



# HANDBOOK OF RESEARCH ON TECHNO-ENTREPRENEURSHIP



# Handbook of Research on Techno-Entrepreneurship

*Edited by*

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# Introduction

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Techno-entrepreneurship is a recent field which has its roots in the now established field of entrepreneurship. Its aim is to study the specificities of entrepreneurial activities in technology-intensive environments. Why is that important? Techno-entrepreneurship combines the risk factors associated with entrepreneuring with the ones due to the highly uncertain nature of technologies development. This 'squared risk' is a real challenge for new high-tech ventures.

As an emerging field, it was important to consolidate the early writings and this is the aim of the present Handbook. Since the inception of this project almost three years ago, it has been decided to be as open as possible in terms of contributions to allow any researchers to feel that they are working in techno-entrepreneurship to contribute to the Handbook. The result is a diverse yet focused collection of contributions: diverse as it ranges from questioning the reality of the field to the study of processes of techno-entrepreneurship, including the role of clusters, incubators and technology transfers and to applications in two of the most techno-entrepreneurial industries of the moment: biotechnology and electronic commerce.

The first part of the Handbook is dedicated to the foundations of the field. The first contribution, by Sylvie Blanco, shows that the concept of technological opportunity recognition is important to resolving part of the uncertainty related to techno-entrepreneurship. Igor Prodan, in Chapter 2, builds a model of technological entrepreneurship in the perspective of regional development by emphasizing key characteristics derived from the literature in entrepreneurship and technology policy. To end this part, Helena Yli-Renko casts light on exchange relationships in entrepreneurship research by mapping the various streams of research on the external relationships of entrepreneurs and entrepreneurial firms in a high-tech context.

The second part focuses on the specific underlying processes in techno-entrepreneurship. Diane Isabelle studies the commercialization of science and technology and the supporting mechanisms. Annaleena Parhankangas and David L. Hawk, using evidence from five new-to-the-world technologies studied over three decades, discuss the balance between exploration and exploitation for high-tech ventures. Behrend Freese, Thomas Keil and Thorsten Teichert focus on radical innovation and how corporate venture capital can help to address the challenges it presents. Finally, Khairul Akmaliah Adham and Mohd Fuaad Said highlight the importance of mentoring in the pre-seeding phase in the case of Malaysian high-tech entrepreneurs.

The third part of the volume is dedicated to incubators and technology transfers. Christian Lendner explores the growing phenomenon of business incubators in universities to help technology transfers and influence on start-ups. Rory O'Shea develops a conceptual framework of university spin-off activities and suggests that university heads and policy makers can encourage and develop university entrepreneurship by using a comprehensive systems approach for the identification, protection and commercialization of university intellectual property. To close this part, Michael Bernasconi and Dominique Jolly present spin-off activities in the case of Sophia-Antipolis, one of the first technopoles in

France, and trace the history of the development of the techno park and the characteristics of its different phases of development.

The fourth part focuses on the specificities of techno-entrepreneurship in e-business with three contributions. Tobias Kollmann describes what is e-entrepreneurship, positions the net economy among the other economies and shows that the electronic value chain and the value-oriented processing of information serve as the starting point for every net economy venture. Antonio Padilla-Meléndez, Christian Serarols-Tarres and Ana Rosa del Águila-Obra study the profiles of e-entrepreneurs in terms of demographics and motivations in the case of Spain. Finally, Lalit Manral focuses on virtual alliances in the Internet context and presents their dynamics compared to traditional alliances.

The fifth and last part of the volume is dedicated to another industry replete with techno-entrepreneurship: the biotech industry. Edward L. Bayham, Jerome A. Katz, Robert Calcaterra and Joseph Zahner make an in-depth study of the St Louis BioBelt and its success factors and present factors complementary to the earlier chapter on Sophia Antipolis. Finally Nicola Dellepiane studies the strategies of small business in the part of the biotech industry dedicated to DNA–RNA.

