 Developmental Approaches

The term 'firm growth' is often used without distinguishing between expansion in terms of rate or size, and development involving internal reorganization. Penrose integrated the concepts of growth, development and process, and revealed the relationship between them (Penrose 1960, 1995). Penrose

was concerned in particular with identifying the forces that change the firm's 'productive opportunity,' which she saw as the key to developing a theory of the growth of the firm.[vi] More recent and influential resource based studies of the firm have diverged from Penrose's concern with processes of growth. They include studies that can be characterised as 'variance approaches ' since the logic of comparing differences applies beyond statistical studies (Mohr 1982). The distinction between variance and process analysis is not the same as that between static and dynamic analysis. Variance studies compare differences in objects of study; process studies of firms examine interconnected causes, outcomes and further feedback effects. What are called "dynamic" studies often compare measures of difference over several points in time; comparative statics of this kind cannot trace the path dependencies, internal rearrangements and feedback effects associated with the process of development. Where the presence or absence of discrete variables (such as types of resource) is associated with performance at time *t* (e.g. in Barney 1996), the logic of analysis amounts to the comparison of variance. Resource based theory of this kind did not at first deal with new firms, but it has now been recognized that "... resource-based models of strategic advantage may need to be augmented by theories of the creative and entrepreneurial *process*." (italics inserted: Barney 2001, p. 53). Penrose's original work provided a process perspective on growth in mature manufacturing firms. We show how an approach of this kind can be applied to entrepreneurial firms.

Resource based thinking is divided into separate streams of work: a 'modern' stream and a variant that goes back to Penrose. Both streams have been concerned with the existence, boundaries, resources and capabilities of firms and how these provide sustained competitive advantage; neither has dealt with the development of new entrepreneurial firms. There are proponents of the modern stream who do not believe that Penrose's book is a useful contribution to modern resource-based theory (Rugman and Verbeke 2002). Their arguments have been countered by Penrose's supporters (Pitelis 2002, Lockett and Thompson 2004). There are on-going differences in the resource based literature over rent creation

and whether competitive advantage should be defined in terms of value creation or performance (Peteraf and Barney 2003). Our aim is to return to Penrose's concern with processes of firm growth. The relevance of resource based ideas to the growth of new companies has been recognized by a few authors, including Brush et al. (2001) and Heirman et al (2003). However we emphasise the feedback element central in Penrose's original conception. This perspective can accommodate the way entrepreneurs adapt and modify their business ideas in a path dependent process of learning and response to internal and external influences (Druilhe and Garnsey 2004).

3 A PENROSEAN APPROACH TO NEW FIRM GROWTH

An idea central to our account is that "The continual change in the productive services and knowledge within a firm along with the continual change in external circumstances present the firm with a continually changing productive opportunity" (Penrose 1995, p. 150). Thus Penrose saw the entrepreneurial matching of resources and opportunities as a dynamic process (Penrose 1995, p.150). This interplay does not emerge as clearly in recent definitions of the field that emphasise the pursuit of opportunities by entrepreneurs (e.g. Shane 2000). New ventures, including university spin-outs have to convert and develop knowledge into resources that match market opportunities (Vohora et al 2004). Endogenous and external causes of growth cannot in practice be separated; it is the interplay between external and internal influences that stimulates growth. For example, in start ups a large founding team (a success attribute) is both a cause and result of favourable perceptions that relate both to the venture's resource endowments and to its prospects in current market conditions.[vii]

Resource contraints induce entrepreneurial behaviour. Entrepreneurs are ready to pursue opportunities before they control the resources they require (Stevenson and Jarillo 1990). Entrepreneurs' desire to be independent agents despite their lack of resources is a spur to innovation. They aim to avoid

dependency by setting up reciprocal arrangements with partners who are offered a share in eventual returns. In creating a new business, they aim to create a resource base that can ensure value is created and captured. But the difficulties of mobilizing resources for start up often make it necessary to modify the initial business idea. Sustaining growth often requires more resources than new firms with an immature resource base can generate; growth creates problems of coordination and exacerbates resource deficiencies. These call for reconsideration of the firm's goals, activities and resources. Efforts to find a solution open up new opportunities in firms that overcome early difficulties. Returns are reinvested or distributed, in ways that cumulatively alter the new firm's resource base and business opportunity. The entrepreneurial firm that sustains growth, as Penrose showed, remains continually open to new opportunities and accordingly adapts and enriches its resource base.

