

***DOCTORAL THESIS***

Title	MANAGING RESEARCH PROJECTS: JUDGMENT AS A SOURCE OF CREATIVITY
Presented by	Nuria Nadal Burgués
Centre	ESADE BUSINESS SCHOOL, Ramon Llull University
Research Unit	Institute of Innovation and Knowledge Management
Department	Strategy and General Management
Directed by	Professor Eduard Bonet i Guinó



*To Carlos*

*“Para reformar el suelo es preciso, evidentemente, apoyarse en el subsuelo. De aquí que los físicos se viesen obligados a filosofar sobre su ciencia.”.- José Ortega y Gasset*



## Acknowledgements

*This one goes out to the ones I love.*

I would like to express profound gratitude for my doctoral director, Professor Eduard Bonet i Guinó, who is committed to making intricate courses of study available to his students. Clarity is the courtesy of the philosopher. Extraordinary does not even begin to explain the way in which Eduard has accompanied me in this intense and personal journey of discovery and writing.

Professor Javier Nieto Santa, a lover of action and reflection, is also due my gratitude for his priceless contribution and involvement to this experience. Javier has been essential in the process of bringing a peculiar pair up into a tremendous trio.

The foundation of this work is due to the work of Professor Hans Siggaard Jensen whose courses on philosophy and management, and his academic articles have been essential in the improvement of my work.

I am indebted to the professors and colleagues at ESADE -they are an exceptional academic community. A special mention is dedicated to my friend Ayeh Solouki whose lack of prejudice I appreciate. Our delightful conversations have widened our worlds. I also would like to mention Professor Elena Bou, Professor Nuria Agell, and Professor Henry Chesbrough whose support and highly valuable experience I truly appreciate. As per their commitment, there are other professors that even having a different affiliation are considered part of ESADE community too. They share and convey their passion for academic research. I would dedicate a special mention and some words of esteem to Professor Deirdre McCloskey.

I would also like to acknowledge to my colleagues and researchers at the Barcelona Supercomputing Center. They triggered my interest in scientific research and its management. Without them the empirical work of this thesis would have been tortuous. They generously supported this work with their friendship, commitment, and openness to all my questions. I would then dedicate a special mention to Mateo Valero, Ernest Quingles, Francesc Subirada, José María Cela, Cristina Montañola, Rosa María Badia, Carlos Pérez, Mariano Vázquez, Guillaume Hourzeaux, Xavier Rubio, Marco Madella, Victor Guallard, Marta Rosselló, María Gonçalves, Oriol Jorba, and Vanja Sisirak.

Finally, I would dedicate this last word to the ones I love, my family, Paulino, Natalia, Anna, Guillaume, and Carlos. I deeply wish you are proud of me.

*Barcelona, 5 of March, 2015*

*This work has partially been supported by European Social Funds and the SUR (Secretaria d'Universitats i Recerca) of the DEC (Departament d'Economia i Coneixement) of the Government of Catalonia. (2014FI\_B2 00145)*



## **CONTENT**

<b>INTRODUCTION .....</b>	<b>1</b>
<b>PART I Conceptual Framework and Literature Review .....</b>	<b>9</b>
<b>CHAPTER 1</b>	
<b>THE USE OF PROJECT MANAGEMENT METHODS IN MANAGING RESEARCH PROJECTS .....</b>	<b>11</b>
1.1. Present Approaches to Scientific Research .....	12
1.2. Science Organized into Projects and Managed with the Methods of Project Management .....	14
1.2.1. Implications of the Management of Research with the Methods of Project Management .....	16
1.3. Limitations and Advantages of Project Management .....	18
1.3.1. Project Management and its influence in the organization of work .....	18
1.3.2. The Influence of Project Management in Scientific Research .....	20
1.4. Type of Research Projects and its Management .....	23
1.5. Objectives, theoretical Research Questions, and Conceptual Framework .....	24
1.6. Summary .....	26
<b>CHAPTER 2</b>	
<b>THE CREATIVE ASPECT OF ROUTINES .....</b>	<b>27</b>
2.1. Approaches and Methods in the Study of Creativity.....	28
2.1.1. Confluent approaches to creativity .....	32
2.1.2. Systems approach to creativity .....	34
2.2. Creativity in Management .....	35
2.2.1. Specialization, Authority and Control .....	37
2.3. The Bond of Routines and Creativity .....	39
2.4. Conclusion .....	45

