

Biazzo, Stefano; Garengo, Patrizia; Bernardi, Giovanni

Article

A new funnel framework to support innovation management in SMEs

The International Journal of Management Science and Information Technology (IJMSIT)

Provided in Cooperation with:

North American Institute of Science and Information Technology (NAISIT), Toronto

Suggested Citation: Biazzo, Stefano; Garengo, Patrizia; Bernardi, Giovanni (2013) : A new funnel framework to support innovation management in SMEs, The International Journal of Management Science and Information Technology (IJMSIT), ISSN 1923-0273, NAISIT Publishers, Toronto, Iss. 8- (Apr-Jun), pp. 78-96

This Version is available at:

<https://hdl.handle.net/10419/97890>

Standard-Nutzungsbedingungen:

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

Terms of use:

Documents in EconStor may be saved and copied for your personal and scholarly purposes.

You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.

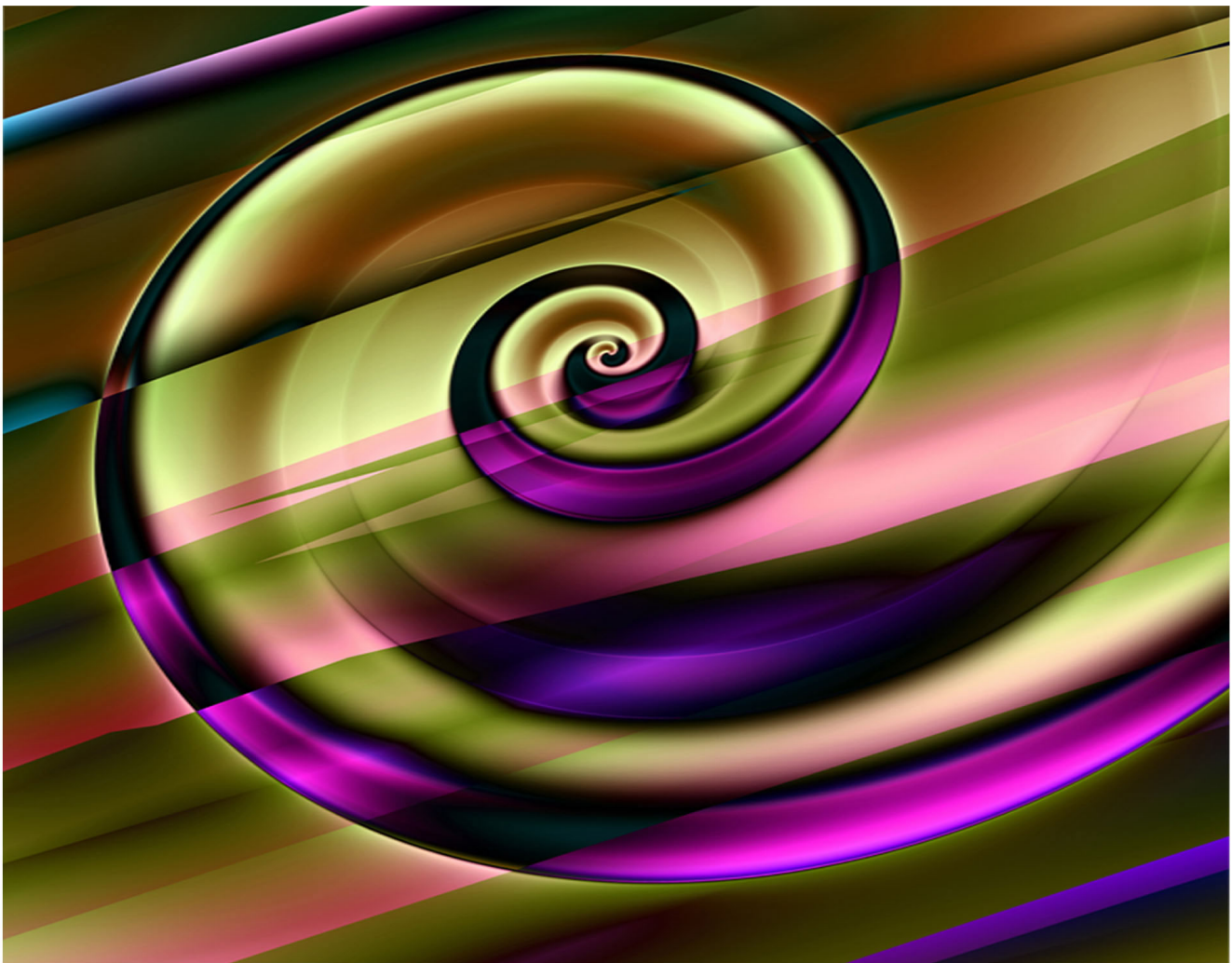
If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.

**An official publication of The North American
Institute of Science and Information Technology**

ISSN:1923-0265

INTERNATIONAL JOURNAL OF

Management Science and Information Technology



NAISIT
PUBLISHERS ■■■

www.naisit.org

The International Journal of Management Science and Information Technology (IJMSIT)

NAISIT Publishers

Editor in Chief

J. J. Ferreira, University of Beira Interior, Portugal, Email: jjmf@ubi.pt

Associate Editors

Editor-in-Chief: João J. M. Ferreira, University of Beira interior, Portugal

Main Editors:

Fernando A. F. Ferreira, University Institute of Lisbon, Portugal and University of Memphis, USA

José M. Merigó Lindahl, University of Barcelona, Spain

Assistant Editors:

Cristina Fernandes, Researcher at NECE -Research Unit in Business Sciences (UBI) and Portuguese University,
Portugal

Jess Co, University of Reading, UK

Marjan S. Jalali, University Institute of Lisbon, Portugal

Editorial Advisory Board:

Adebimpe Lincoln, Cardiff School of Management, UK

Aharon Tziner, Netanya Academic College, Israel

Alan D. Smith, Robert Morris University, Pennsylvania, USA

Ana Maria G. Lafuente, University of Barcelona, Spain

Anastasia Mariussen, Oslo School of Management, Norway

Christian Serarols i Tarrés, Universitat Autònoma de Barcelona, Spain

Cindy Millman, Business School -Birmingham City university, UK

Cristina R. Popescu Gh, University of Bucharest, Romania

Dessy Irawati, Newcastle University Business School, UK

Domingo Ribeiro, University of Valencia, Spain

Elias G. Carayannis, Schools of Business, USA

Emanuel Oliveira, Michigan Technological University, USA

Francisco Liñán, University of Seville, Spain

Harry Matlay, Birmingham City University, UK

Irina Purcarea, The Bucharest University of Economic Studies, Romania

Jason Choi, The Hong Kong Polytechnic University, HK

Jose Vila, University of Valencia, Spain

Louis Jacques Filion, HEC Montréal, Canada

Luca Landoli, University of Naples Federico II, Italy

Luiz Ojima Sakuda, Researcher at Universidade de São Paulo, Brazil

Mário L. Raposo, University of Beira Interior, Portugal

Marta Peris-Ortiz, Universitat Politècnica de València, Spain

Michele Akoorie, The University of Waikato, New Zealand

Pierre-André Julien, Université du Québec à Trois-Rivières, Canada

Radwan Karabsheh, The Hashemite University, Jordan

Richard Mhlanga, National University of Science and Technology, Zimbabwe

Rodrigo Bandeira-de-Mello, Fundação Getulio Vargas – Brazil

Roel Rutten, Tilburg University - The Netherlands

Rosa Cruz, Instituto Superior de Ciências Económicas e Empresariais, Cabo Verde

Roy Thurik, Erasmus University Rotterdam, The Netherlands

Sudhir K. Jain, Indian Institute of Technology Delhi, India
Susana G. Azevedo, University of Beira Interior, Portugal
Svend Hollensen, Copenhagen Business University, Denmark
Walter Frisch, University of Vienna, Austria
Zinta S. Byrne, Colorado State University, USA