Our research revealed that growth in new firms is driven by the problem-solving practices of their entrepreneurs, who grow their firms by responding to new opportunities and enlisting the support of others. On the basis of wider evidence from which the case examples are drawn, we propose that, in response to difficulties they encounter, entrepreneurial firms:

(1) mobilize resources in unusual ways,

(2) gain leverage from limited resources,

(3) reduce their resource requirements (economize)

(4) create new resources – competences, technologies etc.

(5) establish strategic relationships based on reciprocity.

These are not success factors but active processes that combine to promote innovative activities and business models. Entrepreneurial teams, in search of ways around the obstacles they face, are induced to form new kinds of alliance and build new competence and capability often in unexpected ways. Some of these innovative efforts result in competitive advantage for new

firms, where new business models and resources, developed as responses to difficulties, compensate for initial weaknesses.

We present three case studies of 'anomalous' growth as a contribution to building a theory of early firm growth. Anomalous cases can reveal the processes through which an early performance record can be achieved even by firms starting out with weak attributes or facing relatively adverse conditions. We use the cases to identify generic problem-solving processes. Though the form taken by competence creation was firm specific, the way in which problems were addressed applies beyond technology based companies. To show that the problem solving that turns obstacles to advantage is not time and place-specific, the cases are chosen from ventures created in the mid 1950s, 1980s and 1990s, respectively, in three sectors (instruments, Internet, renewable energy) and in three countries: the U.K., U.S. and Germany.

4 PROBLEM SOLVING AND COMPETENCE BUILDING IN NEW FIRMS

4.1 Problem Solving and competence building at Oxford Instruments[viii]

Oxford Instruments, founded in 1959, would have scored poorly on early success attributes. The founder, an academic engineer at Oxford University, lacked business experience and capital. Martin Wood's expertise was in an area with very limited market applications. The firm started as an engineering consultancy. Unexpectedly, once the new firm was under way a radical new superconductor technology emerged, with major market potential. Prior practical and scientific knowledge gave Martin Wood insight into the business prospects of the new superconductor and cryogenics technologies.

An emerging industry often lacks an established supplier network, creating adverse market conditions for early entrants. Oxford Instruments took the initiative over a shortage of liquid helium it needed for

cooling purposes by founding a company to supply the gas, selling to their own customers to cover overheads. This set off a price war. But liquid helium was not a core competence and by disposing of their distribution company through a sale to their rival's competitor, the company was able to ensure steady supplies of liquid helium, and also release capital needed for growth in core areas. Another serious supply problem resulted from deficiencies in super-conducting materials. These problems proved to be barriers to entry, by eliminating a number of their US rivals. The capacity to overcome these problems through persistence and skill conferred competitive advantage on Oxford Instruments.

Technology companies are vulnerable to the saturation of niche markets and to imitation. This threat emerged as their NMR customers began to produce their own magnets. Rather than selling their original company to these customers after 1976, the Oxford Instruments Group was spurred to strengthen its technical lead. This enabled it to maintain its market position and independence.

But the team at Oxford Instruments lacked the business expertise to manage rapid growth. By the time the shortcomings of current procedures were brought home to the founders, a cash flow crisis had loomed and their bank pressed them to sell the company. However, the company's product range and overall performance was strong enough to enable them to change banks and enlist the support of government backed investment fund, the future 3i. The founders' attempts to improve the management system led to a hostile spin-out by senior managers which could have proved fatal. But the departure of many of the management team was used as an opportunity to reorganize the company on a sounder management basis. In these and other ways, Oxford Instruments, transcending what could have been weak attribute scores and unfavourable conditions for growth, found ways to turn serious difficulties to advantage, developing solutions which propelled their innovative growth path.