## **CHAPTER 3**

<b>THE PHILOSOPHY OF HUMAN ACTION IN MANAGING CREATIVE PROJECTS .....</b>	<b>47</b>
3.1. Alfred Schutz’s Theory of Human Intentional Action .....	48
3.2. Phenomenology of Agency Theory .....	51
3.3. Judgment as a Potential Source of Creativity .....	54
3.3.1. The Concept of Judgment and Rhetoric in the Management of Research Projects .....	55
3.4. Implications of the Theory of Human Agency and Human Intentional Actions in Managing Projects and Research .....	58



**PART II Methodology, Empirical Research, and Findings .....61**

**CHAPTER 4**

**EMPIRICAL RESEARCH AND METHODOLOGY.....63**

4.1. Research Questions ..... 63

4.2. Methodology..... 64

    4.2.1. The choice of the sample .....65

    4.2.2. Data collection ..... 66

    4.2.3. Analysis of the data collected ..... 67

**CHAPTER 5**

**THE CREATION OF THE BARCELONA SUPERCOMPUTING CENTER AND THE TENSION BETWEEN ITS STRUCTURE AND AGENCY .....69**

5.1. The Creation of Barcelona Supercomputing Center..... 70

    5.1.1. An Agentic History of the Creation of the Barcelona Supercomputing Center..... 72

5.2. The tension between its Structure and Agency ..... 75

    5.2.1. Mission, Structure, and Types of Work..... 76

    5.2.2. The Tensions and their Resolutions..... 78

**CHAPTER 6**

**MANAGING RESEARCH PROJECTS.....83**

6.1. Tensions between Creativity and Productivity, Categorization of Projects and Forms of Management ..... 83

    6.1.1. Case Study on the View of the Directors of the BSC on the Tensions Between Creativity and Productivity ..... 84

    6.1.2. Case Study of the Grid Computing Group Manager ..... 85

    6.1.3. Case Study of the Group Leader on High Performance Computational Mechanics ..... 88

    6.1.4. Case Study of an Associate Research Scientist at Columbia University and the NASA Goddard Institute for Space Studies ..... 91

6.2. Judgment and Creativity in Managing Research Projects ..... 93

    6.2.1. Case Study on A Project on Social Agents Simulations..... 94

    6.2.2. Case Study on A Project on Archeological Simulations ..... 97

6.2.3. Case Study on a Group of Scientists Modelling the Atmospheric Transport of Particles .....	99
---	----

**CHAPTER 7**

<b>CONTRIBUTIONS AND FURTHER RESEACH .....</b>	<b>103</b>
7.1. Contributions at the theoretical level .....	103
7.2. Contributions at the empirical level .....	104
7.3. Limitations and Further Research .....	106

<b>References</b> .....	<b>109</b>
<b>Annexes</b> .....	<b>121</b>
Annex 1: Brief biographical notes of the interviewees .....	121
Annex 2: Interview procedure used in the study .....	126
Annex 3: Spanish Roadmap for Unique Research and Technology Infrastructures .....	131
Annex 4: Data Source Collection: Web and Text Documents .....	133



## ***INTRODUCTION***

### **A Research Journey**

My interest in the subject of science and research grew out of my work experience as a research project manager at the Barcelona Supercomputing Center (BSC), a leading research institution in Spain. As it is conceptualized by the European Union and research institutions, my responsibilities as a project manager were to take care of the administrative affairs of several research projects which involved guaranteeing the financial and accounting commitment of the projects and ensuring that yearly the reports of the progress and deliverables were sent to the sponsoring institutions on time. In this job, especially in the preparation of reports, I worked close with the researchers. These activities puzzled my earlier understanding of scientific research as a free and creative activity, and I realized that in these kinds of institutions the research activity is performed under the pressure of productivity. These considerations awaken my curiosity for understanding the research work under this tension.

Within this context, I decided to engage myself in doing research and I started the Master of Research and Ph.D. program at the ESADE Business School. During the Master of Research, I examined the roots, ideas, methodologies, and requirements of Project Management. Project Management is inspired by Scientific Management approach, which introduced the mass production methods that led to the creation of the assembly lines. Considering this, Project Management involves dividing complex tasks into more simple or elementary tasks to efficiently coordinate and control a project. The application of Project Management methods requires the precise formulation of the project's goals, constraints, and operations (Carayannis, Kwak, & Anbari, 2005; Gido & Clements, 2009). In contrast, sometimes scientific research goals, propositions and operations are ambiguous and require creativity and freedom to be disambiguated.