Editorial Review Board

Adem Ögüt, Selçuk University Turkey, Turkey
Alexander B. Sideridis, Agricultural University of Athens, Greece
Alexei Sharpanskykh, VU University Amsterdam, The Netherlands
Ali Kara, Pennsylvania State University -York, York, USA
Angilberto Freitas, Universidade Grande Rio, Brazil
Arminda do Paço, University of Beira Interior, Portugal
Arto Ojala, University of Jyväskylä, Finland
Carla Marques, University of Trás-os-Montes e Alto Douro, Portugal
Cem Tanova, Çukurova University, Turkey
Cristiano Tolfo, Universidade Federal de Santa Catarina, Brazil
Cristina S. Estevão, Polytechnic Institute of Castelo Branco, Portugal
Dario Miočević, University of Split, Croatia
Davood Askarany, The University of Auckland Business School, New Zealand
Debra Revere, University of Washington, USA
Denise Kolesar Gormley, University of Cincinnati, Ohio, USA
Dickson K.W. Chiu, Hong Kong University of Science and Technology, Hong Kong
Domènec Melé, University of Navarra, Spain
Emerson Mainardes, FUCEPE Business School, Brazil
Eric E. Otenyo, Northern Arizona University, USA
George W. Watson, Southern Illinois University, USA
Gilnei Luiz de Moura, Universidade Federal de Santa Maria, Brazil
Jian An Zhong, Department of Psychology, Zhejiang University, China
Joana Carneiro Pinto, Faculty of Human Sciences, Portuguese Catholic University, Lisbon, Portugal
Joaquín Alegre, University of Valencia, Spain
Joel Thierry Rakotobe, Anisfield School of Business, New Jersey, USA
Jonathan Matusitz, University of Central Florida, Sanford, FL, USA
Kailash B. L. Srivastava, Indian Institute of Technology Kharagpur, India
Karin Sanders, University of Twente, The Netherlands
Klaus G. Troitzsch, University of Koblenz-Landau, Germany
Kuiran Shi, Nanjing University of Technology, Nanjing, China
Liliana da Costa Faria, ISLA, Portugal
Luiz Fernando Capretz, University of Western Ontario, Canada
Lynn Godkin, College of Business, USA
Maggie Chunhui Liu, University of Winnipeg, Canada
Marcel Ausloos, University of Liège, Belgium
Marge Benham-Hutchins, Texas Woman's University, Denton, Texas, USA
María Nieves Pérez-Aróstegui, University of Granada, Spain
Maria Rosita Cagnina, University of Udine, Italy
Mayumi Tabata, National Dong Hwa University, Taiwan

Paolo Renna, University of Basilicata, Italy
Paulo Rupino Cunha, University of Coimbra, Portugal
Peter Loos, Saarland University, Germany
Pilar Piñero García, F. de Economía e Administración de Empresas de Vigo, Spain
Popescu N. Gheorghe, Bucharest University of Economic Studies, Bucharest, Romania
Popescu Veronica Adriana, The Commercial Academy of Satu-Mare and The Bucharest University of Economic
Studies, Bucharest, Romania
Ramanjeet Singh, Institute of Management and Technology, India
Ricardo Morais, Catholic University of Portugal
Ruben Fernández Ortiz, University of Rioja, Spain
Ruppa K. Thulasiram, University of Manitoba, Canada
Soo Kim, Montclair State University, Montclair, NJ, USA
Wen-Bin Chiou, National Sun Yat-Sem University, Taiwan
Willaim Lawless, Paine College, Augusta, GA, USA
Winston T.H. Koh, Singapore Management University, Singapore

The International Journal of Management Science and Information Technology (IJMSIT)

NAISIT Publishers

Issue8 - (Apr-Jun 2013)

Table of Contents

1	ANALYSIS AND MODELING OF THE DETERMINANTS OF MOBILE BANKING ACCEPTANCE SAMUEL HENRIQUE SILVA BIDARRA, University of Granada, Spain FRANCISCO MUÑOZ-LEIVA , University of Granada , Spain FRANCISCO LIÉBANA-CABANILLAS , University of Granada, Spain
28	DEVELOPING CAREER SELF-MANAGEMENT SKILLS: A STUDY IN HIGHER EDUCATION JOANA CARNEIRO PINTO, Portuguese Catholic University of Lisbon, Portugal MARIA DO CÉU TAVEIRA, University of Minho, Portugal
54	THE EFFECT OF CORPORATE GOVERNANCE ON THE FINANCIAL STRUCTURE OF LISTED FIRMS J. AUGUSTO FELÍCIO, Technical University of Lisbon, Portugal RICARDO RODRIGUES, CEGE – Centre for Management Studies, Portugal
78	A NEW FUNNEL FRAMEWORK TO SUPPORT INNOVATION MANAGEMENT IN SMES STEFANO BIAZZO, University of Padua , Italy PATRIZIA GARENGO, University of Padua , Italy GIOVANNI BERNARDI, University of Padua , Italy

This is one paper of
The International Journal of Management Science and
Information Technology (IJMSIT)
Issue8 - (Apr-Jun 2013)

A new funnel framework to support innovation management in SMEs

Prof. Stefano Biazzo
Department of Industrial Engineering
University of Padua (Italy)
Email: stefano.biazzo@unipd.it

Dr Patrizia Garengo
Department of Industrial Engineering
University of Padua (Italy)
Email: patrizia.garengo@unipd.it (Corresponding Author)

Prof. Giovanni Bernardi
Department of Industrial Engineering
University of Padua (Italy)
Email: giovanni.bernardi@unipd.it

Abstract

The effective management of an innovation process is widely recognized as an important pre-requisite for organisations competing in the current business environment, irrespective of size. Although front-end activities have now long been recognized as crucial for successful new product development, many companies, especially small and medium enterprises, appear unaware of the importance of these activities.

This study aims to identify a structured approach for supporting the assessment and improvement of innovation management processes in SMEs. A framework, inspired by the *funnel of innovation*, is designed and described in detail in all its phases, and a methodology for its implementation is suggested.

Keywords: Innovation management, small and medium enterprises, new product development, innovative organisation.

1. Introduction and research objective

In the last few years, scholars and practitioners have stressed that innovation, should be a key priority, as a means of sustaining competitiveness (Filippetti and Archibugi, 2011). Given recent recessions and the accompanying uncertainty, companies need to seize new opportunities, not by retrenching, but by

rebalancing: focusing on the right innovation projects and then executing those innovations more efficiently, effectively and creatively (Fu, 2010; Hue *et al.*, 2010).

Product innovation is not merely “*coming up with ideas*”; rather, it ought to be an on-going activity that supports competitive ability. It is no longer possible to exclusively rely on brilliant intuitions or genial ideas, by building comfortable niches that are difficult to replicate in time: the enterprise should present itself in the market as a *serial innovator*, able to manage its innovative process in an effective way, so to maintain innovation alive over time.

Product innovation is not a closed process; a new paradigm called Open Innovation has been increasing in popularity (Chesbrough, et al., 2008). Up until not too long ago, internal research and development were seen as a strategic resource and even as a barrier to entering certain sectors, where it was thought only large companies with important resources and long-term research programmes could compete. We are now experiencing a change in the paradigm, as we move from closed innovation to open innovation. In the closed innovation paradigm, innovation requires control. Firms are expected to generate their own ideas and then develop them, set them up, commercialize and fund them. This vision calls for total self-sufficiency, as there is no trust in the quality and availability of others’ ideas. This closed approach to innovation, however, is no longer sustainable anymore. The open innovation paradigm is taking over. This paradigm assumes that firms can and should use external, as well as internal ideas, and both internal and external paths to market, as they look to advance their technology (Chesbrough, 2004).

In the context of business transformation processes, innovation is today increasingly connected with competition, due to its *strategic centrality* as a source of competitiveness. Although this statement is almost pleonastic, in reality the process of new product development is not often considered as a priority in relation to other operational processes, such as production, purchases, marketing, and so on.— Because these processes seem, based on superficial and short-term consideration, more connected with business performances, they tend to be given a privileged position in investment projects and in resource allocation in general, as well as in the attention and involvement of top managers and owners. Nonetheless, innovation is today arguably the strongest driver in competitive development, at the various levels: a firm that does not produce innovation is generally bound to lose competitiveness. The connection may not always be so direct, especially in the short term, but it is inevitable in the long. Acs and Audretsch (1990) empirically verified this relationship between innovation and company growth in different sectors, especially in manufacturing. It cannot be stated that only *high tech* companies are innovative. If we consider the product as a bundle of technologies, even in apparently low tech products, there can be high-level technologies for specific functions or single components (for example, as in the case of Mems in videogames made by Nintendo or nanotechnologies in some textile applications).

The recent evolutions in delocalization paths and the lengthening of production chains, also as a response to the economic crisis, have had a big impact on the continuity and validity of the models that are based - especially for small manufacturing enterprises - on the model of local clusters or districts. Such a model represented the *humus* of innovation or, according to some (Camagni, 1991; Aydalot 1986), the *milieux innovateurs* for SMEs, promoting with its territorial proximity the so-called *widespread innovative capacity* (WIC). WIC was considered by some almost as a form that, at the systems level, replaced the traditional function of R&D of large enterprises; and it existed as a result of the proximity to leading enterprises of the district. The delocalization of activities to low-cost suppliers made the search for technological investment less necessary, at least in the short term, and in fact blocked innovation, except in rare cases, which as a result acquired special significance. Widespread innovative capacity (WIC) may be suited for situations of incremental and *low tech*

innovations, but it is no longer sufficient to sustain the acquisition of important competitive differentials in contexts of major change.

