Understanding the dynamics of strategic risks and resources in innovative ventures

Serghei Floricel

Department of Management and Technology,
École des sciences de la gestion,
Université du Québec à Montréal,
P.O. Box 8888, Downtown Station,
Montreal (Quebec), H3C 3P8 Canada
Fax: 514-987-3343 E-mail: floricel.serghei@uqam.ca

Abstract: This paper presents a model of the evolution of activities, risks, and required resources for innovative ventures. A key implication of the model is the importance of surprising events in the life of ventures. Such events happen in most innovative ventures and appear to be a major source of preventable failures. Reacting to these events requires significant inflows of new resources into the venture. However, inflows are usually prevented by the disconcerting effect of surprising events on venture participants and by the centrifugal reactions they trigger among participants. The model is used to provide recommendations for developing business plans elements that can diminish the impact of unexpected events on innovative ventures and can reduce the number of preventable failures.

Keywords: innovative ventures; risk; uncertainty; turbulence; resources; business planning; flexibility.

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Biographical notes: Serghei Floricel is a Professor in the Department of Management and Technology at the University of Quebec in Montreal. His research focuses on the management of innovation and of large projects and was published in Research-Technology Management, R&D Management, International Journal of Technology Management, and by MIT Press. He is Research Director for the Managing Innovation in the New Economy (MINE) program. He developed with the Research Institute for SMEs of Trois-Rivières (Canada) a risk assessment questionnaire for the innovation projects of small and medium size firms (eRisC). He has a PhD in Administration, an MBA, and a Bachelor's Degree in Engineering.

1 Introduction

Many innovations come from ventures initiated by individual entrepreneurs and small firms, and many regions owe their economic dynamism to a large number of innovative ventures. The relative success that entrepreneurial ventures have had in commercialising discontinuous innovation has spurred an entire body of literature about the inability of

large firms to innovate (see Dougherty and Heller, 1994; Christensen, 1997; Leifer et al., 2001). Yet, entrepreneurial ventures also fail very often, wasting the efforts and resources invested in them and endangering their owners' financial health. While many failures are inevitable because of risks inherent in innovation, some of them could be prevented. This paper presents a dynamic model that enhances our understanding of the relation between risks and resource requirements in innovative ventures. The model is grounded, on the one hand, in the academic literature on business strategy and innovation, and, on the other hand, in 17 case studies of innovative ventures. This model enables us to provide recommendations for the development of business plans that could reduce the number of preventable failures.

A key implication of the model is the importance of surprising events in the life of a venture. It is well known that successful ventures strike a dynamic balance between the evolving risks of their innovation project and the resources that they attract and deploy. But seeking this balance often leads to an emphasis on anticipatory planning, namely on analysing the market, technical and other aspects of the venture in order to predict future evolutions and secure the needed resources. Yet, the study of large-scale engineering projects and of the innovation projects of large companies suggests that unpredicted and often unpredictable events are likely to occur in any complex project (Floricel and Miller, 2001; Verganti, 1999). The case studies carried out for this research suggest not only that surprising events happen in most innovative ventures but also that they are a major source of preventable failures. Reacting to such events requires significant inflows of new resources into the venture. However, inflows are usually prevented by the disconcerting effect that surprising events have on venture participants and by the centrifugal reactions they trigger among participants. Because most ventures have limited internal resources, barely sufficient for the anticipated activities and risks, the lack of new resource inflows leads to the demise of the venture, and the related loss of investment and accumulated knowledge.

To avoid such situations, business plans must include measures that enable the innovative ventures to react to unexpected events and minimise their consequences. These measures include: trying to 'provoke' the occurrence of unexpected events as early as possible, before significant resources are committed to a given course of action; increasing the flexibility of the venture by staging the resources investment, and hence limiting that are committed, or sunk, into a particular trajectory; modularising the organisational and technical aspects of the venture in order to contain the effect of unexpected events to a limited portion of the project; developing proactively alternative paths, including other, shorter term and less risky projects, which can provide resources to the main project of the venture; and cultivating external links to which the venture can turn quickly in order to attract additional resources.

These insights are developed throughout the paper. Hence, Section 2 provides a theoretical background on strategy and risks in innovative ventures, which distinguishes anticipated risks from unexpected events. After briefly discussing the methods used for analysing the case studies, Section 3 details the dynamic model that relates the activities, risks and resources of an innovative venture, and suggests why unexpected events often have significant negative consequences for the venture, especially as it approaches the commercialisation stage. A conclusion section presents detailed recommendations for the development of business plans.