From this point of view, managing research with the methods of Project Management became, for me, more problematic. There were already some researchers working on the tensions between productivity and creativity and in managing research. Hans Siggaard Jensen (2011) emphasizes that some research projects fulfill the conditions of Project Management in an approximate, abstract way while others are very ambiguous and require forms of management not considered in Project Management. Trevor Pinch and Weibe Bijker (1984) suggest that scientific and technological developments occur in two stages. In the first stage, or open rhetoric stage, different actors can attribute different meanings to the physical or conceptual objects with which they are working. In the second stage, they achieve the stage of rhetorical closure in which the resolution of a controversy can have two scenarios. One scenario leads to closure by converging the initial variety of meanings into one single one. The other closing scenario is the redefinition of a problem in which the meaning is translated to establish a solution to quite another problem.

The manifested discrepancy between Project Management and the research activity, led me towards inquiring into managing research, under the tension between free creativity and controlled productivity. It could be done at the conceptual and empirical level, in relation to the work I did at the BSC. My preliminary work situated the basic concepts of the tension and included an empirical investigation into how it influenced the creation and the structure of the BSC, and how some of the researchers either adapted to or informally transformed the structure of the organization.

The next step focused on adopting a more extended notion of project, which could include Project Management as an extreme case, but it could also include other types of projects that allow for flexibility and ambiguity. This extended notion of projects was based on Alfred Schutz's (1953) notion of "mental project". His phenomenological philosophy introduces the foundations of Social Sciences, justifies the use of interpretative methods, and analyses the structure of intentional human actions. For Schutz (1953) an intentional action transforms one state of affairs into another state of affairs and includes a purpose, a mental project, and an act. His notion of intentional action involves a more flexible notion of project than the one offered by Project Management. The concept of "mental project" is defined as a mental rehearsal of the future act. A project can be a mere idea or a very specified one, to frame it can be more or less difficult, but it always involves the actor's imagination and can be considered as a hypothesis of what will occur in performing the act.

Schutz (1953) emphasizes that only the acts of other people's actions are observable and that their purposes and their mental projects have to be interpreted. As this is one of the main aims of his work, he does not explicitly explore the relations between actions and judgment, which constitute a central subject in this dissertation. At this point, I used Schutz's notion of action and his critical view of repeated actions and subactions. Schutz's analysis of the common notion of repeated actions emphasizes that repeated actions are similar actions whose differences are not relevant for the actor. And the subactions of an action are usually similar to previously performed actions.

The fact is that because the performance of an act is not a mere mechanical activity, but involves interpretation, therefore judgment is also necessarily involved. And, the fact that, repeated actions are different from one another -as the performance of the second action involves interpretation and judgment on the extent to which the pattern of the first action has been taken as a tacit model and thus followed, and the fact that, with a number of "repeated" subactions we can perform a completely new action –all this allows to conceptualize that there is room for creativity even in the most routine environments.

Considering this, my research points out that creating a project for achieving a new state of affairs requires creativity and judgment that intervene in the following stages: first, creating a project is combining many subactions, similar to previously performed actions or routines. Second, routines considered as similar actions whose differences are not relevant for the actor, involve judgment. And finally, performing an act requires judgment in assessing whether or not it follows the expected development of the project or deviates from it, or indeed whether it suggests new kinds of actions, which opens new possibilities. Creating and developing

projects, even very rigid or specified ones, which fulfill strictly or almost strictly the requirements of Project Management, is a creative activity as it involves constant judgment.

After these reflections, I realized that the tension between creativity and productivity that I had identified in the creation of the BSC constituted an important aspect of the tension between the structure of an organization and the agency of its researchers. With the purpose of examining this subject, I participated in a seminar on contemporary debates in social sciences at the Copenhagen Business School (CBS). It was there that I was introduced to theories of human agency, not in the sense of agency theory of the principal and agent relations or other similar economic approaches, but in the sense of phenomenological studies into human action. Through my research in this area, I became familiar with the work of Mustafa Emirbayer and Anne Mishe (1998), whose work I consider to be a development of Alfred Schutz's concepts. Their work emphasizes that the past experiences of people and their future expectations constitute their mental framework for their present projects, activities, and performances. The phenomenological approach to the theory of agency led me to identify the importance of the concept of routines in my research.