After reading one or several of these contributions, the reader will realize how vast and yet mostly unexplored the field of techno-entrepreneurship is. There is a definite need for the exploitation of existing findings and their integration into readable frameworks and for the exploration of the numerous aspects of entrepreneuring in technology-intensive industries. As the high-tech of today is the commodity of tomorrow and as the start-ups of today are the multinationals of tomorrow, no doubt this field will become of interest in the near future to more and more researchers, policy makers and practitioners.

# PART 1

## FOUNDATIONS OF THE FIELD



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# 1 How techno-entrepreneurs build a potentially exciting future?

*Sylvie Blanco*

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## **Summary**

Technology-based entrepreneurship is assumed to be one of the most important sources of economic value creation and development in Europe. Major incentives and means have been implemented to foster, secure and accelerate the creation and the early growth of high-tech new ventures – whatever their origin. However, despite years of experience, the problem of predicting potential growth and profits of future businesses remains highly uncertain. Actually, techno-entrepreneurship seems to entail both high potential future profits and high uncertainty. A major question concerns the possibility to prove, at least partly, the future value of an opportunity before its realization. This calls for a better understanding of the concept of technological opportunity seen as an anticipated profitable business so as to enable researchers and practitioners to develop procedural knowledge. This chapter proposes to learn from successful techno-entrepreneurs about the way they represent their opportunity early before its concretization so that both procedural and declarative basic knowledge may be identified.

## **Introduction**

Techno-entrepreneurs aim at creating and capturing economic value through the exploration and exploitation of new technology-based solutions. To do so, they have to find their way in an existing world in order to (re)create a new one where they will be able to reap the benefit of their idea and vision. This process, which mainly belongs to opportunity recognition, raises an important issue about the ability to match current and future technologies, market needs and resources in a vision of a future business opportunity which is recognized as exciting by external actors. The ability to recognize business opportunities is one of the first and major skills an entrepreneur should acquire as it will dramatically shape the future of his venture. However, our understanding of this achievement remains vague and hardly actionable to support practitioners. To our view, despite a thorough understanding of the opportunity recognition process, its determinants of success and failure, quite an important lack of understanding remains as to appropriate anticipative approaches. Two questions remain without a satisfying answer: what does reliable knowledge about the future consist of? How to gather and produce such knowledge in an effective manner?

Actually, as in the managerial literature, the entrepreneurship literature assumes that entrepreneurs are able to anticipate and to build a credible vision of their future business. Mostly, two series of parameters explain these abilities: willingness to bear uncertainty and specific cognitive abilities starting with alertness. Techno-entrepreneurs would be

more willing to bear uncertainty and more knowledgeable about overcoming this difficulty than non-entrepreneurs. Their alertness provides them with the ability to detect and exploit early signs of change and then to tell plausible stories about their future business. Besides, they know how to build precise plans according to detailed objectives, thus taking into account the potential impact of anticipated risks and problems. They formulate a plan for execution, that is to say a series of actions and events in order to capture the opportunity they have in mind. These tasks allow them to detect exciting future businesses and to motivate their potential partners so that they may gain access to the required resources to launch their business platform. Finally, opportunity recognition means both gathering knowledge and conceptualizing future business value. The way these tasks are achieved and combined is crucial to building trust, leveraging external resources and attracting a higher level of investment, of customers and of partners. However, so far, we do not know about the principles and procedures allowing us to gather knowledge about the future and to conceptualize the opportunity as it may concretize. That is why we propose to learn from three successful but different experiences of technological opportunity recognition and to analyse them as anticipation mechanisms.

## **Technological Opportunity Recognition as Anticipation in the Light of Uncertainty**

### **1.1 Technological opportunity recognition**

In his landmark work on capitalism evolution and transformation, Schumpeter (1934) put the emphasis on entrepreneurs as those who, in opposition to traditional capitalists (who exploit existing resources, fields and activities), engage in new activities or ventures that did not exist before. He emphasized how entrepreneurs explore new opportunities in order to build a new world order while deconstructing the old one, thus allowing capitalism to constantly reinvent itself. Hence, entrepreneurship can be defined as an activity and a process involving the discovery, creation and exploitation of opportunities in order to create value thanks to the introduction of new goods, services, processes and organizations.