The development of external relationships - be it for production outsourcing or open innovation - in the process of new product development, leads to the lengthening of supply chains well outside of the district in view of SMEs' globalization or internationalization. However, remaining in long supply chains for innovation is far more complex than keeping cluster relationships. At the same time, there is also evidence of limitations regarding the other ambitious presumed pillar of SMEs' development that is "innovation without research", based on the systematic reorganisation of innovations generated elsewhere. Such an innovation model without research has been exhausted, however, due to a mix of interacting factors. Foremost amongst these was the acceleration of knowledge and innovation spreading processes across the world, thanks to new information and communication technologies, and to the increased mobility of all production factors (Moncada-Paternò-Castello et al., 2010). This capacity to propose *market-oriented* innovations - niche solutions that are customized and based on the systematic recombination of innovations generated elsewhere, connected with entrepreneurial creativity and with the flexibility of enterprises gathered in local districts - enabled some companies to remain competitive despite features that were in contradiction with the prevailing theories on dimension-innovation relationships.

Given the need for innovation capability in SMEs, this study aims to identify a structured approach to support the assessment and improvement of innovation management processes. The remainder of this paper is structured as follows: section 2 synthesizes the research background of this study; section 3 describes the funnel framework as an integrated view of the innovation process; section 4 proposes a three-step methodology supporting the effective use of the funnel framework; section 5 presents our conclusions.

2. Background

The innovative capacity of an enterprise does not coincide with its capability to manage individual projects, designing and developing new products. Rather, the ability to be systematically innovative is closely related to "pre-project" activities (Khurana and Rosenthal 1997, 1998). An empirical investigation by Cooper and Kleinschmidt (1994) concluded that "the greatest differences between winners and losers were found in the quality of execution of pre-development activities". Indeed, over the last 20 years, the so-called "fuzzy front end" of product development has been receiving particular attention from both scholarly literature and managerial practice. Cooper and Kleinschmidt (1994) identified the pre-development activities and the definition of product and project prior to the development phase as the two main determinants of a product's likely success. Verganti (1997), in analysing the early phases of product innovation projects, talked about the importance of the "pre-project activities". Khurana and Rosenthal (1997, 1998) labelled all of these activities "pre-phase 0" and described their key role in the effectiveness and efficiency of product development, since they determine project selection, quality, cost and time frame.

Despite this recognized relevance, in most organisations the front end is still the weakest point of the innovation process (Khurana and Rosenthal, 1997). The majority of SMEs has no awareness of the relevance of front-end activities (Herstatt et al., 2004; Calabrese et al., 2005; Freel, 2000): the front of the innovative processes (*front-end of innovation*) is often excessively "fuzzy" and it is not systematically and formally managed; attention is paid to individual product development projects (*back-end of*

innovation) instead. As illustrated in Figure 1, the innovation management system in SMEs can be represented as a “cloud of uncertainty”, followed by a tunnel of product development projects.

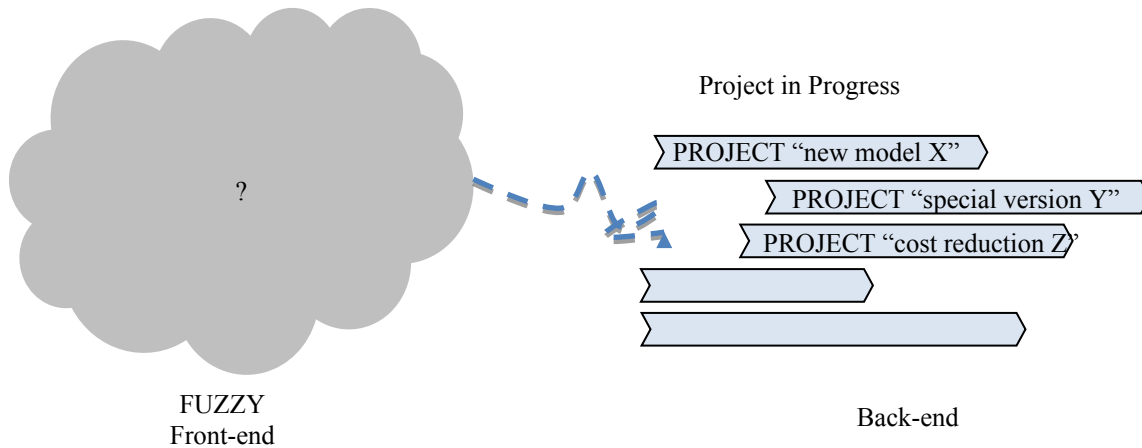


Figure 1 – A vision of the innovation process: a cloud of uncertainty and a tunnel.

Developing innovation capacity requires the ability to adopt an integrated approach to the management of innovation processes. The recent literature on lean management demonstrates the relevance of this approach in improving the ability to “see the processes” (Rother and Shook, 2003; Morgan and Liker, 2006; Womak 2011) to establish effective and sustainable improvement paths (see, for example, the focus on the principle of value streams of Haque and Moore 2004).

Dovetailing on this work, we have developed a tool to support SMEs in the visualization and analysis of their innovation processes based on the metaphor of the funnel.

The innovation funnel has been well established in the literature since Wheelwright and Clark highlighted the importance of pre-project phases and project portfolio management in 1992. In the models used in literature (see for instance Chesbrough 2004 and Cooper, 2011), the funnel is generally used to illustrate the progress of a project and to highlight the importance of the “selection”: at the beginning of the process there are many “ideas” or research projects that are then selected, but only a few reach the final part of development. Figure 2 shows the typical use of the metaphor of the time-based funnel.

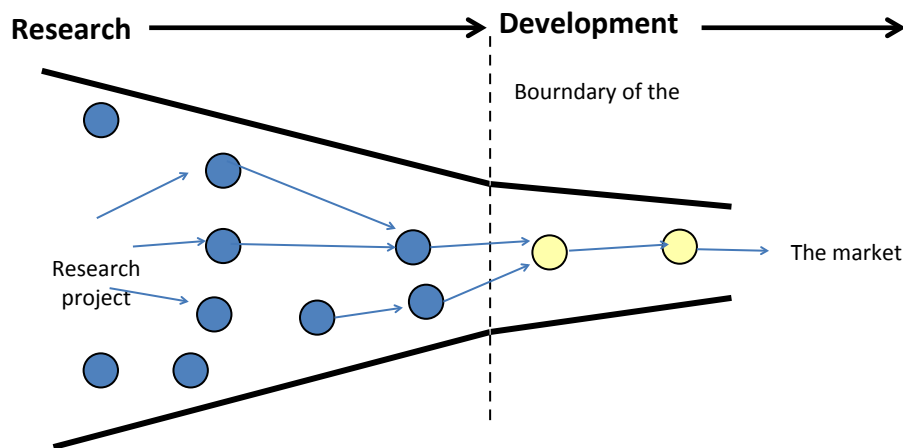


Figure 2 – Time-based funnel (source: Chesbrough 2004)

As previously mentioned, our aim is to support SMEs in developing an integrated view of the activities that contribute to launching innovative products. The metaphor of the funnel is used to visually illustrate the "system of spaces" that must be carefully managed to be consistently innovative. The spaces demarcate different sorts of related activities that together form the continuum of innovation (Brown, 2008) and must be integrated. The model of the funnel proposed here to visualize this concept is therefore not time-focused, as is typically used in scholarly literature.

3. An integrated view of innovation processes: the funnel framework

The innovation funnel framework shown in Figure 3 below highlights three areas of activities (the "spaces") that affect the innovation capacity of a company:

1. The development of knowledge about the market and technology, which feed the funnel (Intelligence);
2. the area of identification of opportunities, that calls for openness, the ability to absorb new knowledge and systematic creativity (Discovery);
3. the area pertaining to the *development of such opportunities* into industrially manufacturable products, where are critical the capacity to perform quick experimentations and alternative solutions, the integration of the product with the process, and the speed of engineering design (Development).