The concept of routines, which is close to the notion of work protocols, was defined as the rules guiding the way we have to perform certain kinds of activities. So routines are prescriptive and normative. Anthony Giddens (1984) was aware of the difficulty of determining *a priori* the development of an action and therefore redefined the concept. He places rules as resources for action, but not as determining the action itself, as they have been previously conceptualized. Giddens' influence is notorious in the theory of practice for the study of social behavior and for the study of organizational work. This stream of research stresses the importance of routines as offering alternatives, as a routine is viewed not as a single pattern, but rather as a set of patterns, from which organizational members enact particular performances. The research also studies how routines are created, implemented, resisted and modified, and connects it with the fact that routines facilitate organizational change (e.g. Pentland & Rueter, 1994; Feldman, 2000; Feldman & Pentland, 2003).

The study of the tensions between creativity and productivity in scientific research, acquires a new perspective when looking at the organizational work from the agency theory point of view. And I introduced new concepts to the interpretation of the creation of the BSC and, in 2012, I presented a preliminary work at the Organization Studies' Workshop, held in Rhodes, Greece. This work emphasized the ways in which actors who create an organization give meanings to their work activity. And it conceptualized the basic aspects of routines as a kind of "mental project" that is formulated, socialized and imposed on people with the purpose of enabling them to enact "repeated" actions, which are similar actions that require judgment.

This identification has two main consequences. First, it allows recognition of the creative functions of judgment on building projects, performing their associated actions, repeating actions and combining subactions when we study the creative functions of routines. The theory of practice and sociological approaches points out the transformational functions of routines and mention the concept of judgment, but they have not identified the role of routines as different sources of creativity. And second, this identification it allows consideration of

the operations of building and developing a research project as an activity that involves routines. The application of general methods and specific qualitative, mathematical, and statistical methods, as well as empirical methods for working in laboratories can be seen as subactions of research constituted by routines. Even if researchers are not aware of it, modern routinization of many aspects of scientific research has been a basic contribution for the professionalization of research activity.

Along with my research, I have reviewed the literature on creativity because this subject constitutes an important part of the research. The beginning of the study of creativity was based on the study of the personality traits of the creative person which involves the study of the biographical material of famous individuals (e.g. MacKinnon, 1962). A short time later, three new components were included and identified as, the process, the product, and the place. This fragmented view of creativity clarifies some of the aspects that are involved in the phenomenon of creativity. From the initial inclination to study each of the creative components separately, a new trend emerged and confluent approaches to creativity were then introduced. The social psychology of creativity brought new possibilities to the study of creativity and successfully merged the individual perspective with the social milieu (e.g. Amabile, 1983; Csikszentmihalyi, 1988). This new perspective stresses the exploration of the set of factors that influence creative performance in the work place (e.g. Amabile, Conti, Coon, Lazenby, & Herron, 1996; Shalley & Gilson, 2004; Puccio & Cabra, 2010). This research culminated in a set of individual attributes and organizational determinants that affect the creativity of an organization. These results questioned the traditional organizational and management approaches focusing on efficiently controlling the production process.

Several management disciplines, such as accounting and control management systems, seized on the importance of dealing with subjects implicit in the management of creativity such as uncertainty, innovation, and change. Without altering their foundations, they suggest new methods that deal with the paradox between creativity and productivity, to face the new organizational context. The management control systems literature affirms that their methods promote creativity and control simultaneously, ensuring the selection, development and efficient execution of new ideas in projects (e.g. Davila & Ditillo, 2009; Adler & Chen, 2011). Meanwhile researchers in the field of creativity reject these ideas and claim that their methods undermine the freedom required to perform under conditions of uncertainty, as, according to them, the primary sources of creativity rely on the worker's motivation and self-determination whose goal is to influence management processes.

None of the previous disciplines have studied and approached the subject of creativity as a routine involving judgment. Consequently, a project even being under the strict requirements of Project Management and being formed by a large number of similar subactions, is a creative work that involves judgment. The judgment contained in a routine creation and recreation establishes a base for innovation and creativity in every recognized activity or operation, such as scientific research. All of these activities involve the actors' mental activity to interpret the situation and make appropriate choices as the basis for defining and developing scientific projects and their creativity. As a consequence, creativity occurs in even very restricted environments because routines, activities and operations are considered



to be different from one another, even though these differences are not considered to be relevant by the agent.