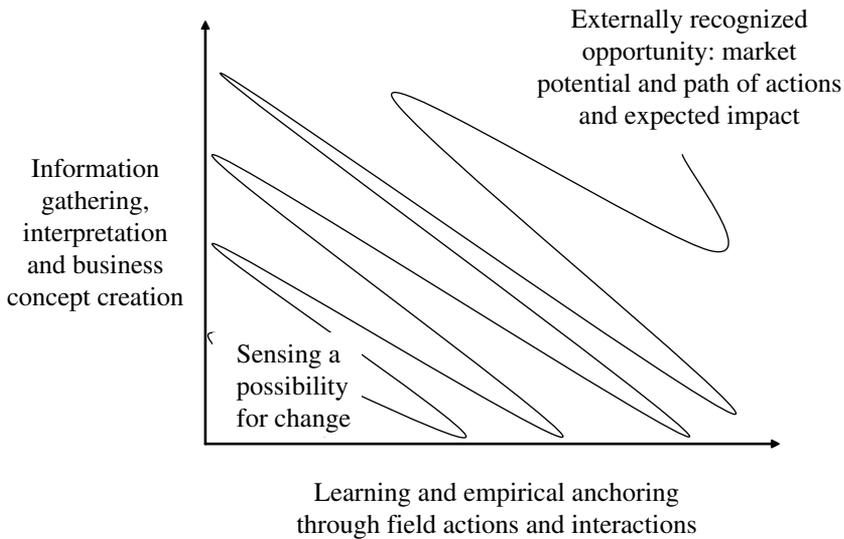
As argued by Shane and Venkataraman (2000) and Van der Ven and Wakkee (2004), a major topic of entrepreneurship research lies in the way individuals recognize opportunities for business creation. This is one of the first critical abilities in the early stages of the business development process, 'which begins with the realisation of the idea whereby one or more founders take concrete action to set up a commercial enterprise. The process is said to be concluded when a business platform has been established' (Klofsten, 1997). Entrepreneurs are those people who sense, create and respond to change regarding a possible opportunity for profit. Different approaches have been and are still adopted to understand this phenomenon. We can distinguish three main streams of thinking about the nature of an opportunity (Davidsson, 2004): the objective approach suggesting that opportunities do exist in the environment so that analysing key parameters would allow detecting and picking them up – like 'mushrooms'; the subjective objective approach focusing on the ability of a few people to practise this picking, depending on individual characteristics; and the subjective creative approach where the opportunity is built in the mind of the entrepreneurs using partly creative thinking, taking into account external conditions and taking for granted that the opportunity validity will never be fully proven beforehand but afterwards.

Currently, technology-based entrepreneurship means that technology is at the core and origin of the new venture thanks to its potential to accomplish new performance through innovation. Many authors on entrepreneurship have recently paid attention to the concept of innovative opportunities (Gaglio, 1997; Hills and Shrader, 1998; De Koning, 1999; Singh, 1999; Ardichvili et al., 2003). They agree on the fact that it is a social construct based on an initial idea and depending on individuals' value, cognitive behaviours, knowledge, connections to the external environment and motivations. Introducing technology in the scope of entrepreneurship brings in more novelty, new eventualities related to R&D power and assets as well as specific constraints and contexts. As soon as technology is involved, entrepreneurship consists in bringing important changes into the market compared to the more traditional entrepreneurship. Something new or significantly different will be created and exploited and its shape depends both on entrepreneurs' subjective thinking and on environmental conditions. Our position is typically to adopt the subjective creative approach to entrepreneurship.