2 Theoretical background

Innovative activities are typically divided in four qualitatively distinct classes, or stages, (Hartmann and Myers, 2001). These build upon each other and, in real projects, are interlaced. The first category, technology research, includes the discovery and demonstration of operating principles, basic technical concepts and architectures. This sort of activities may be performed on a non-commercial basis, for instance in universities or public labs. They may precede the establishment of a venture and continue during the other stages. The second stage, definition, refers to searching for concrete customers, markets and product forms, as well as making fundamental decisions regarding the goals and form of the innovative venture. In the third stage, product development, activities include understanding customer needs and market dynamics and translating them into concrete technical specifications and marketing strategies, as well as designing, building and testing functional products and production processes. The fourth stage, commercialisation, refers to the production, marketing and distribution of new products.

To sustain this stream of innovative activities, a venture depends on the continuing availability or inflow of many different resources (Pfeffer and Salancik, 1978), such as funds, knowledge, skilled personnel, organisational capabilities, specialised equipment, etc. Funds can be used to finance the acquisition or development of most other resources~~, hence~~ while some resources are more difficult to obtain, the availability of funds, is a good proxy for the accessibility of all required inputs. Most resources, including financing, flow to a venture based on expectations about the chances it has to produce a good return for resource providers. The innovative activities that are performed in the later stages ~~normally are~~ usually ~~deemed to~~ require increasingly costly resource investments. Yet, ~~it is also usually assumed that~~ the progress of these activities also produces knowledge that reduces uncertainty, seen as the possible variance of the prospects that the venture has to create value (see for instance Scherer, 1999). If prospects remain good, lower uncertainty means lower risk, enabling higher amounts of resources to be invested in the venture. The decreasing uncertainty assumption justifies staged investment decision approaches (Cooper, ~~1995~~) as well as the practice of having multiple rounds of financing, which successively involve financial institutions with lower risk appetites.

Studies of managerial risk perception in projects (March and Shapira, 1987; Shapira, 1995) also suggest that, when anticipating the future, managers do not perceive uncertainty as exogenous and do not try to lump all aspects of the project into one single indicator of uncertainty. Instead, managers perform a multi-dimensional mapping of the risks affecting the projects and search for mitigating actions that can help them 'manage' these risks to improve the value creation prospects of the venture. This approach is similar to strategic planning based on the identification of strategic issues (Ansoff, 1980). In line with this multi-dimensional approach, practical methods for assessing the value creation potential of innovation projects often rely on 'questionnaires' or 'scorecards' that evaluate whether the project displays certain factors that are known to be associated to success or failure (e.g., Cooper, 1981; Hise and Groth, 1995). Some scorecards are specially designed for use in the early stages of entrepreneurial ventures, where eliminating poor prospects or correcting potential weaknesses will lead to significant resource savings (see for instance Udell, 1989). Others are built on the assumption that success factors are different in each stage of an innovative venture. For example, the

Bell-Mason Diagnostics (Bell and McNamara, 1991) scorecard and assesses a project on 12 dimensions against a different ideal profile for each of four stages. Many authors also argue that the nature of success factors, risks, and mitigation measures varies with the specifics of the venture, such as the degree of technological and market novelty of the innovation (Hartmann and Myers, 2001; Ulrich and Eppinger, 2000). Research suggests that such scorecards are quite reliable and produce better results than financial methods such as the net present value (Cooper et al., 1998; Astebro, 2002).

But recent contributions on the dynamics of risk question the assumption of a steady decline in uncertainty as well as the emphasis on anticipatory planning. Research on complex projects hints that unexpected events raise significantly the level of uncertainty and risk in the late stages of the life cycle, calling for retaining strategic flexibility in these stages (Floricel and Miller, 2001; Verganti, 1999). Moreover, studies of radical or disruptive innovations show that development and commercialisation activities often show that current plans are not working, and this learning is followed by a corresponding increase of uncertainty and risk. Successful commercialisation of such innovations require several iterations that repeat all or some of the lifecycle stages until a viable way to produce value is discovered (Lynn et al., 1999; Leifer et al., 2000). Environmental turbulence, prevalent in certain sectors of the economy, increases the frequency and severity of unexpected events, which reduces the relevance of anticipatory mitigation and place responsive and iterative strategies at the forefront (Brown and Eisenhardt, 1997; MacCormack et al., 2001).

Responding to unexpected events late in the life cycle of a project, or producing significant iterations, requires a large amount of additional resources. But in the diminishing uncertainty model the resource cooptation process is seen as a linear increase in resource investment that parallels, with more or less slack, the decrease in uncertainty. This approach to financing innovative ventures is not designed to address major and, especially, unexpected difficulties and increases in uncertainty. When such events arrive late in the project lifecycle, they are seen as the equivalent of a project failure and as a signal for terminating the venture in order to stop any further resource waste. Yet, the number of preventable failures of this type can be reduced by understanding the inevitable changes in the nature of the risk and their relation to the resource requirements of innovative ventures. The perceptual model of risk presented in the following section explicitly gives unexpected events a key place in the evolution of venture risks and links it to the temporal sequence of activities and to the evolution of resource requirements.