Finally, the actor's judgmental activity is considered an internalized rhetorical activity, as she presents arguments to herself, evaluates them, and then finally persuades herself in order to make decisions and specify projects. The management of creativity resides in managing the distinctiveness between actions that occur at the individual level in each organization or project. The actor's self-reflection establishes the possibility of delivering unexpected outcomes, which are considered creative.

This conceptual framework and the empirical research to which it is associated, would be of relevance in managing research. Concretely, the notions of project and routine developed in the conceptual framework offer new and better ways of preparing and executing research projects. Moreover, many concepts allow understanding the ignored function of judgment in the methods of Project Management. Therefore, this perspective should be of the interest of decision-makers linked to scientific policy as well as managers and scientists of research institutions and professionals who apply Project Management.

## **A Chapter-by-Chapter Presentation**

This doctoral thesis is divided in two main parts, the first part includes the conceptual research, and the second part develops the empirical research guided by the theoretical developments offered in the conceptual part.

### *Part I: Conceptual Framework and Literature Review*

Chapter 1 includes a background on the management of scientific research and the influence of Project Management methods. It also develops some of the advantages and limitations of both organizing the work into projects and the use of Project Management when managing scientific research. This Chapter ends suggesting a wider notion of project, capable to deal with the paradox between productivity and creativity research organizations deal with. This wider notion of projects includes not only the type of projects characterized by the concreteness and predictability of their goals, but also this type of projects that present difficulties in providing specific descriptions of their goals and operations. This wider notion of projects allows introducing new forms of management to cope with the diverse type of projects, that go from very specific to very ambiguous, and that involve creativity. Considering this context, this chapter sets the aim and objectives of this doctoral work.

Chapter 2 reviews the literature on creativity. The exploration of the literature on creativity includes two main perspectives that focus on the study of four different components –the person, the process, the product and the place. The uniperspective view examines separately the four components of creativity while the multiperspective view groups some of the components to study creativity. The subject of creativity in management studies is important since creativity is involved in the organization's sustainability and growth. However, recent studies show that creativity challenges some core management functions – specialization, authority and control, and stimulates the debate among the tension between

productivity and creativity. Different from previous studies, I introduce new aspects of the tension between productivity and creativity by looking at organizational routines. Organizational routines are considered the fundamental unit of analysis in organization studies. The idea that routines are not mere mechanical actions, but they involve judgment to be created, accomplished, resisted or changed, aligns routines to creativity.

Chapter 3 is essential to grasp the theoretical perspectives that inform the new concepts of project and routine introduced in the previous chapters and necessary to understand the role of judgment in managing research projects and formulate other aspects of the subject of creativity that have not considered before. The fact that organizational routines involve judgment to be created and developed, and the fact that the judgmental activity of an individual can be considered a fundamental creative activity, introduces new aspects on the subject of creativity. With this aim the following phenomenological theories are considered: Alfred Schutz's 1953 theory of human intentional action and Mustafa Emirbayer and Anne Mishe's (1998) theory of human agency. This chapter develops a notion of judgment and the connection between judgment and rhetoric as creative endeavors. The chapter ends outlining some of the implications of this theoretical framework in the management of research and research projects.

#### *Part II: Methodology, Empirical Research and Contributions*

Chapter 4 introduces the methodological aspects of the study, such as, the approach, the choice of the sample, the data collection and analytical method, and it also sketches the subjects have been developed in the conceptual framework and that are going to be disclosed in the empirical research. The choice of the research methodology is aligned to the theoretical and epistemological approach presented in the conceptual section based on the phenomenology of the human intentional action. The use of interpretative approaches contains understanding the purpose of other people's actions with the method of double hermeneutic which distinguishes between two levels, common sense level and scientific interpretation level of human actions to interpret the meanings of people's actions.

Chapter 5 presents two case studies that complement one another. The first, The Creation of the Barcelona Supercomputing Center (BSC), emphasizes the political decisions and the institutions that led to create it, as well as the scientific mentality of the main actors and the history and forms of work of the precursory scientific institutions. Those characteristics are very important for situating the second case study, The Tension between its Structure and Agency, presents the mission and structure of the BSC as well as the ways that groups of researchers reacted against this structure and, in an informal way, transformed it and their work conditions.