The process of opportunity recognition starts with the sensing of a need or a possibility for change and action and ends with an innovative solution in which future potential economic value is clear enough and externally recognized. To achieve this, information and knowledge should have been gathered in order to answer key issues regarding (a) how well market needs and technology-based solutions are matched so that one can believe in the 'truth' of a market potential with a limited sense of doubt; (b) how feasible this view is through a path of actions taking place in a malleable and not fully determined environment on which the course of actions will exert a predictable and mastered impact; and (c) how exciting this plausible future may be according to possible options, potential impact and probable consequences for stakeholders.

Opportunities emerge from an idea transformed into a conceptual vision, itself refined and validated through information gathering and concept creation (De Koning, 1999). These two different activities are achieved under very heterogeneous conditions from one situation to the other. For instance, the innovation can consist in transferring existing technological elements from one industry to another, offering new ways to do existing business or to meet existing or potential needs, answering to new market drivers triggered by dominant actors in the industry. However, techno-entrepreneurs do have to pay attention to the problem of matching technology-based solutions with market current and future needs, expectations and constraints. It implies that entrepreneurs have to gather information on the users' wills and constraints regarding the innovative solution and to interpret this information to gain access to a potential market. This refers essentially to the search for information for which entrepreneurs would have specific skills, different from those of managers (Kaish and Gilad, 1991).

However, as in the innovation process, techno-entrepreneurs will have to undergo a series of other activities, including thinking, imagining, incubating, demonstrating, promoting and sustaining (Jolly, 1997). They will extend their resources and knowledge about technology, market and managerial skills through their external networks, thus deploying their absorptive capacity (Cohen and Levinthal, 1990). Because of the novelty of the situation, the high level of uncertainty and the subjective creative characteristics of the opportunity recognition process, it is admitted that action is central to most theories of entrepreneurship and depends concomitantly on various elements, such as knowledge, motivations and (arguably) a stimulus. 'Because action takes place over time, and the future is unknowable,



*Figure 1.1 Opportunity recognition as a learning process*

action is inherently uncertain. This uncertainty is further enhanced by the novelty intrinsic to entrepreneurial actions, such as the creation of new products, new services, new ventures, etc.’ (McMullen and Shepherd, 2006). Action may depend on both available knowledge and willingness to gain deeper understanding. It might be directed at extending knowledge about the market, the technology and the available resources, currently and in the future, or at establishing concrete elements such as partnering. Concurrently, techno-entrepreneurs have to create and validate the plausibility of a new business concept. They would use either storytelling or clockbuilding (Collins and Porras, 1994) to draft and redraft their vision linking the past to the present and the future. Hence, the maturation of the initial idea consists in both anchoring it into reality through creative connections and external recognition and enriching it so that it becomes a complete solution upon which to create a profitable venture. Figure 1.1 represents the opportunity recognition process according to these elements. This process is like a continuum of random steps and heuristic rules applied by entrepreneurs, as suggested by Baron (2006), ranging from systematic information search methods to very subjective and interpretive approaches. Building a viable technology-based opportunity is as much a process of experimentation through actions and interactions as one only of systematic information search and analysis through well-known decision tools. These diverse activities may take place anywhere at any time, mainly in the mind of the entrepreneur. Such a statement raises many questions: should specific anticipation or future-oriented methods be implemented? Are these methods useful, relevant and practicable and, if so, under which conditions? For what purpose and when should they be implemented? Which one to implement, in connection with which other one? For which outcome: a probable, an actual, a plausible or a possible representation of the future? Undoubtedly, some procedural knowledge about how entrepreneurs carry out their anticipations might be helpful for newcomers. It should be part of their human capital and more precisely their procedural knowledge (Davidsson, 2004). This implies going further into understanding the

existing knowledge about information gathering and concept creation procedures applied by techno-entrepreneurs.