4.2 Problem Solving and competence building at Hotmail Corporation[ix]

Hotmail, founded in 1996, lacked the early success attributes enjoyed by its rivals. Juno, for example, had experienced managers, substantial funding, size at start-up, and marketing support (Hugo and Garnsey 2002). But these shortcomings were compensated for and actually became the basis for a powerful proprietary technology which enabled the venture to be sold to Microsoft for an unprecedented sum a few years later. The venture was unsuccessful in raising the capital needed for their original business idea for data management software on the Internet. By rethinking their productive activity, the entrepreneurs were able to reduce their investment requirements. Difficulties the founders had in communicating with each other while in employment, together with the adverse investor response to their early product idea, led to the detection of a much more promising opportunity: e-mail on the web. Problem-solving was path dependent, the new solution emerging from the database management software they had already developed. They built on their earlier competence to create new competence: a powerful proprietary technology.

They also faced an acute shortage of funds for the marketing that was essential if their service was to attract users. The concept of viral marketing emerged as the solution to this funding shortage. They attached the "Get your Hotmail account here" postscript to the messages of existing customers. Because the service was of value to customers, it was not dismissed as spam and instead propelled the expansion of e-mail use at a rate unprecedented in the history of communications. In contrast, competitor companies burned their investment funds on less effective marketing. But in consequence the numbers of users overloaded Hotmail's servers. One of the founders, Jack Smith, told us: "These were the early days of Internet architecture… In those days the right solution couldn't be had at any price. We were the fastest growing email provider, and about the largest… Any vendor solution (of any type) we tried melted down under our loads… Today solutions are available that would have made things easier." They were left with only one solution: to develop a new, more scalable technology themselves and implement it while minimising interruption to the firm's current users. Once their new software was operating, the degree of scalability it offered became a valuable resource, and another reason for

the legendary returns achieved by the founding entrepreneurs when they sold their company to Microsoft.

4.3 Problem Solving through competence building at Solar Rise

Unlike the entrepreneurs cited above, the founder of Solar Rise A.G was an experienced businessman, but his idea for a power station based on photovoltaics had to overcome very unfavourable conditions which could have been major barriers to growth. He had no experience in the energy industry and little capital. Insufficient returns could be achieved from a public good such as renewable energy purely on a market basis. This obstacle encouraged the entrepreneur to lobby vigorously for the introduction of higher compensation through legislative support, in the interests of environmental improvement. In the emerging photovoltaics industry there was an absence of professional suppliers. The founder's response was to develop the resources required in-house, building competence that enabled the company to improve on what was available in the marketplace. The energy industry is dominated by powerful companies. The growth of the new venture was endangered by the impending entry of a major competitor who might have been encouraged by the success of the new venture to oust it through vertical integration. Instead of retreating in the face of this risk, the founder sought to pre-empt the move of the larger rival. By undertaking vertical integration before he would otherwise have done so, his firm developed capabilities that provided early competitive advantage.[x]

5 DISCUSSION

The difficulties faced by these new firms provided the stimulus to creating the technological competence and marketing capability which propelled their growth. Initial disadvantages were addressed by mobilizing resources in new ways, by resource economy, resource leverage and by creating new resources. These efforts were linked in a dynamic process of problem-solving that required strategic relations with others. This behaviour was highly interactive. Resource economy was

achieved internally by rearranging the firm's activities and resources in order to produce more with less. All three companies used their initial resources to gain further leverage. When faced with a resource deficit that could not be remedied externally, the ventures set out to build their own proprietary resources. Cooperative interactions with other parties, including funders, regulators and suppliers, were used to mobilize resources and open further opportunities. When market solutions proved unavailable, this became not so much a barrier to the pursuit of the original business idea as an opportunity to develop a new business idea.

A key feature of the response to adversity was cognitive. These entrepreneurs viewed the situation they faced as a soluble problem which they could address proactively and on which they could have some impact. They reconsidered their situation and found ways to turn obstacles to their advantage by re-routing the venture. Recurrent problem solving of this kind enabled these firms to build capability on a cumulative basis. As Penrose anticipated, to succeed they had to match their resources (in particular the competence they had developed) to shifting opportunities. Information asymmetries, technologies advancing ahead of market provision and government regulation were sources of opportunity in the three cases. From the case studies we see that entrepreneurial opportunities emerge as leads and lags create asynchronies between supply and demand and that innovative responses to 'market failure' drive entrepreneurial activity (cf Metcalf 2004).