Chapter 6 presents seven case studies on the way researchers manage research projects, which in a direct or indirect way are related to the Barcelona Supercomputing Center (BSC). The cases are classified in two groups. The first group focuses on the tension between productivity and creativity that researchers in organizations deal with. It includes a first case presenting the vision of the tension of the directors of the BSC that influences the vision of

the researchers. The second group concentrates on the conceptual spaces in which creativity can be developed and how researchers take advantage of them.

Finally, Chapter 7 includes a summary of the theoretical and empirical contributions of this doctoral work and the subjects of further research considering both the new conceptualizations that lead to some new empirical findings.

### **Academic Publications**

This doctoral work has been previously presented in several workshops and conferences and published in several academic articles and conference proceedings. Below the list of academic journals and conference proceedings where this work has been published:

Nadal-Burgues, N. (2014). *Project specification: creativity and rhetoric in scientific research*. Journal of Organizational Change Management, 27(5), 807 – 818.

Solouki, Z., Nadal-Burgues, N., & Zander, U. (2013). *Management Forms: When Control is Irrelevant*. Proceedings of the 35<sup>th</sup> DRUID Conference 2013, in Barcelona, Spain: ESADE, Ramon Llull University.

Nadal-Burgues, N. & Bonet, E. (2012). *Limitations of Project Management when Managing Research: An Empirical Study at the Barcelona Supercomputing Center*. The International Journal of Management, 1(2), 1-20.

Nadal-Burgues, N. (2011). *Managing Research: An Empirical Study*. Proceedings of the 4<sup>th</sup> International Conference on Rhetoric and Narrative for Management Sciences, 2011, in Barcelona, Spain: ESADE, Ramon Llull University.



# **PART I**

## **Conceptual Framework and Literature Review**

This part falls into three main sections, each of which outlines various strands of argumentation and reviews bodies of literature that I consider to be relevant to my goals.

# CHAPTER 1

## THE USE OF PROJECT MANAGEMENT METHODS IN MANAGING RESEARCH PROJECTS

*“El tiempo de la ciencia y del pensamiento no es el de los relojes y los calendarios.” - Patrick Deville, “Peste y Cólera”*

Since ancient times, philosophy and science have been considered fundamental to the development of free societies and this development has relied on the intellectual orientations of the philosophers and scientists. However, the purposes and the methods of scientific research have experienced profound changes throughout history. The classical Socratic philosophers were free to behold and admire reality detached from any practical purposes. Plato and Aristotle considered intellectual contemplation to be the highest human endeavor, having a limitless value in itself. Plato’s philosophy and science was based on the idea of contemplation as the way to gain knowledge and thereby reach the truth, and considered geometry as a method of contemplation, a step on the way to understanding “*Pure Ideas*”, and disdained its practical application.

Modern Philosophy and Science, starting from the seventeenth century, began when Francis Bacon (1561-1626) claimed that the purpose of science was to know the world so as to transform it, with the aim of improving human life. Bacon introduced the idea of a universal collaboration among researchers for gathering an impressive amount of data. Galileo Galilei (1564-1642), one of the founders of modern empirical sciences, introduced mathematical functions in the study of the motion of astral bodies. He approached craftsmen and shipbuilders in the shipyards of Venice, and built instruments of measurement, breaking the elitist mentality of science.

The Enlightenment led to the creation of the first schools of engineering to be based on the mathematical and physical sciences. However, scientific research was not related with and submitted to the pressure of practical applications, industrial developments or market requirements but towards “that which is useful for life, for individual and collective well-being” (Descartes, 1637/1968: 14). They were free in the sense that they followed the path of their own creativity, rather than the pursuit of existing practical aims, and there were no constraints with which it could be inhibited. From this point, in the western tradition, science and research have been considered “a creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture and society, and the use of this stock of knowledge to devise new applications” (OECD, 2002: 30). This idea of science neither implied nor demanded the management of the research.

The nineteenth century, meant the participation of industrial companies in the development of important scientific discoveries, looking for exclusive economic benefits.