### **1.2 Information gathering and concept creation in the opportunity recognition process**

In the entrepreneurship literature, information search appears to be an important task aimed at reducing the perceived uncertainty of all the stakeholders involved in a given opportunity. Facing a high level of perceived uncertainty, many studies, among them Kaish and Gilad (1991), discuss entrepreneurs' cognitive peculiarities, with their demonstration of perceptual differences and biases. Most authors and practitioners agree on the information to be gathered. Information needs match the three dimensions of the opportunity and are correlated to the level of perceived uncertainty. On the technological dimension, since most techno-entrepreneurs build on non-proven technologies with regard to their industrial diffusion, they face specific technological risks, ranging from technical feasibility to compatibility with the target applications and the context of implementation. Technology-driven new businesses most often build on technology development activities although this may be triggered by market needs. They can be integrated into different paths with increased difficulties and uncertainties: technological evolution, new combination of existing technologies or technological revolution. Technological uncertainty and risk depends on many factors, including the R&D stage, the level of accumulated knowledge and experience, the industrialization of the process, the availability of appropriate raw materials, the degree of integration and interdependence with other technologies within a technical system and the different technical options within the technology or in competitive technologies. Furthermore, in all these situations, problems of technical feasibility and compatibility might be hard to solve since technical requirements may not be known until the technology application is clearly identified. Also, another main technological challenge may be the upscaling from laboratory production to full production. This type of uncertainty is most often handled by scientists and R&D people. It is specific to techno-entrepreneurs in comparison to other entrepreneurs who have also to remain aware of technology evolution and potential discontinuities as potential opportunities and/or threats.

On the market dimension, techno-entrepreneurs have to match technological opportunities with market opportunities throughout the technology development process. They have to do so in order to develop appropriate applications, services and/or products in a way that will create value which the firm will be able to capture. Market uncertainty is about the eventuality that a new technology-based application may meet neither the customer's expectations nor a profitable market. Sometimes, these mismatches are hidden by a few potentially interested customers, namely the pioneers. They may reveal themselves as technological gatekeepers gathering scientific information and free-riding on what is proposed, but with significantly different expectations from those of willing customers, backed by purchasing power. Often, techno-entrepreneurs need to decide which technological options and applications to develop without much reliable information about customers' future expectations and behaviours as these latter are most often even unaware of the existence of a potential new solution. Market uncertainty in that case is an order of magnitude higher. Indeed, the realization of projected and/or potential markets will often be the consequence of how and when the technology will prove itself. Further, facing a more volatile market with shorter product life cycles makes it still more uncertain. Hence,

risk for techno-entrepreneurs is not only technological but also market-related. Various options are possible when it comes to finding a path from technology to market in the lower level of uncertainty where customers are already known.

However, these recommendations sound hardly practicable as the information may not exist and be available in the context of technology-based opportunity recognition. Entrepreneurs often cannot even conceive the forms of what they will gather during their venture and thus will build, learn and adapt their trajectory while walking it. At least, information search should take into account some basic principles of uncertainty reduction. Uncertainty is referred to as situations within which people perceive their environments as not predictable thus being unable to decide and to act. A lot of attention has been devoted to uncertainty by researchers in management and entrepreneurship (McMullen and Shepherd, 2006). They noticed that uncertainty can be detrimental to entrepreneurial action because personal characteristics would not allow people to overcome problems such as not perceiving the need or possibility for action, not knowing what to do and thus not being willing to act. However, our purpose is to deal with techno-entrepreneurs, that is to say the people who are able and willing to act and to bear uncertainty. They have to gather complementary information about the propensity of each of the conditioning events of the potential opportunity to occur so that evaluation and decision are made possible. This statement suggests that people are able to judge or to evaluate a cue or a future event, to build an appropriate response and to anticipate its potential impact. These three points match the three levels of perceived uncertainty proposed by Milliken (1987): state uncertainty when the future environment is not predictable; effect uncertainty when the impact of a change is not predictable; and response uncertainty when the choice of options is not clear or their likely consequences are not predictable.

In the case of technology-based opportunities, the uncertainty view allows us to refine the concept: state uncertainty refers notably to the state of the future market: it requires that the entrepreneur identify a possibility for action by forging a belief about a potential change in the market, 'a conviction that certain things are true', qualified by a 'sense of doubt'; this potential change can be assimilated to a possible event. Effect uncertainty may refer to the potential actions and reactions of actors in the market. Different options might coexist without it being possible to know, beforehand, which one will turn out to be true. Response uncertainty implies that the entrepreneur build or create a path of actions matching the past, the present and the future, explaining how to cope with a breach in innovation continuity and identifying the possible impact of a given response.