3 A model of risk and resource evolution

The model presented in this section builds upon the insights from the research literature on strategy, innovation, and project management, presented in the previous section. In particular, it extends Floricel and Miller's (2001) model of strategic risk evolution in complex projects. The model is also grounded in 17 cases studies of innovative ventures. All ventures were established in the 1990s and were developing one core innovation project (see Table 1 for details on each case). Each case study is based on one or more individual semi-structured interviews with entrepreneurs, venture capitalists, bank employees and government officials involved with the venture. The interviews lasted about one hour and a half each, were recorded and subsequently transcribed. The resulting data were analysed using a semi-grounded (Corbin and Strauss, 1990)

model-building method. The content of the interviews was analysed qualitatively, in order to identify a large number of instances (or 'exemplars') of relevant phenomena such as perceptions of risks, resource cooptation, expected and unexpected events. A systematic comparison helped identify recurring themes, develop concepts and dimensions, and identify dynamic links of general relevance between these constructs. The resulting dynamic model of risk and resource evolution is shown in Figure 1 and detailed below.

Table 1 Summary of case studies (firm name removed for confidentiality)

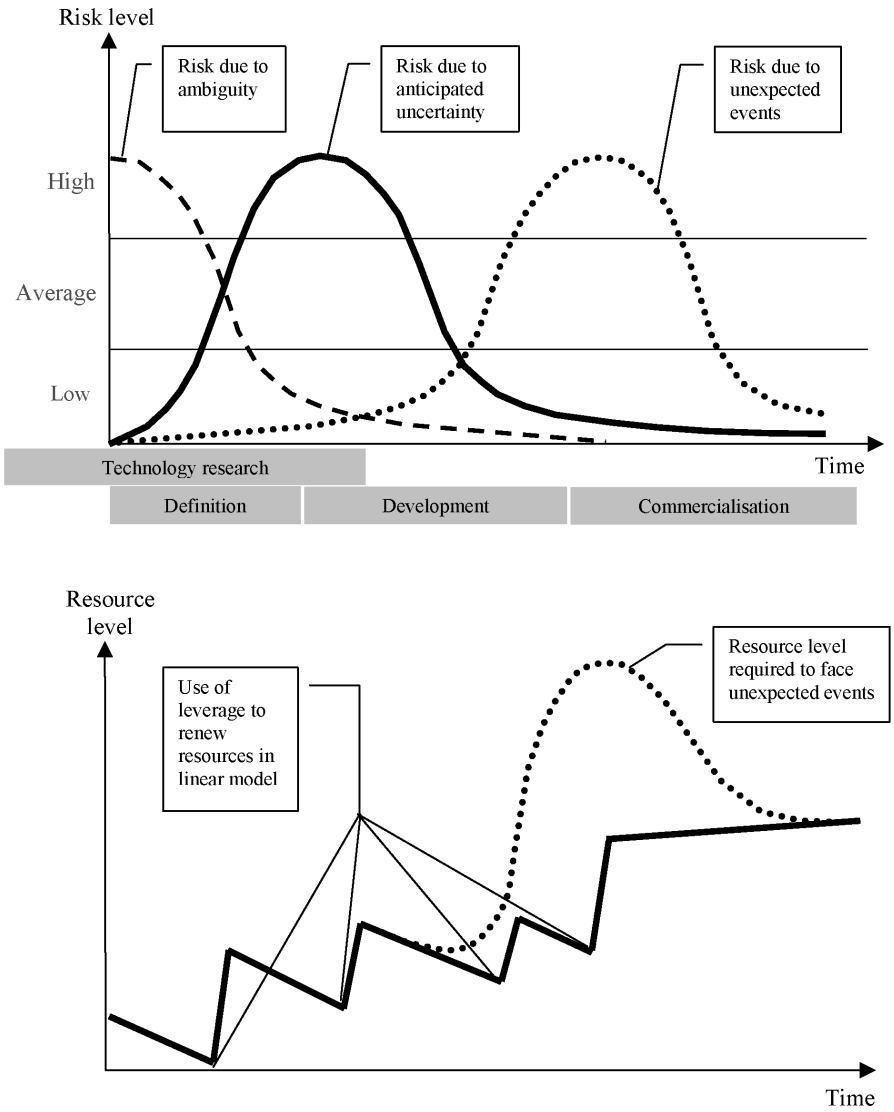
Geographic area	*Main innovation project*	*Venture still exists (end 2005)*
Montreal, Canada	Diagnostic test for a specific disease	No
Montreal, Canada	Biomarkers for specific class of diseases	Yes
Vienna, Austria	Diagnostic biochip for a specific class of diseases	Yes
Montreal, Canada	Production of active chemical compounds from plants	No
Toronto, Canada	Pain and stress relief device	No
Ottawa, Canada	Device for inspecting and cleaning optic fibres	Yes
North Carolina, USA	Vaccine for HIV	Yes
Shawinigan, Canada	Heating devices for industrial rolls	Yes
Trois-Rivières, Canada	Radio tracking system for industrial processes	Yes
Montreal, Canada	Feeder for a specific type of industrial equipment	No
Montreal, Canada	Device helping deaf students learn in normal classes	Yes
Montreal, Canada	Magnetic material for anti-theft devices	Yes
WestVirginia, USA	Power plants using coal residue as a fuel	No
Quebec City, Canada	Medical device steriliser	Yes
Montreal, Canada	System for treating geospatial data	Yes
Montreal, Canada	System for geo-referenced land videography	Yes
Montreal, Canada	Glue-based wound closure product	No