The mouth of the funnel represents the divergent-creative-explorative phase of the *identification of opportunities*, which materialises into a set of *preliminary product concepts*. The final part of the funnel, which progressively grows narrower to highlight the decrease in uncertainty and the convergence to technical solutions that will then be commercialised, illustrates the phase in which ideas are transformed into products to be sold (*product development*)

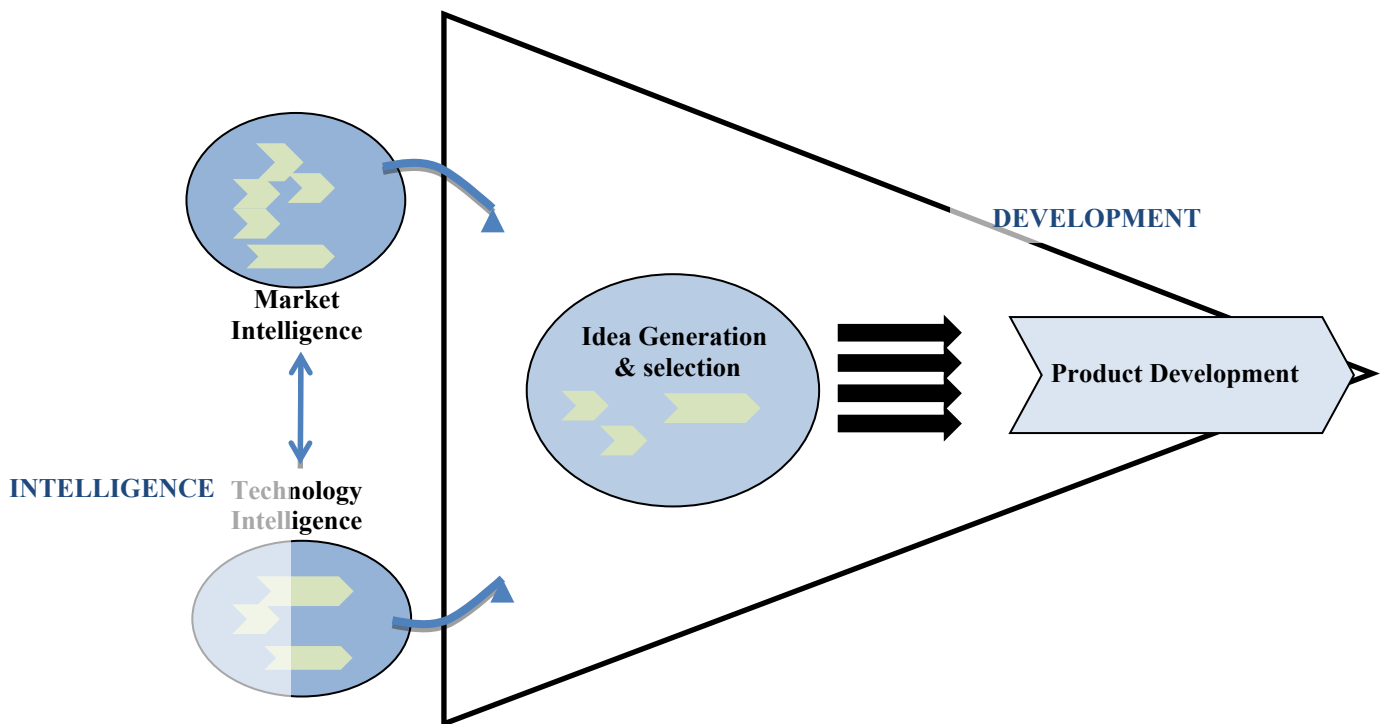


Figure 3 – The innovation funnel.

Market and technology intelligence, and the creative efforts to generate preliminary concepts (*discovery*), are asynchronous activities distributed over time; they are activities that should be carried out regularly, at different times, to build up that stock of know-how and ideas that can then be “launched” into the final part of the funnel. The image represents the fact that such activities are the *engine of innovation*; without an adequate flow of opportunities (the preliminary product concepts) from which to *select* high-level innovation projects, the ability and efficiency in the follow-up development phase are wasted resources.

A preliminary product concept is the *embryonic form of a new product* and consists of a high-level view of the envisioned solution to meet market opportunities; it is the seed that could grow in the future and turn into successful innovation; it is the oral and/or visual description of a new product that summarizes the benefits that users and customers will receive: the assumed form and technologies. It represents some sort of *mission statement* (Ulrich and Eppinger, 2008) that starts up the process for the development of new products.

The final part of the funnel – product development – begins with a *preliminary product concept* that was selected and considered as promising. There are two main development phases:

- the *concept development* phase (or product definition);
- the *detailed product and logistic-production system design* phase (product/process design).

The output of the *concept development* typically includes: the description of the target market segments and the channels through which to reach such segments; the product price; its functions, characteristics and preliminary architecture; the technologies that the product will be based on; and the determination of the necessary resources to complete the development. There are not necessarily any technical specifications, since these are usually developed in the engineering design phase (see Bacon *et al.*, 1994). The product definition document represents the point of reference for detailed design, and its creation calls for the evaluation of customer needs, competitor products, risks, technological opportunities and of the regulations in place where the product will be located. The detailed design will turn the product definition into a manufacturable and commercializable object.

In scholarly literature, there are some authors who have used the term “concept” to refer to the result of concept development. For example, Clark and Fujimoto (1991) stated that the product concept specifies how the functions, structure and messages associated with the product that will attract and meet potential customers. In this formulation, the concept must clearly define the four following dimensions of the product: *what the product does; what the product is; who needs it; and what it means*. In Ulrich and Eppinger (2008), the concept is the description of the form, functions and features of a product and is usually accompanied by a set of specifications, an analysis of competitor products and an economic explanation of the project. Other authors, by contrast, use the word “concept” to refer to a product idea that is not yet well defined (see for example Khurana and Rosenthal, 1998; Crawford and di Benedetto, 2003); in that sense, we used the expression “preliminary concept”.

The opportunity identification and concept development (that is, all of the activities that occur prior to the engineering of the detailed design) are known as the *front-end* of innovation, or even as the “*fuzzy front-end*” (Smith and Reinertsen, 1991), where the adjective “fuzzy” is used to indicate the uncertain, non-sequential and often unpredictable nature of initial research and exploration activities of new product ideas. This is in contrast with the more structured and formal development of the activities of detailed design to follow. This phase is also known at the international level as: the *front end of innovation* (Nobelius and Trygg, 2002; Koen *et al.*, 2001); *early stages of the product development* (Nobelius and Trygg, 2002; Khurana and Rosenthal, 1998), *early innovation phases* (Lichtenthaler *et al.*, 2004), *pre-development* (Hüsig & Kohn, 2003) and *pre-project activities* (Hüsig & Kohn, 2003).

The front-end generally represents the phase that offers the biggest opportunities for improvement of the whole innovation process. There is a lot of research showing that success in product innovation is deeply connected with the initial phases of the product’s lifecycle (Hayes *et al.*, 1988; Gupta and Wilemon, 1990; Rosenthal, 1992; Wheelwright and Clark 1992; Clark and Wheelwright, 1993; Brown and Eisenhardt, 1995). The importance of the activities that precede the detailed design of a product/process has been empirically validated (Cooper and De Brentani, 1991; Cooper, 1994; Cooper and Kleinschmidt, 1994, 1995).

Next to the importance given to the initial phases of the innovation process, the front-end is – paradoxically - often companies’ greatest weaknesses in the whole innovation process (Khurana and Rosenthal, 1997, 1998). Companies often invest a lot in the speed of product development processes, in order to be able to compress the “time to market”, with the result of focusing attention on the final phases of the process, because they are easier and more natural to structure. Improving the bottom phases, while ignoring the quality of those that are at the top, however, often proves an effort yielding disappointing results.

Front end of innovation: Intelligence and Discovery

The front end of innovation consists of three main activities. Although the logical sequence might be to have the intelligence activities (on markets and technologies) precede the generation of the preliminary product concepts, we chose to illustrate the circularity of the relationship between them. As noted

earlier, the front-end innovation space, due to the high levels of uncertainty that need to be tackled, does not necessarily evolve in a linear manner; rather, the activities often follow an iterative logic. Product innovation is the search for “new interlocks” between the needs of the target market and the solutions that “solve” such needs (Ulwick, 2002): therefore, market intelligence and technology intelligence are the two supporting columns of innovative capacity.

Market Intelligence. Market Intelligence refers to those activities that analyse the demand and supply, and the environment in which these are embedded. Market intelligence in such activities aim at building an adequate stock of knowledge on three fronts:

- *Market segmentation:* does an explicit, clear and shared segmentation of the market exist? Was the choice of segmentation variables adequately weighted, based on the variables’ ability to capture differences in the market?
- *Customer motivations:* are the market segments characterized by an explicit, clear and shared list of customer purchasing motivations? What changes are taking place in these factors and what are likely future directions of purchase motivations?
- *Competitors:* are objective and systematic reports with analyses and comparisons of competitors’ products carried out? Is up-to-date information available on our competitors’ economic and financial performance?

Technology Intelligence. Technology intelligence is the development of people’s awareness of the technologies that are or may in the future become important to the firm. It consists of technology forecasting and visioning, and technology acquisition activities.