At this stage, it is worth adding some new comments. Currently, the potential market seems to be knowable up to an acceptable sense of doubt; that is to say, facts and numbers may not be true or false. This amounts to information equivocality. The knowledge of what to do, referring to the path of actions, may rely on known patterns of innovation (Baron, 2006) which may guide information search activities but also information analysis and knowledge creation. This approach might be assimilated to reasoning by analogy or case base reasoning. This raises a series of new questions to be explored if we are willing to produce procedural knowledge about technology-based opportunity recognition: which items are at the core of certain things to be gathered and interpreted? How to select and validate them, according to which criteria? Which patterns may be coherently connected to new situations of innovation and entrepreneurship (Baron)? How to connect these patterns to new situations: is it through adjustment or combination of patterns? Is

there room for subjectivity and creativity? Is the output the creation of one or various representations of the opportunity, including, for instance, optional paths?

Concept creation is the other major activity of the entrepreneur in the opportunity recognition process. In a situation of equivocality, techno-entrepreneurs might then also proceed through sensemaking. Sensemaking is instigated in situations within which current and expected states generate discrepancy, thus triggering the need for meaning and for a plausible sense of the future. 'Explicit efforts at sensemaking tend to occur when the current state of the world is perceived to be different from the expected state of the world, or when there is no obvious way to engage the world' (Weick, 1995). The idea that sensemaking is focused on equivocality gives primacy to the search for meaning as a way to deal with uncertainty. Thus we expect to find explicit efforts at sensemaking whenever the current state-of-the-art is perceived to be different from the expected state of the world. This is what may characterize techno-entrepreneurship. When the situation feels 'different', this circumstance is experienced as a situation of discrepancy, breakdown, surprise, disconfirmation, opportunity or interruption. Diverse as these situations may seem, they share the properties that, in every case, an expectation of continuity is breached, ongoing organized collective action becomes disorganized, efforts are made to construct a plausible sense of what is happening and this sense of plausibility normalizes the breach, restores the expectation and enables projects to continue. The core of sensemaking lies in the interplay of action and interpretation. Entrepreneurs are thrown into a continuing, unknowable, unpredictable streaming of experience in search of answers to the question 'What's the story?' but also 'How to make it happen?' Plausible stories animate and gain their validity from subsequent activity.

This proposal advocates a search for plausibility rather than probability. It is the redrafting of an emerging story so that it becomes more comprehensive, not a matter of accuracy, even though entrepreneurs may hold the opposite opinion. It requires resilience in the face of criticism. However, the entrepreneur is aware that he will never get *the* story! Mills (2003) found that stories tend to be seen as plausible when they tap into a continuing sense of the current climate, are consistent with other data, facilitate projects, reduce equivocality, provide an aura of accuracy (reflect the views of a consultant with a strong track record) and offer a potentially exciting future. He adds that taking action generates new data and creates opportunities for dialogue, bargaining, negotiation and persuasion that enrich the sense of what is going on. Finally, entrepreneurs have to design a virtual path that links what exists at present, happened in the past and will be done and realized in the future. In that sense, they put the world in order through sensemaking activities (Weick, 1995), using storytelling but also plan building, as suggested by Collins and Porras (1994).

This overview on information search and concept creation within the scope of the opportunity recognition process reveals a lack of explicit reference to anticipation approaches in management as they are hardly evoked. However, it allows us to identify a preliminary series of heuristic rules that might be applied by techno-entrepreneurs. They are listed in Table 1.1.

These heuristic rules may generate some conflicts with managerial practices and academic theories. More specifically, the idea that sensemaking is driven by plausibility rather than accuracy (Weick, 1995) conflicts with academic theories and managerial practices assuming that the accuracy of managers' perceptions determine the effectiveness of