3.1 Value creation perspectives and the evolution of risks

Ambiguity. An innovative venture is a stream of actions effected by different participants connected by common value creation goals. Generally, risks are contingent upon actions that have not yet been undertaken (Luhmann, 1993). But risks are even higher if the intended actions, for instance the way the venture would create value, are not yet defined. Hence, in the initial stage of a venture, perceptions of risks are dominated by ambiguity regarding future actions, due to a lack of clarity regarding the nature of the innovation project, its intended markets, technology, product, etc. This lack of definition makes investment to appear risky and usually precludes resources flows to the project. For example, venture capitalists interviewed with regard to the biotechnology ventures in our sample pointed out to their reluctance to invest in firms that had only a technology

platform but no clear product or business model. Hence, initial activities concentrate on defining the parameters of the venture, for instance on delimiting the scope of the project and building a business case. The early business plan is the preferred way to codify and communicate these parameters. In the process, these activities establish a shared cognitive framework, which participants will use as a reference for further action. As details become clearer the risk due to ambiguity diminishes (discontinuous line at the left of Figure 1).

Figure 1 The model of risk and resource lifecycle in innove ventures



anticipated uncertainty. Once the definition phase establishes a reference framework for the venture, risk perceptions shift their focus to the uncertainty affecting the success of the intended actions. Managers are not sure whether intended actions, such as using

a given technical solution and targeting a certain market segment, will enable them to achieve an adequate value creation level. In this case, risks stem from the possibility that some aspects of the future reality will turn out unfavourable for the project, although they may also turn out more favourable than expected. Managers can-not predict perfectly the outcomes of relevant technical, market, and other processes because they have only imperfect knowledge about them. In addition, the success may be contingent on actions outside the control of the venture, such as customer response in the targeted segment or the adoption of a regulation that legitimates the given technical solution. This risk related to uncertainties within the cognitive framework is the one usually considered in the planning literature. Because of its 'evident' nature it is represented by a continuous line in the risk graph of Figure 1.

As Scherer (1999) points out, uncertainty is highest in the initial development stage when, even if a reference framework is defined, little market research, concept testing, design or prototyping has been performed. Knowledge production activities, such as technical and market feasibility, gradually reduce uncertainty with respect to envisioned actions. Hence, activities that reduce technical uncertainty may involve, successively, a literature review, analytical modeling, physical prototyping etc., they produce knowledge that enables an ever closer approximation of the behaviour of the final innovative product (Ulrich and Eppinger, 2000). Market uncertainty is reduced through market research, simulated market tests, and limited product launches, etc., which give a progressively closer picture of the final customer response in the target segment.

Theorists and the interviewed practitioners agree that uncertainty increases overall with the degree of project novelty and the lack of relevant experience in the firm. Hence, from a technical viewpoint, a project is more risky if it is a radical innovation rather than a marginal improvement of an existing technology (Clark and Fujimoto, 1991). The market potential is more uncertain, and risky, if the venture has to create a new market as opposed to selling into an existing market, particularly one in which the firm is already present with other products (Hartman and Myers, 2001). In market creation situations, ventures have to generate consumer awareness for a new class of products, change consumption and purchasing behaviours, build distribution, etc. All this additional effort is spent with little knowledge about the relation between effort and success.

But case studies confirm that entrepreneurs, their financial backers and other stakeholders, use knowledge production to map and address separate risks rather than to assess uncertainty overall. Within the cognitive framework of the venture, they focus on situations that can create obstacles in achieving the value creation goals, put additional pressure on resources, or reduce the control of the venture over relevant processes. Once these elements identified, participants seek active mitigating measures that reduce the likelihood or the impact of these elements. For example, a product that triggers a complex purchasing process in the client's organisation, requiring the approval of multiple stakeholders, departments and organisational levels, will lengthen and complicate the sales process and will require additional human and financial resources. In one of the studied cases, this even bankrupted the venture, because it did not have the cash flow needed to survive during the long time period before orders were placed. To mitigate this risk, other ventures leased their products or priced them under the thresholds that trigger lengthy approval processes. Other examples of anticipated risks are shown in Table 2.