We are not suggesting that any and every deficiency can be transformed by entrepreneurial problem-solving into an asset. The cliché that every problem is an opportunity does not recognize that problems can combine in such a way as to close off opportunities and crush motivation. Undoubtedly early endowments are facilitating and attract other favourable attributes in a self-reinforcing process. Undoubtedly timing played a large part in securing favourable outcomes for these firms. But more than good luck is involved in repeatedly identifying and exploiting resources and timely opportunities so as

to improve productivity and build capability. Luck is a necessary but not a sufficient condition for turning obstacles into opportunities. External support is essential – but the new firm must have something to offer partners in return. Building competence in response to problems made it possible to establish useful partnerships that further increased the firms' capability. Not only opportunities but impending threats can be turned to advantage when they spur creative thinking about objectives and new strategic moves. [xi]

5.1 Complementarities between research approaches

Though Penrose's own work was qualitative, studies using a developmental approach can be used to inform and to interpret quantitative analysis.[xii] Evidence from studies examining change over time could be used to trace measurable tracks of development and types of growth path (Garnsey and Heffernan 2002). Insofar as accounts of stages of growth are based on first hand observations of development, they represent findings from fieldwork which could be used to identify growth mechanisms and processes.[xiii] There is as yet no tradition of theoretically informed and standardised observations from fieldwork on new firm development, equivalent to ecological field studies.[xiv] This would require case study work having greater comparability across research projects, starting from a common conceptual base. The explanation proposed here requires further specification along these lines before it can be formally tested.

5.2 Concluding Reflections

We have seen that obstacles that stimulate problem-solving can include funding shortages, technological failings, supplier deficiencies and unfavourable market conditions, among others. Under conditions of uncertainty and resource shortage, entrepreneurs continually run up against difficulties and constraints. In some cases these very obstacles give rise to responses that are novel, market focussed and economical. Penrose showed that unused resources can set off a feedback process propelling growth

(Penrose 1995).[xv] Our cases show that not only unused resources, but also resource shortages and other adversity can promote the ingenuity in the creation of resources and recognition of alternative opportunities. That such responses are a common feature of entrepreneurial problem-solving shows that there is potential to turn adversity to advantage in large numbers of new ventures.[xvi]

But even where early problems are overcome in a young company, this is no guarantee of long term success in a market economy. The case studies cited illustrate the extent to which further difficulties arise as earlier problems are solved. External change and internal pressures exert continual challenges. Early success can be followed by reversals but most young firms lack the reserves needed to reverse setbacks (Garnsey and Heffernan 2002). Asymmetric reversals in young firms underlie the attrition rates that are revealed by panel studies of new entrants (Caves 2003).

Internal dynamics in entrepreneurial firms are fuelled by recurrent feedback between obstacle, innovative response and further outcome, as firms attempt to match their productive activities to market opportunities and build capability. It is these feedback processes that make outcomes unpredictable. New firms are complex adaptive systems, shaped by dynamic processes, both internal and external. System behaviour cannot be predicted with any accuracy when interconnected chains of action and reaction combine in multiple ways with many possible outcomes. As Prigogine pointed out, the aim of sciences dealing with complexity is not prediction but understanding (Prigogine 1980). Understanding can be used to interpret current developments and view them in perspective, making it possible to foresee what scenarios are likely to unfold.

The experimental mode adopted by effective entrepreneurs has implications for investment practices. Investors seek ways to resolve the dilemmas of risk and foregone opportunity. A solution advocated by the control theory of venture capital is to keep a close watch over investees' progress and to control

their activities by making further funds contingent on performance (Gompers and Lerner 1998). This can be helpful when investors have been entrepreneurs themselves, understand their *modus operandi* and can help them build strategic relations. But those who expect from new ventures consistent direction, steady growth and the ability to fulfil planning targets, misunderstand the kinds of developmental problems that new ventures face and the way in which these can be solved.[xvii] Growth setbacks are to be expected in new firms, and important learning flows from such experiences. The control theory of venture capital advocates staging capital infusions and terminating under-performing investment if prospects deteriorate (Gompers 1999). Other penalties may be imposed on entrepreneurs, for example their share position is set to deteriorate if performance targets are not met (Smith and Smith 2000). These safeguards may reduce investor losses. But they may also block the venture's capacity for further exploratory behaviour and for effective experimentation and learning in response to changing circumstances. These are the key problem-solving strengths of entrepreneurial ventures and the reason why their companies are a primary site of innovation in the economy. Because the stock market, in particular, expects predictable and consistent behaviour from quoted companies, once new ventures go public, their freedom to come up with radically new solutions is curtailed.[xviii] Yet entrepreneurial firms that experiment with emerging technologies and revise their targets and business models in response to new opportunities are those that may reap the greatest returns for investors.