These acquisition activities pertain to the selection of critical technologies for the business and the appropriation of selected technologies. This selection is, needless to say, a critical process, because it addresses companies’ financial and human capital investments, and could limit their future options. Traditional research and applied research activities carried out in laboratories inside the company represent *just one* appropriation method. Technologies can be acquired from the outside by means of licensing agreements or joint ventures, through the acquisition of components or sub-systems that contain the technology of interest, or even through collaboration agreements for the joint development of special technological competencies.

This view of technology acquisition activities clearly illustrates the *Open Innovation* paradigm: successful innovation can no longer be based on control (i.e. the closed innovation model, realm of the “not invented here” syndrome), but on the thinness of the line between the company and the environment outside of it: being able to identify and use the know-how that was developed elsewhere is an essential ingredient of an enterprise’s innovation capacity.

Generation and selection of preliminary product concepts. The generation of preliminary product concepts is the moment when the creative synthesis of the knowledge on market opportunities and available technologies occurs; it is the process that, based on the knowledge gathered from the previously described research activities, turns the information on the market and on technological opportunities into preliminary concepts. As has been explained earlier, a preliminary product concept is the *embryonic form of a new product* and consists of a high-level view of the envisioned solution to meet market opportunities; it is the seed that in the future could grow and turn into successful innovation.

The generation of concepts is a complex process of *ideation and selection*. The ideation phase can be put into place in several different forms: from creative processes - completely left to the causality of one’s creativity - to systematically “designed” processes managed with appropriate organisational mechanisms centred on the organisation of events, which can directly or indirectly influence the

production of ideas. In the literature, the expression “idea management” is often used to refer to structured generation processes and idea filing (ref. Belliveau, Griffin and Somermeyer, 2002; Montoya-Weiss and O’Driscoll, 2000; Koen et al., 2001). Ideas may come from internal or external people, for example customers, suppliers, consultants or even the “public” – anyone who comes into contact with the company through the web (as in the recent development of “crowd sourcing” software with which it is possible to launch challenges to the on-line “crowd”, so as to receive creative and problem solving solutions to specific technical-scientific issues that the enterprise believes it will not be able to best solve with just its own internal resources).

The selection phase deals with the design of the tools and mechanisms for the assessment and selection of the concepts in which to invest, to continue the journey inside the innovation funnel.

Back end of innovation: Development of opportunities

The development of opportunities is the process that turns the preliminary product concept into a sellable product with an industrialized production process. As previously noted, there are two main steps here:

- the *concept development* phase (product definition), aiming to detail and transform the embryonic information contained in a preliminary product concept, turning it into an “integrated product definition” with, on the one hand, the specifications of the product that the firm intends to develop (the product requirements in terms of general features, specific market features, functions, expected critical performances, shape and preliminary construct, value proposition, etc.) and, on the other hand, the expected revenues, costs and investments (the product’s economic potential in terms of produced wealth during its lifecycle);
- the *detailed design* phase of the product and of the production logistic system.

The link between the two phases is a recurring one, which emphasises that product definition can evolve even during the detailed design (this phenomenon is known as “flexibility of the development process”: Biazzo, 2009). Although changes in product requirements and expected functions may have a negative impact on costs and development times, in many situations it is not a good idea to “freeze” a product definition for the entire duration of the design phase. An extremely critical issue is the company’s ability to manage, in a systematic and reasoned way, the changes in product definition, in order to find that delicate balance between excessive rigidity in “freezing” the product requirements, which could lead to modifications to the product after it has been launched, and an unplanned flexibility, which easily degenerates into the classic problem of *scope creep* (uncontrolled changes throughout the project from adding new features, or the escalation of the required product performances).

Concept development. The concept development phase consists of two main activities:

- understanding customer needs (in the target markets) and identification of opportunities in terms of needs;
- product definition and business case elaboration: clear identification of the product’s *value proposition* and its positioning, *vis a vis* competitors’; exploration of possible technical solutions in order to estimate production costs; required investments and development times.

These two logical steps in the concept development phase reflect the type of separation that should be maintained between “space for needs” and “space for solutions”. The space for needs describes customer needs with respect to the activities that are performed *through a product* (with a functional or even emotional nature, such as the indication that the customer belongs to a certain group by showing possession of a certain product; they represent the reason “why”, the *raison d’être* of products’ functional, performance and symbolic features. Identifying needs means understanding the reasons certain product features have value for the customer.

The search for needs (the so-called VOC - *Voice of the Customer*) is often the weakest part of the innovation process, especially in smaller enterprises. Assuming that we already perfectly know the needs of our customers is a mental attitude always lying in ambush and it can short-circuit the development process of new products. Managers and entrepreneurs can be found who do not believe that a systematic research on their customer needs is useful; their statements typically follow the *mantra* of “we already know what our customers need”.

Obviously, enterprises generally do know a lot about their customers’ needs: it is an experiential competence that is implicitly developed over time. What is not obvious, however, is that it is the *thorough and detailed knowledge* of their specific needs that a business ought to know in order for a certain product to become successful. This type of knowledge occurs when a sizable set of needs, expressed in a precise and unambiguous system (hence, free of generic statements such as “easy to use”, which do not help with product development) is gathered, organized and *weighed*, based on the relative importance of the different features, from the customer perspective. It is the *detail* in the need identification process that makes the difference in product innovation.

Detailed design. The detailed design phase refers to all the engineering activities involved in the technical development of products and production processes. Although it is a highly specialized job, in relation to the type of product being developed, the detailed design process can be outlined in four main activities (ref. Ulrich and Eppinger, 2008).

- *System-level design:* includes the definition of the product architecture and the decomposition of the product into subsystems and components. Outgoing information usually constitutes the product layout, a functional specification for each of the subsystems of the product and a preliminary flow diagram for the production process.
- *Sub-system design:* includes a complete specification of the geometry, materials and tolerances of all the unique parts in the product and the identification of all the standard parts to be purchased by suppliers. It defines the production process for each component to be manufactured inside the company’s production system. The result of this phase is technical documentation with designs and files describing the product’s components and its construction, the specifics of the parts to be purchased and the product’s production process.
- *Testing and refinement:* construction and evaluation of multiple pre-production versions (prototypes), both physical and analytical (such as computer simulations and 3D models).
- *Production ramp-up:* in the production ramp-up phase the product is made using the intended production system. The purpose of the ramp-up is to train the workforce and to understand the reliability of the production process and the product, and to solve any problem before officially releasing the product on the market.

The increase in the variety of products and the acceptance of personalisation requests are an evident trend (and one that often cannot be dodged) in numerous sectors, defined by scholarly literature as *mass customization*. The effort to align the offer with a set of customer needs that keeps becoming more and more heterogeneous and diversified may create some important unwanted effects at the level of operational performance: increases in stock levels; longer delivery times and direct and indirect costs; increased purchasing costs deriving from diseconomies of scale; overload of departments involved in new product development.

Offering a large variety of products while maintaining efficient and fast deliveries is a complex project challenge that revolves around choices pertaining to product architecture: every product is made by assembling some building blocks; a product’s architecture is the “sketch” according to which the various functions are realized from the building blocks of the product itself.

In the framework of detailed design, the system design phase is becoming ever more important and critical, as it is during this phase that attention is paid to architectural choices and to the management of the *trade-off* between product personalization and efficiency.

4. The funnel framework in use: a three-step methodology

We began the paper by stating that innovative capacity is not based on sudden brainwaves, but rather on the characteristics of the funnel and on how the *innovation funnel* works; these aspects need to be explicitly and rationally designed and implemented. In this perspective, we have developed a methodology, action centred on the funnel framework and divided into three steps.

- *Step 1: Learning to see the funnel.* In order to support managers of SMEs to eliminate the disintegrated vision of the innovation processes that we have illustrated in Figure 3, a training session is necessary to explain the structure and characteristics of the innovation funnel in detail.
- *Sep 2: Brainstorming around the funnel.* After creating a language and a common vision on innovation processes, a brainstorming workshop is carried out to compare the current practices of innovation management with the proposed framework.
In this session, participants identify the weaknesses in the company's innovation process and are pushed to formalise them synthetically through the use of post-it notes. These notes are posted by the participants on "the funnel space" where the problem arises. In this way, there is an immediate perception of visual and spatial density of the areas requiring improvement.
- *Step 3. Definition of the action plan for improvement.* Participants are encouraged to consider the three areas of action:
 - Analysis and systematic *design of the funnel's architecture*: what activities should be performed to identify innovation opportunities? Who should be involved? What tools and methods should we use? How and with what organisational modes should the product requirements be defined? What are the main decision-making moments in the product development phase? How should any changes in the product requirements be managed?
 - Implementation of adequate organisational and operational methods to *manage single product development projects*: how is the project group defined? What methodologies and tools should we use to manage times, costs and quality?
 - Adoption of tools and techniques for the *management of the project portfolio* to effectively allocate financial and human resources.