Table 2 Examples of anticipated risks in ventures

Venture aspect	*Risky situation*
Technical	The design or the production of the innovation relies on technologies or parts that are not currently mastered by the venture
	The project has a level of complexity for which the venture does not have the required experience or competencies
	The manufacturing of the product requires a novel high-volume dedicated process
	The operation of the product is conditioned by the adoption of a technical standard
	The operation of the product is conditioned by the development and provision of complementary products
	The performance of the product is conditioned by its compatibility with existing the existing technical infrastructure and practices
Market	Only one or a few large firms are potential customers and they can impose conditions on a small venture
	The product will be sold in a fragmented market in which customer needs are not homogeneous and no distribution partner ~~has~~ a sizable part of potential customers
	A large competitor is present or intends to enter the market, especially one that can influence distribution channels or offer more complete product family
	The product will be sold in a market prone to price and promotion wars, reducing the window of opportunity for the venture to consolidate itself in the market
Other	Commercialisation is conditioned by a regulatory approval or certification for the product or its manufacturing process
	There is possibility of social or political resistance with respect to the product, the underlying technology, or their social and environmental impact

Knowledge production and other development activities as well as risk mapping and mitigation activities reduce uncertainty and clarify the value creation prospects; often, they also increase the chances of success. This process naturally leads, within the reference framework of the venture, to situations that are difficult and require additional resources. For example, in of the examined cases, a substance that was used initially to glue wounds proved to be chemically unstable. The venture had to hire an expert in chemistry to develop a replacement solution. In the end, the technical solution he developed, which involved two components rather than one, was not only adequate but had additional benefits compared to the solution considered initially. However, in other cases the process uncovers adverse circumstances that become 'showstoppers' (Leifer et al., 2000); such situations clearly prove that the value creation perspectives of the venture very poor and, as a consequence, the flow of innovative action stops.

Unexpected events. But many ventures also encounter problems that stem from events that are totally unexpected, that fall outside the initial reference framework. While uncertainty with respect to the elements envisioned initially diminishes, these 'discoveries' shift the reference framework; new or previously unanticipated elements enter the picture and, in many cases, considerably increase the uncertainty and the risk.

Luhmann (1993, p.43) depicts the perception of a discontinuous shift in the reference framework in the following way:

> "When we look back, we no longer understand why in a present now belonging to the past we had been so cautious or, as the case may be, why we had made such a risky decision. And from out of the future another present stares us in the face, in which we will in retrospect certainly come to a different appraisal of the risk situation we are experiencing in the present."

The case studies show that unexpected events, especially those that cause significant shifts in the reference framework, usually occur later in the project life cycle, when the stream of action ~~is~~ no longer consists just of planning and analysing but starts confronting the concrete physical and socioeconomic reality. Surprises are common in innovation projects when full-scale prototypes are built, when market tests and commercialisation begins, or when ~~the~~ products undergo regulatory approval procedures. Because most activities focus on reducing the expected uncertainties and are oblivious to the almost certain onset of unexpected events, the risk from these surprising events is represented by the dotted line shown at the right of Figure 1.

Some unexpected events occur because ventures lack the required resources and time to perform extensive development activities or simply because these activities are inadequate. For example, in one of the case studies a venture discovered, when approaching commercialisation with the device it produced, not only that tens of similar devices, much cheaper even if inferior, were available on the market, but also that whole idea behind the operating principle of the device, had been discredited since the 1980s, because these crude devices had proven ineffective. In another case, using the diagnostic product of the venture required a minor chirurgical intervention. Despite its usefulness, almost no customer agreed to undergo the procedure merely for diagnostic purposes. Both ventures were unsuccessful, for reasons could have detected earlier ~~an~~d hence~~, could have~~ avoid~~ed~~ the waste of resources.

But, in most cases, surprises stem from the genuine complexity of the real world, from uncontrollable circumstances ~~and~~ behaviors of independent actors, and from the limitations of the anticipatory analytical approaches and models that ventures can realistically use. For instance, during our study a newly elected government decided to cut government support in the form of venture capital funds for biotech firms. This led to a wave of bankruptcies and consolidations, including the bankruptcy of one of the ventures in our sample. In another case, the value creation ~~perspective~~ of venture that was developing a power plant using residual coals were quashed by an unexpected reduction in the price of normal coal, to which the payments that the plant would receive were tied contractually. None of the project participants expected that, after decades of continuous growth, coal prices would suddenly fall; they only expected, and factored in the estimation models, various percentages of price increase.