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[i] Successful founders have a higher than average educational level and are more likely to have external investors and a strong management team. Ambitious founders, willingness to share equity, a multi-skilled management team and marketing expertise, among other factors, have been identified as attributes of new firms that are associated with growth (Utterback et al. 1988; Barkham et al 1996, Reynolds and White 1997, Cosh and Hughes, 1998).

[ii] In his useful summary of the literature, Storey reported that growth firms tend to have older than average founders (1994.p.158). However Barkham found that younger owner-managers had faster growing firms (Barkham et al 1996 p.62). Storey reports many other inconsistencies.

[iii] In the sense of capability used by Teece et al 1997.

[iv] Useful studies include Bruno et al. 1992; Cardozo et al. 1995; Delmarand Davidsson 1998.

[v] Birley and Westhead did not find evidence that firms pass sequentially through a series of growth stages (Birley and Westhead 1990, p. 555). However, this type of cross sectional data from a range of firms of various ages cannot track phases of activity that are firm-specific and path dependent.

[vi] "If we can discover what determines entrepreneurial ideas about what the firm can and cannot do, that is, what determines the nature and extent of the 'subjective' productive opportunity, we can at least know where to look if we want to explain or to predict the actions of particular firms. If we can further establish that there are significant factors expanding the productive opportunity of a firm and causing it to change in a systematic way over time with the operation of the firm, we are on the trail to a theory of the growth of firms" (Penrose 1995, p. 42).

[vii] This point was contributed by an anonymous referee.

[viii] This case is based on unpublished material kindly supplied by Audrey and Martin Wood. See Audrey Wood's history of Oxford Instruments (Wood 2000).

[ix] A fuller case study of Hotmail by the authors is available through the European Case Clearing House

[x] Further details are available in Hugo O. 2002. *Understanding New Venture Growth as a Development Process*, Unpublished PhD Dissertation: University of Cambridge

[xi] A defensive response to threats differs from the creative response to opportunities which Penrose described, involving risk averse loss-avoidance instead of growth-seeking behaviour. In contrast, there was a creative response to threats in these cases.

xii See Garnsey E., Stam E., Heffernan P., Hugo O., 2003, New Firm Growth: Exploring Processes and Paths, Erasmus Research Institute of Management Rotterdam, ERS-2003-096-ORG

[xiii] The process analysis provided by Greiner (1972) for example, has greater explanatory power than most descriptive accounts of growth stages. As he pointed out in correspondance with Van de Ven (1992) Greiner's study was not replicated, perhaps because he was not specifically interested in start ups which came to dominate the growth stage literature.

[xiv] In contrast for example with ecological models, such as source-sink models of the expansion of species, which are informed by extensive observation at the local level (Wilson 1993 p. 191). Such studies are needed for quantitative models informed by real data.

[xv] In a company with aspirations to growth, unused resources are viewed as a form of waste. Penrose showed that unused resources result from the barriers to achieving a perfect resource mix under conditions of growth. When perceived as a problem, the waste implied by unused resources can set off a growth-promoting innovation as an entrepreneurial response. Our case studies reveal, further, that resource deficiencies can have a positive effect when they provide focus and encourage ingenuity.

[xvi] After completing the research for this paper, we found management training literature that aims to help managers turn obstacles into opportunities. These training methods were inspired by the study of entrepreneurial responses to adversity (Stolz 1997).

[xvii] High expectations may be encouraged by Indexes of rapid growth ventures which drop firms from the data base when their performance is impaired, the very conditions that provide understanding of what can go wrong (Garnsey and Heffernan 2001).

[xviii] Teams that leave established companies may have tried out a number of products and markets before spinning out. Further research is required to see whether the benefits of consistent strategic direction are related to the maturity of the business idea and extent of pre-venture experimentation.