In the following paragraphs we bring attention to the main issues that characterize step 3, i.e. *designing the architecture of the innovation funnel, managing product development projects, and project portfolio management*.

Designing the architecture of the innovation funnel. The design of the innovation funnel's architecture can be metaphorically imagined as the construction of the road that we need to take (i.e. the "innovation process") to identify opportunities and then turn them into products. The effort of giving the funnel a "shape" is an important lever of competition, because it is during this "organisational design" activity that the foundations of a company's innovative capacity are built – by adding innovative practices that were previously neglected, modifying redundant information flows and redefining action sequences. A well-defined process (as we will state once again in the pages to follow, this does not mean a bureaucratic one) should put into practice the company's know-how on the best practices to be

adopted when managing an innovation project; the lack of a process (or worse, the presence of a process formalized on paper but actually ignored) is a sign of unexpressed innovation potentials.

In designing the architecture, there are *three challenges* to be faced: the first has to do with the funnel's mouth. To be efficacious, it is necessary to expand the knowledge base and the entryway to information, so as to increase the number of product ideas and opportunities. The second challenge deals with the narrow part of the funnel: the larger variety of opportunities and concepts identified needs to be adequately selected and turned into clear product requirements, so financial and human resources can be allocated to the most interesting projects. The third challenge consists of shortening the back-end of the funnel, that is, ensuring that the selected projects reach the company's goals with speed and efficiency.

A reference model for the design of the back-end of the *innovation funnel* is the well-known "Stage-Gate" system developed by Cooper et al. (2002). This is a process featuring stages and gates. Each stage consists of a series of "good practices" that must be activated in order to progress, up to a decision-making point represented by a gate. The gates represent interdisciplinary decision-making moments which verify whether the goals of the previous stage have been achieved and decisions are made about moving forward with the project to the following stage.

It is not unusual to run into the idea that the structure of the innovation process itself (especially the establishment of a Stage-Gate game) necessarily produces bureaucratization, resulting in waste, slowing down and inefficiency. In our opinion, this idea is quite dangerous and misleading. Structuring a process does not necessarily mean that documents and controls will become rigid; structuring a process means ensuring that, during the course of the activities, methodologies, techniques and tools correlated with high levels of innovation performance will be applied. Thus, the outcome of structuration will greatly depend on the level of competence of the process "designers", as far as *good practices* in the management of innovation are concerned.

The structuration-bureaucratization equation is likely to be influenced by the ISO 9001 quality standards, which often lead the enterprise to use a logic of "ritual conformity", that is, to separate business processes from the procedural impositions of the formal quality system. Inspections are often connected with the culture of conformity to forms and procedures, instead of being used as a tool to evaluate the effectiveness of actions and results (Biazzo, 2005).

The structuration-bureaucratization equation is also influenced by the implicit assumption that the definition of a process must necessarily be realized with diagrams whose scope is to detail workflow (such as the traditional and widespread flowcharts of quality assurance manuals). Even this view can be dangerous and misleading: flowcharts are suited for the representation of processes with a low level of uncertainty and a mostly transnational content; they are not at all suited for the representation of innovation processes, which feature uncertainty, variability and iteration.

Over the last few years, a topic that has been attracting a lot of attention is that of *flexibility* in product development processes. Flexible development processes are those that are able to manage - without too much negative impact on times and costs - changes to the product definition during the detailed design of the product and the production process.

Interest in flexibility was born from the observation of the practices adopted by firms with high innovation performance - working in conditions of high uncertainty and dynamism regarding market needs and their technological choices. Uncertainty regarding the market comes from not being able to understand customer needs and finding it hard to translate those needs into functional and symbolic product features. Technical uncertainty, on the other hand, has to do with the innovation level of the project solutions that will have to be explored.

Initial uncertainty progressively decreases as the product development process continues, thanks to the acquisition of information and to the solving of project-related problems. At the same time, however, the cost and time of unforeseen modifications - due to either external changes (for example, the request to modify a product feature because of the launch of a competitor product) or internal changes (discovering a better technical solution) – increase during the advanced stages of the process (MacCormack and Verganti, 2003; Thomke and Reinertsen, 1998).

A way to take care of the issue of expensive iterations due to unforeseen changes is the *anticipation* of uncertain information; that is, the attempt to analyse restraints and future opportunities as early as possible, and to “freeze” the fundamental decisions regarding the product and the production process (Souder and Moenaert, 1992: p. 505). This anticipation strategy takes place in a *precise and early product definition* (Kalyanaram and Krishnan, 1997). Another way to deal with uncertainty in new product development is *reaction* (Verganti, 1999), that is the ability to rapidly (and without excessive costs) introduce changes in the advanced stages of the project, delaying the “freezing” of the product definition and pushing it as close as possible to the time of market introduction.

Some researchers (Iansiti, 1995, Iansiti and MacCormack, 1997; MacCormack and Verganti, 2003) have proposed a fascinating dichotomy: the contraposition between the flexible process model – which seeks to delay the product definition freeze point and the ability to adapt quickly – and the “traditional” model, which is characterised by early and sharp product definition, and is associated with the Stage-Gate processes. The latter are thought to be well suited and effective in sufficiently stable contexts, since they are coherent with the search for anticipation and freezing of as many decisions as possible. Flexible processes, by contrast, are suitable in highly turbulent environments, that is in contexts where change (either technical or market-related) is frequent and big.

In a recent article, we demonstrated that even this last equation between Stage-Gate systems and their lack of flexibility is actually the result of a distorted view of the structuration concept (Biazzo, 2009). A process structured into “stages and gates” is not necessarily rigid: the specific Stage-Gate configuration that will not be flexible is the one that features a slightly experimental initial phase of product development that ends with a precise and intentionally blocked definition of the product. The level of flexibility will depend on the choices concerning how to manage the evolution of the product definition and on the level of detailing that the product requirement document calls for.

Managing product development projects. The management of development projects refers to the planning and coordination of necessary resources and activities to turn preliminary concepts into industrialized products (Project Management – PM). PM is twofold: there is an *organisational dimension* that pertains to the definition of a project team and an *operational dimension* that pertains to the methodologies and techniques used for planning and controlling projects.

On the one hand, the definition of a project team has to do with its composition in terms of the heterogeneity of the resources that each business function brings; on the other, it has to do with the identification of key organisational roles, especially that of the project leader. Having an inter-functional composition is an important characteristic of the project team, i.e. the variety of skills and specialisations represented within. Taking advantage of inter-functional teams is the solution that, in the most evident way, is associated with the achievement of important innovation results and is adopted by more and more organisations.

Both practitioners and researchers in the field, agree on the crucial importance of a “team leader”; regardless of the specific responsibilities and type of authority that the role may undertake. Most of the strong tensions generated by the inevitable search for *trade-offs* between the often opposing needs that functional specialists hold fall on the project leader’s shoulders. Literature distinguishes between two main types of project managers: “lightweight” and “heavyweight”. A project manager is defined as

“lightweight” when there is no direct responsibility over operational resources assigned to the projects and when the manager actually holds a subordinate position with respect to middle management. In this case, the manager acts as a coordinator by controlling the progress of the project and managing the flow of information. In the case of a “heavyweight” project manager, responsibilities go beyond simple coordination tasks: the manager is the sole responsible for the development of the product concept and ensures that the view and the fundamental features of the product are maintained throughout the project. This manager possesses the technical competencies to be able to dominate product design (he/she is a “system designer”, ref. Ward, 2007) and, at the same time, has an entrepreneurial approach (a business vision linked to the product and economic/financial awareness). Such a manager has strong influence over the resources involved in the project and holds a top position in the organisation that can be compared to that of a middle manager.

Traditional literature highlights that choosing the type of project manager (either light or heavy) should depend on how complex the project is and what levels of uncertainty will be faced during the project: high levels of complexity and uncertainty must be managed by heavyweight project managers. We would propose, however, that a heavy role is essential, regardless of the characteristics of the project: a team needs a guide, it has to be managed, not “administered” by a coordinator. It is almost inevitable for a lightweight project manager to turn into a bored bureaucrat or an “accountant” of the project’s progress.

As far as the operational aspect of Project Management is concerned, it is possible to identify two paradigms of reference in the set up of planning and control activities: the *rational* paradigm and the *relational* paradigm.