The more turbulent are the technical, market and regulatory environments the more likely it is that ventures will encounter surprises (Emery and Trist, 1965; Bettis and Hitt, 1995). Turbulence in the technical environment means constant and unexpected change and novelties in technologies, infrastructures, tools, materials and components. Such events enable competitors to offer a superior product or affect components and materials currently used, calling for a redesign of the product. While firms in more stable sectors saw little relevant change, the ventures we studied in the biotech sector witnessed many competing technological discoveries, competitors that proposed alternatives to serve the

same need or even entire paradigm shifts during the life cycle or their projects. Market turbulence occurs in the form constantly changing user needs, competitors that introduce frequently new products, and a constant flow of new entrants. In the end, firms in turbulent environments incorporate the expectation of surprising developments into their reference frameworks and organise their activities accordingly (Bogner and Barr, 2000).

3.2 Resource cooptation

Normal linear cooptation. As mentioned above, ventures need different resources in order to advance their innovative activities. The literature and the case studies show that resources flow to a venture based on three main considerations. The first one, the value creation potential of the venture after factoring in the various risks it faces, results from a combination of market, technical and other aspects. This aspect and the related risks have already been discussed above. The second consideration is the ability of the venture to find a protected niche that enables it to capture most of the value it creates (Alvarez and Barney, 2005). The third consideration refers to the key human resources of the venture, namely the abilities of its owner-entrepreneur and top executives. The last two considerations will be discussed in more detail below.

Interviewees among resource providers were interested in the presence of barriers that enable the venture to capture the value it creates, as suggested by an almost obsessive attention to intellectual property protection issues, by the discussions of issues such as the nature of market competition~~, the creation of an organisational memory and of successors that can take over in case key experts leave the company or are no longer able to work etc~~. This concern is echoed by strategy research, which suggests that, in competitive environments firm performance is related to favourable asymmetries in market access or internal capabilities (Porter, 1980; Wernefelt, 1984), which preclude entry, attack or imitation by competitors. Such 'appropriability regimes' (Teece, 1986) or 'isolating mechanisms' (McGee and Thomas, 1986) that enable innovators ~~value~~ capture result from institutional frameworks (Cohen, 2005; Stigler, 1971), economies of scale and scope in innovation, production and distribution (Scherer, 1990), network and reputation effects (Shapiro and Varian, 1999) or the nature of knowledge and resources (Barney, 1991).

Besides the potential and protection of a venture, resource providers also emphasise the human potential of its owners and top executives. The literature (Harris and Jackson, 1999; Heunks, 1998; Karlsson and Olsson, 1998) and our case studies suggest that the abilities of the entrepreneurs and the management teams play a significant role in the success of a venture. Resource providers mentioned that they appreciate the ability of an entrepreneur to understand the real resource requirements of a venture, to develop an inspiring long-term vision and explain it in simple terms to resource providers, to develop a network of contacts among these providers. Personality traits, such as the willingness to share control, were also evaluated. Experience is also important, as demonstrated by the existence of many successful 'serial entrepreneurs'. In many ventures that were studied, when these abilities were not present, resource providers forced the entrepreneurs to accept on the management team executives with a different background and in some cases even replaced the entrepreneur with professional managers. The importance of top executives is underscored by the fact that many interviewees among resource providers showed a preference for financing "an average project proposed by an excellent team, rather than an excellent project proposed by a weak team". But these human aspects may

be overemphasised because resource providers may be more confident in their own ability to evaluate a person that in their ability to evaluate the potential of a venture. As will be discussed below this over-reliance on personal trust may be worsening the ability of a venture to react to unexpected events.

The expectations regarding the value creation opportunity together with the barriers that enable the value capture create a niche that protects the venture. This niche and the resource providers are like a 'social elevator' (Sorokin, 1959) that helps the innovator transform an innovative idea into an established company. The mix of participants changes frequently, as actors join the venture to bring complementary knowledge and resources. Some participants are invited to join merely because credibility of the opportunity increases with the number and reputation of actors who support it (Podolny and Stuart, 1996). Early resource providers, such as venture capitalists, are keenly interested, from the moment they join the niche, in having a clear exit strategy. By selling their interest to other investors, large firms, or on the public financial markets, they hope to obtain a return on investment well before the venture enters the commercialisation phase. Niches last only as long as the expectations about the evolving opportunity for value creation and capture are positive; when this is no longer the case resource providers reorient their investment.

Ventures grow by repeatedly leveraging the results of uncertainty-reducing innovation activities in order to renew resources. Most early funds providers are strategic investors or venture capitalists. Entrepreneurs use their ideas to build a rough 'vision of the future' and act to persuade resource providers to give their venture seed money. Then, funds are used for activities that produce knowledge that reduces the risk of the~~ir projects~~. Results from these activities are, in turn, used as a springboard to negotiate another round of financing, which has lower cost. In turn, these funds are used to create a functional prototype. This prototype and other results are leveraged to obtain financing for commercialisation, including sometimes through an initial offering in public financial markets. This process continues until the venture becomes self-sustaining and can finance further activities with the proceeds from the sale of its products. The almost linear process of resource cooptation, which echoes the almost linear reduction in uncertainty, is depicted by the solid line in the lower part of Figure 1.

Cooptation after turbulent events. The linear mode of growth gives ventures a moving a 'resource horizon', with a limited temporal depth. Most small innovative firms have to live with a precarious situation in terms of resources (Julien et al., 1996). An interviewee argued that it is almost useless to think beyond the next six months (or the time afforded by current financing round). In other words, ventures have a rolling span of attention that includes only the nearest set of activities, for which it has resources. Resource bottlenecks occur even for anticipated activities, especially when the venture approaches transition~~s~~ between financing rounds, as financing rounds ~~did~~ not correspond neatly to the stages of the innovative activities. Funds dry up, for instance, before the venture could finalise its development activities. Concerns about obtaining the next financing round put a constant pressure on entrepreneurs and managers. Executives, who are also sometimes the key technical experts of the venture, spend significant efforts for obtaining the needed resources.

But these difficulties increase significantly when the venture encounters unexpected events that shift its frame of reference in the later stages of its project. The fact that surprises usually occur late in the lifecycle of the project makes them even more difficult to tackle, because the entire resource configuration of the venture is oriented towards

activities anticipated within the initial framework. Earlier technical choices, market strategies and partnership agreements irreversibly commit or sink resources in directions that are no longer feasible, and reduce the flexibility that managers have in responding to surprises. Reorienting the project requires significant additional financial and human resources, which puts an important strain on already precarious small firms. Only an easy access to additional external resources enables ventures to perform the almost complete iteration required to save the innovation project. Yet, even if the project has good value creation perspectives in the new situation, these perspectives are very uncertain and require additional validation. Thus, ventures ~~may be~~ refused access to these additional resources.

In addition to the renewed uncertainty and risk perceptions, the impact of exogenous unexpected events on innovative ventures is amplified by non-linear endogenous processes that affect the participants and the relations between them. The normal startling effect of unexpected events may paralyse participants' capacity for creative response. In addition, some participants may experience well-known shift 'between hope and fear' (Lopes, 1987) documented by the behavioural studies of risk. Namely, according to the two-reference point theory of risk taking (March and Shapira, 1992; Shapira, 1995) participants' reference for judging their situation may shift from an 'aspiration level', a benchmark for setting expectations that varies function of the already achieved performance and accumulated resources, to a 'survival level', a dreaded, rock bottom point where all resources are exhausted. The fact that resource providers all over sudden envision such an exhaustion point may explain why they cut their support for the venture very swiftly in some of the cases we studied.

The fact that managerial preparedness and trustworthiness is used by resource providers as a dominant evaluation point for the venture (Knight, 1994; Zopounidis, 1994) also increases the non-linear effect of unexpected events. The personal trust, which compensated for the inability to judge the intrinsic value creation outlook of the venture, disappears as a result of surprises. In some cases of ventures, following unexpected events, entrepreneurs that used to be the darlings of venture capitalists became pariahs. Without the halo effect of their personalities the perspectives of the project probably appear much bleaker to resource providers than they really ~~were~~ following the unexpected event. Even if resources are not cut immediately, the openness and cooperation that could help participants find a creative solution for the new situation disappears. ~~A~~After the unexpected price hike that affected their value creation perspectives, participants in the venture that was building an innovative power plant using residual coal~~,~~ started hiding their activities from the representatives of other participating firms and began exchanging formal documents in order to position themselves for a possible arbitration.

Given the ubiquity of unexpected events, the main argument of this paper is that a much higher number of innovative ventures than previously thought fail not because of a normal attrition due to the inherent risk of innovation, not because of the normal difficulties in securing resources, not even because of the fact that the venture undergoes the reality test for the first time in its lifecycle, but because of the inability to marshal resources that would enable the venture to overcome the effects of unexpected events. This type of failure is particularly painful because it arrives rather late in the lifecycle, when a lot of resources are already invested and ventures have developed organisational processes and competencies. In the case of the venture specialising in the production of

active chemical compounds from plants, failure arrived when it had just invested in a new building with state of the art production facilities.

In sum, many of the ventures that fail because of unexpected events could be, in fact, saved with an inflow of additional resources and may go on to create significant value for the resource providers and the society. Saving them usually requires a significant increase in resource cooptation, which, in proportion, corresponds to the dotted line in the lower part of Figure 1. But entrepreneurs and the ventures they own are not prepared to face this reverse tidal wave that affects ~~other~~ participants' attitudes~~,~~ following an unexpected event~~,~~ and the ensuing resource drought. Below we will discuss some of the measures that can be taken beforehand in order to reduce the need for additional resources and to increase the survival chances of these ventures.