The *rational* paradigm features a sequence of planning methodologies that make up the classic *corpus* of knowledge on Project Management, namely:

1. the Work Breakdown Structure of the project to define all the actions that need to be undertaken to achieve the goals. The main scope of the work breakdown is to identify some basic work packages that represent the activities that can be independently managed and assign each activity to one person;
2. the elaboration of the network of activities, defining priorities between the various work packages and making an estimate of their duration;
3. coming up with the start and finish dates of the various activities by means of the Critical Path Method (or less commonly, the Programme Evaluation and Review Technique, which features a probabilistic method to assess the duration of the activities based on three data: optimistic duration, pessimistic duration and average duration). With such methods, the margin of flexibility (*float, slack*) for each activity - i.e. how long an activity can be put off without impacting the project’s finish date. The critical path method consists of the activities whose margin of flexibility is zero;
4. control of the project’s progress by checking any difference from what was planned using, for example, a bar diagram on a temporal scale (Gantt diagram).

It is known that the application of such methodologies often brings disappointing results: rational planning techniques do not yield the results that one was hoping for, CPM schedules end up being unrealistic and of little use to the management of the project’s progress, turning into documents that are not connected with reality, or that are occasionally updated just to fill in a report or to send a communication to the outside.

This dissatisfaction with the traditional and rational approaches to Project Management that still dominate project management literature, recently encouraged a critical observation of theoretical bases and project management methodologies (Koskela and Howell, 2002; De Meyer *et al.*, 2002). The central

point of “project management reforming” initiatives is to let go of the idea that a project is a network of activities whose duration needs to be calculated and objective interdependence links determined, and give room to the idea that a project is firstly a *network of people*. This perspective – which we can call *relational* - produces two main consequences:

- planning cannot be separated from action and, therefore, it is not possible (and it makes no sense) to plan the entire network of activities at the beginning. Planning is an on-going event and details progressively form over time (with a *rolling wave* type of plans). The “planning” action is a coordination activity that needs to be carried out by whoever deals with the operational part of the job;
- the project is a network of discussions, engagements and actions and therefore has to be a collaborative and social event: the project is a “conversation” where those responsible for activities undertake reciprocal duties, as far as their tasks are concerned; temporal relationships between activities are the product of a “negotiation” among those responsible for the activities, and not an intrinsic attribute of interdependence between abstract activities; and the duration of an activity is also a product (of course within a certain range of values) of a “negotiation” that depends on the needs of the final “customer”.

Project portfolio management. An innovation strategy defines the enterprise’s competitive arenas in terms of product/market combinations and modes of competition through the portfolio of products which the enterprise puts on the market. Defining strategic arenas is extremely important, since it guides the company’s innovation and product development efforts and reduces the chances of an unfocused search for new product ideas and opportunities to be developed, which could lead to a waste of energy in uncorrelated initiatives that are not synergic (ref. Cooper and Edgett, 2010).

The strategic choices that take shape when the enterprise begins investing: it is the project portfolio that puts innovation strategy into practice, with decisions regarding where to allocate financial and human resources. Portfolio management is a dynamic decision-making process through which a list of product innovation projects is constantly re-examined and updated. New projects are evaluated, selected and finally organized according to a priority using that process; active projects may either be abandoned or accelerated; available resources may be allocated or reallocated among active projects (Cooper *et al.*, 1999). Project portfolio management is vital to the competitive and profit-related success of the enterprise for three main reasons:

- managing the portfolio actually means putting the company strategy into practice (what products, markets and technologies will be attacked?);
- managing the portfolio means defining the allocation of human and financial resources;
- managing the portfolio means seeking balance in investments, taking into account the *trade-offs* between risk and profitability, between support of the acquired competitive position and efforts to grow further, between long and short-term innovation projects.

Not managing, or managing the project portfolio in an ineffective and vague way, can have some important and dangerous consequences (Cooper *et al.*, 2000), namely:

- too many projects and resource overload: the list of active projects tends to get too long easily; financial and human resources seem to be too dispersed and the quality of execution suffers from it. Lack of resources is just one part of the problem; the other is the inability to allocate resources in an effective manner;
- lack of discrimination between projects, which amplifies the problem of ineffective allocation of resources;
- lack of balance between short-term orientation and long-term orientation: short-term projects (cost reductions, product line extensions; incremental changes in performances) are undoubtedly important; the problem is the excessive use of resources dedicated to these projects to the

detriment of riskier projects that aim at building the company's future competitive capacity. Without a strategic view and an explicit management of the project portfolio, tactical choices inevitably prevail and favour the projects that have a more immediate and less uncertain economic and financial impact.

There are three main goals of portfolio management:

- *maximising the value of the portfolio*, allocating resources, so as to maximise the value of the portfolio with reference to specific indicators;
- *obtaining a balanced portfolio* in relation to different parameters, such as the presence of long- vs. short-term projects, the presence of high-risk and high-potential projects *vis a vis* low-risk, lower-potential potential projects; presence of projects that require different levels of innovation effort;
- *obtaining a portfolio that reflects and gives value to the company strategy* (strategic alignment) in terms of allocation of resources in the areas of strategic interest – products, markets and technologies – and of adherence of single projects to the company's mission.

5. Conclusion

The paper has relevant implications for theory and practice, as it identifies a framework, focused on the funnel model, which supports the analysis and the re-engineering of innovation processes. The proposed approach is especially important for smaller enterprises where there is often a narrow view of innovation management, usually limited to the back end, i.e. the product development process. The funnel framework can be a key tool to create a language and a common vision of innovation processes. This is a necessary prerequisite for the effective implementation of projects.

The innovation funnel is well known in scholarly literature, however it is generally used with a time-based perspective. The aim here, by contrast, is to allow the evolutionary path of an idea from the front-end phase to the product development phase to be visualised, and at the same time make clear the need of a selection process in order to identify winning products. The proposed model is designed to visually illustrate the "system of spaces" that must be carefully managed to be consistently innovative. As a consequence, it is not time-focused, rather activity-focused.

The framework is described in detail in all its phases and it is correlated with a specific methodology designed to offer managers guidance when facing the assessment and redesign of an innovation process.

As a result, this framework becomes a tool that can be easily applied and enable a small firm to improve its innovation process, firstly in terms of integration of front end with back end.

Future research might look at further developing phase 2 - "brainstorming around the funnel". In particular, it could be useful to design a structured assessment tool to complete the funnel framework and support both the brainstorming activities and the assessment process. Triggering questions could be included in order to facilitate the assessment, understanding and adoption of international best innovation practices.

In addition, although this paper has highlighted the relevance of the proposed funnel framework, there is a pressing need for an empirical study to further investigate how the adoption of the framework will impact on SMEs' innovation output.

References

1. Acs, Z., & Audretsch, D. (1990). *Innovation and Small Firms*. Cambridge, MA: The MIT Press.
2. Aydalot, P. (1986) *Milieux Innovateurs en Europe*. Gremi, Paris.
3. Bacon, G., Beckman, S., Mowery, D., & Wilson, E. (1994). Managing product definition in high-technology industries: a pilot study. *California Management Review* 36(3), 32-57.
4. Belliveau, P., Griffin, A., & Somermeyer, S. (Eds.). (2002). *The PDMA toolbox 1 for new product development*. New York: John Wiley & Sons, Inc.
5. Biazzo, S. (2005). The new ISO 9001 and the problem of ceremonial conformity. How have audit methods evolved?. *Total Quality Management & Business Excellence*, 16 (3), 381-400. doi:10.1080/14783360500054145
6. Biazzo, S. (2009). Flexibility, Structuration and Simultaneity in New Product Development. *The Journal of Product Innovation Management*, 26 (3), 336-353. doi:10.1111/j.1540-5885.2009.00662.x
7. Brown, S.L., & Eisenhardt, K.M. (1995) Product development: past research, present findings, and future directions. *Academy of Management Review*, 20(2), 343-378. <http://dx.doi.org/10.2307/258850>
8. Brown, T. (2008). Design thinking. *Harvard Business Review*, June, 86(5), pp. 84-92
9. Calabrese, G., Coccia, M. & Rolfo, S. (2005). Strategy and market management of new product development and incremental innovation: evidence from Italian SMEs. *International Journal of Product Development*, 2(1-2), 170-189. doi:10.1504/IJPD.2005.006675
10. Camagni, R. (1991). Local milieu, uncertainty and innovation networks: towards a new dynamic theory of economic space, in GREMI, in Camagni R. (Ed) *Innovation networks: spatial perspectives*, Belhaven Press, London.
11. Chesbrough, H, Vanhaverbeke W. & West J. (2008), *Open Innovation: Researching a New Paradigm*, Oxford University Press, USA.
12. Chesbrough, H. (2004). Managing open innovation. *Research-Technology Management*, 47 (1), 23-26. doi:10.5437/08956308X5405003
13. Clark, K.B. & Fujimoto, T. (1991) *Product Development Performance*. Cambridge MA: Harvard Business School Press.
14. Clark, K.B. & Wheelwright, S.C. (1993). *Managing New Product and Process Development*. New York, NY: The Free Press.
15. Cooper R. G. (2011). *Winning at New Products: Creating Value Through Innovation*, Publisher: Basic Books.
16. Cooper R.G. & De Brentani U. (1991) New industrial financial services: what distinguishes the winners. *Journal of Product Innovation Management* 1(8), 75-90. doi:10.1016/0737-6782(91)90002-G
17. Cooper, R.G. & Kleinschmidt, E.J. (1994) Determinants of timeliness in product development. *Journal of Product Innovation Management*, 11(5) 381-396. doi:10.1016/0737-6782(94)90028-0
18. Cooper, R.G. & Kleinschmidt, E.J. (1995). Benchmarking the firm's critical success factors in new product development. *Journal of Product Innovation Management*, 12 (5), 374-391. doi:10.1016/0737-6782(95)00059-3
19. Cooper, R.G., & Edgett, S.J. (2010). *Portfolio management for new products: Picking the winners*. Working Paper, Product Development Institute.
20. Cooper, R.G., Edgett, S., J. & Kleinschmidt, E.J. (2000). New Problems, New Solutions: Making Portfolio Management More Effective, *Research-Technology Management*, 43 (2), 18-33.