4 Conclusions and implications for business plans

This paper ~~shows the~~ processes whereby ~~the~~ unexpected events can cause problems for innovative ventures and suggests that these processes make unexpected events a major cause of preventable failure for this type of ventures. These conclusions are based on qualitative research, which is particularly suitable for theorising complex processes. However, certain conclusions such as the relative incidence of turbulent events and preventable failures caused by them would benefit from additional validation, based on research using quantitative methods and relying on a larger sample of ventures. If the suggested conclusions receive additional confirmation, further research should focus on ways to reduce ~~the~~ preventable failures. Some of root causes ~~why~~ ventures ~~are unable to~~ overcome unexpected events could be institutional, originating in the organisation of the financial system and the prevailing venture evaluation methods, which are, as we mentioned, based on a linear model of diminishing uncertainty. But venture managers can also takes steps towards reducing the effect of unexpected events. The remainder of this section suggests elements that could be included in business plans in order to increase the capacity of the venture to respond to unexpected events.

It is difficult to know what can be done to prepare for unexpected events when, by definition, these events are unknown in advance to managers. One of the possible avenues is to 'provoke' the occurrence of unexpected events as early as possible, before significant resources are committed to a given course of action. As mentioned above, many unexpected events occur when the project confronts the physical and social reality. Thus, business plans could emphasise early tests of real prototypes and involving real clients as a way of provoking unexpected events. Research on ventures working in turbulent environments, such as internet startups, shows that they repeatedly use imperfect 'probe' products in order to get rapid client feedback. Some of them, such as Netscape, used as many as seven iterations involving successive 'Beta' prototypes in their innovation projects. Those who prepare the business plan must weigh the additional complexity and the reduced control over development, as well as the potential loss of reputation with clients against the benefit of having an early warning system for unexpected events.

Another possibility is to retain as much flexibility as possible by developing a business plan that prioritise or stage the resource investment in a way that limits the amount of resources that are committed, or sunk, into a particular development trajectory. Hence, rather than addressing all aspects of a venture head on, projected development

activities could first address key issues and, only if results turn out favourable for the venture, invest in developing the rest of the project. Ventures could also use, as much as possible, flexible technical solutions, manufacturing process and alliances. For example, a strategy of using in products, whenever possible, generic and reprogrammable electronic components rather than rigid special purpose components, or even software rather hardware, could both delay costly investment in developing the components and give designers the option to reprogram them later. The human equivalent is relying on generalists rather than narrow specialists. Those who prepare the business plan must weigh the potential increase in cost or loss of performance against the benefit of increased flexibility.

Business plans could also include the proactive development of alternative paths. To increase their ability to secure additional funding or simply in order to survive, many of the biotech ventures that were studied pursued, in response to unexpected events, alternative projects that had shorter a term and were less risky. These projects could quickly generate revenues and provide resources to the main project of the venture. For some ventures, this approach had the positive consequence of enriching them with a vision for growth based on multiple technologies, products and markets. In many cases, rather than responding to unexpected events, such projects could be planned and even started in advance, by relying on the interests and creativity of R&D personnel. In this case, those who prepare the business plan must weigh the potential loss of focus for the venture against the increase in the number of trajectories for further development.

Another possibility is to emphasise organisational and technical modularity in order to contain the effect of unexpected events to a limited portion of the venture. Modularity means limiting the interactions between different subsystems of a project or organisation. To do so, business plans should emphasise proactive investment in the architectural design of products and organisations. For example, resources could be dedicated to the early definition the functionality of the different subsystems and of the interfaces between them. Those who prepare the business plan must weigh the additional cost and the loss of efficiency that may result from the use of modular structures against the increased responsiveness and flexibility that such structures provide.

Finally, the business plan could become a promotional tool for cultivating external links to which the venture can turn quickly in order to attract additional resources. In the final stages, when unexpected usually events occur, business plans must promote the base of accumulated knowledge and the other results that the venture has obtained, and show how these could be leveraged in case of unexpected developments that will change radically the nature of the venture. Business plans should also include alternative action~~s~~ paths prepared for such eventualities and show how the providers of additional resources could minimise their exposure in case such events occur. Those who prepare the business plan should weigh the possible loss of confidence from current resource providers against the benefit of a faster resource access.

In conclusion, the research presented in this paper contributes to the theory of innovative venturing by providing a better understanding of the sources of avoidable failure for ventures. After further research and careful validation, the theoretical and practical insights could improve business plans and, hence, ease the access of innovative ventures to resources, as well as provide guidance to entrepreneurs and their advisors.

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