21. Cooper, R G.;Edgett, S. J.; Kleinschmidt, E J. (2002). Optimizing the Stage-Gate Process: What Best-Practice Companies Do—II, *Research-Technology Management*, 45 (6), 43-49
22. Cooper, R.G., Edgett, S.J., & Kleinschmidt, E.J. (1999). New Product Portfolio Management: Practices and Performance. *Journal of Product Innovation Management*, 16 (4), 333–351. doi:10.1016/S0737-6782(99)00005-3
23. Crawford, M., & Di Benedetto A. (2003). *New products management* Boston: McGraw-Hill.
24. De Meyer, A., Loch, C. H. & Pich M. T, (2002). Managing project uncertainty. *Sloan Management Review*, 43(2) 60-68. doi:10.1109/EMR.2002.1032403
25. Filippetti, A., & Archibugi, D. (2011). Innovation in times of crisis: National Systems of Innovation, structure, and demand. *Research Policy*, 40(2), 179-192. doi:10.1016/j.respol.2010.09.001
26. Freel, M.S. (2000). Barriers to Product Innovation in Small Manufacturing Firms, *International Small Business Journal* 18(1), 60–80. doi:10.1177/0266242600182003
27. Fu, Z. (2010). Explore new economic growth points in the post-crisis era, on the basis of independent innovation, **International Conference on Management and Service Science, MASS** 24-26 Aug. 2010
28. Gupta, A.K., & Wilemon, D.L (1990). Accelerating the development of technology-based new products. *California Management Review*, 32(2), 24-53.
29. Haque B., & James-Moore M. (2004) Applying lean thinking to new product introduction *Journal of Engineering Design*, 15 (1), 1-31. doi:10.1080/0954482031000150125
30. Hayes, R., Wheelwright, S.C. & Clark, K.B. (1988). *Dynamic Manufacturing. Creating the Learning Organization*. New York NY: Free.
31. Herstatt, C., Verworn, B. & Nagahira, A. (2004). Reducing project related uncertainty in the “fuzzy front end” of innovation: a comparison of German and Japanese product innovation projects. *International Journal of Product Development*, 1(1), 43–65. doi:10.1504/IJPD.2004.004890.
32. Hue, G., Sales, J., Comeau, D., Lynn, D.G., Eisen, A. (2010). The American science pipeline: Sustaining innovation in a time of economic crisis. *CBE Life Sciences Education*, 9 (4), 431-434. doi:10.1187/cbe.09-12-0091
33. Hüsig, S., & Kohn, S. (2003). Factors Influencing the Front End of the Innovation Process: A Comprehensive Review of Selected Empirical NPD and Explorative FFE Studies, in: *Proceedings of the 10th International Product Development Management Conference*, Brussels, Belgium, June 10-11, 545-566.
34. Iansiti, M. & MacCormack, A. (1997). Developing Products on Internet Time. *Harvard Business Review* 75(5), 108–117.
35. Iansiti, M. (1995). Shooting the rapids: system focused product development in the computer and multimedia environment. Working Paper 95-026, Boston: Harvard Business School.
36. Kalyanaram, G., & Krishnan V. (1997). Deliberate product definition: Customizing the product definition process. *Journal Marketing Research*, 34, 276-285. doi:10.2307/3151864.
37. Khurana A., & Rosenthal S. R. (1997) Integrating the fuzzy front end of new product development. *Sloan Management Review*, 38(2), 103–120.
38. Khurana, A. & Rosenthal, S.R. (1998). Towards Holistic "Front Ends" In *New Product Development*. *Journal of Product Innovation Management*, 15(1), 57-74. doi:10.1016/S0737-6782(97)00066-0.
39. Koen, P., Ajamian, G., Burkart, R., Clamen, A., Davidson, J., D’Amore, R., Elkins, C., Herald, K., Incorvia, M., Johnson, A., Karol, R., Seibert, R., Slavejkov, A. and Wagner, K. (2001). Providing clarity and a common language to the ‘fuzzy front end. *Research Technology Management*. 44 (2), 46–55.

40. Koskela, L. & Howell, G. (2002). The underlying theory of project management is obsolete, in Slevin, D. P., Cleland, D. I. and Pinto, J. K. (eds), *Proceedings of PMI Research Conference*, Project Management Institute, pp. 293–301.
41. Lichtenthaler, E., Savioz, P., Birkenmeier, B., & Brodbeck, H. (2004). Organisation of the early phases of the radical innovation process. *International Journal of Technology Intelligence and Planning*, 1(1), 100-114.
42. MacCormack, A., & Verganti, R. (2003). Managing the Sources of Uncertainty: Matching Process and Context in Software Development. *Journal of Product Innovation Management* 20, 217–232. doi:10.1111/1540-5885.2003004
43. Moncada-Paternò-Castello P., Ciupagea C, Smith K., Tübke A, & Tubbs M. (2010), Does Europe perform too little corporate R&D? A comparison of EU and non-EU corporate R&D performance. *Research Policy*, 39 (4), 523–536 doi:10.1016/j.respol.2010.02.012
44. Montoya-Weiss, M. M., & O'Driscoll, T. M. (2000). From experience: Applying performance support technology in the fuzzy front end. *Journal of Product Innovation Management*, 17(2), 143-161. doi:10.1016/S0737-6782(99)00032-6.
45. Morgan J., & Liker J. K. (2006). *The Toyota Product Development System: Integrating People, Process, and Technology*, Cambridge: Productivity Press
46. Nobelius, D., & Trygg, L. (2002). Stop chasing the front end process - management of the early phases in product development projects. *International Journal of Project Management*, 20(5), 331-340. doi:10.1016/S0263-7863(01)00030-8
47. Rosenthal, S.R., (1992). *Effective Product Design and Development*. Homewood, IL: Irwin.
48. Rother, M., & Shook, J. (2003). *Learning to see: Value-Stream Mapping to Create Value and Eliminate Muda*. Brookline, Mass: The Lean Enterprise Institute.
49. Smith, P.G. & Reinertsen D. G. (1991), *Developing Products in Half the Time*. New York: Van Nostrand Reinhold.
50. Souder, W. E. & Moenaert R. K., (1992). Integrating Marketing and R&D Project Personnel Within Innovation Projects: An Information Uncertainty Model. *Journal of Management Studies*, 29(4), 485-512. doi:10.1111/j.1467-6486.1992.tb00675.x .
51. Thomke, S.H. & Reinertsen, D. (1998). Agile Product Development: Managing Development Flexibility in Uncertain Environments. *California Management Review*, 41, 8–30.
52. Ulrich, K.T. & Eppinger S.D. (2008). *Product Design and Development* (4th edition). New Jersey: McGraw-Hill.
53. Ulwick, A.W. (2002). Turn customer input into innovation. *Harvard Business Review*, 80(1), 91-97.
54. Verganti, R. (1997). Leveraging on systematic learning to manage the early phases of product innovation projects. *R&D Management*, 27 (4), 377–392.
55. Verganti, R. (1999). Planned flexibility: Linking anticipation and reaction in product development projects. *Journal Product Innovation Management* 16(4) 363-376. doi:10.1016/S0737-6782(98)00067-8.
56. Ward A.C. (2007), *Lean Product and Process Development*, Cambridge MA: Lean Enterprise Institute.
57. Wheelwright, S. C. & Clark K. B. (1992), *Revolutionizing Product Development*, New York: Free Press.
58. Womack J. P., & Shook J. (2011) *Gemba Walks*. Cambridge, MA: Lean Enterprises Inst. Inc.