Since the beginning of this stage, science and research is no longer considered independent from its application nor able to function without external governance and oversight of resources as it is crucial in supporting industrial development and societal needs (Geuna, Salter, & Steinmueller, 2003; Etzkowitz & Leydesdorff, 2000). Well-known examples of research-driven corporations include DuPont (1802), the common abbreviation for E. I. du Pont de Nemours and Co., and Edison (1877). For instance, DuPont grew rapidly through the manufacture of gunpowder, half of which was supplied to the Union Army during the American Civil War. DuPont established a tradition of basic scientific research in manufacturing gunpowder from which other chemicals were soon derived. In 1928, DuPont set up the foremost industrial laboratory for basic research and became the largest chemical company in the world, a privileged position it has maintained to the present day. It has patented many commonly used materials such as, Nylon, Lycra, and Neoprene. As a result, market economies have intensively coupled innovation with research, since scientific discovery has become a source of competitiveness. With this, the fundamental element of a market economy has proved to be innovation (Schumpeter, 1934).

### **1.1. Present Approaches to Scientific Research**

During World War II, with the development of some important military projects and the development of the methods of Project Management, science and research started to be organized into projects and managed following the methods of Project Management. The management of research is characterized by the introduction of National and Regional policies that relate research to innovation and economic development, and those political plans constitute the main economic source of the scientific research. The Research Programmers of the European Union and the OECD have promoted a new shift in the rationale, the objectives and the management of scientific research whose aim is to “move towards increased market responsiveness, budget pressures and effects to increase clarity over research roles” (OECD, 2011: 12).

The growing complexity of the knowledge system is rooted in the systematic efforts to strengthen its production, since it is considered to be a competitive advantage both at the governmental and industrial level (H. S. Jensen, 2008). The effect of research and innovation on the welfare of the state led to the massification of university education and scientific research. The capitalization of scientific theories affected the form of research organizations, their roles and most certainly their missions (Gibbons et al., 1994; Jacob, 1997; Jensen, 2008), which were traditionally concerned with freedom and creativity and had no constraints. These apparent changes place the study of scientific research and its management as the central topic of the present doctoral research.

Today, the management of research often implies both ensuring the urgency of the commercial use of new scientific discoveries and the maintenance of the intellectual freedom involved in scientific discovery. These requirements add new meanings and practices to research and its management that are not accounted for in more traditional forms of



management. The transformation of research practices and research institutions has resulted in the development of a variety of approaches and disciplines concerned with the study of research and innovation as the catalysts of growth. The present situation of scientific research has triggered important research programs in the study of innovation, the activity and the management of research.

Among the vast array of studies on innovation, this doctoral research will be primarily interested in highlighting significant works in innovation processes as these have attempted to foster the links between innovation and scientific research. That is to say, research which has focused on the process of adoption, diffusion and use of an innovation in organizations. It should be noted that innovation process studies might include many other lines of inquiry, such as organizational learning and network theory. Studies of organizational learning processes consider the learning effects between the creation of new ideas and their use to guarantee organizational performance. Jim March (1991) examined some of the problems organizations experience in allocating resources when dealing with the exploration “of new possibilities” and the exploitation “of old certainties” (March, 1991: 71). His work offered an adaptive perspective of the learning effects on the balance between exploration and exploitation. Adaptive studies reached their peak with Max Boisot’s (2011) book “Collisions and Collaborations: The Organization of Learning in the Atlas Experiment at the LHC”. This research is based on the creation and exploitation of “Atlas”, a giant scientific infrastructure. Boisot discloses new managerial dimensions based on organizing cultural diversity, informality and, surprisingly, trust (Boisot, Nordberg, Yami, & Nicquevert, 2011).

Network theory is related to innovation through its explanations of the processes that interact with network structures to yield certain outcomes (e.g. being innovative, being creative, performance rates or getting a job) (Borgatti & Halgin, 2011). The work of Mark S. Granovetter (1973) “The Strength of Weak Ties” and Ronald S. Burt (1992) “Structural Holes” are well-known examples. Based on the premises of these theories, social network studies claim that the characteristics of the structure of the network of actors and the patterns of interaction between them increase the chances of new knowledge combinations (Granovetter, 1973; Burt, 1992, 2004; Gilsing, Nooteboom, Vanhaverbeke, Duysters, & Van den Oord, 2008). Further research has been conducted focusing on the kind of intermediaries involved in the acquisition, diffusion, transfer and adoption of such new knowledge (Howells, 2006) and their ability to articulate it to innovate (Hargadon & Sutton, 1997; Obstfeld, 2005). Network theory inspired the introduction of networks as new organizational forms, whose loose coupling structure enables the generation of new knowledge (Powell, 1990).

Studies in the activity of research have approached the study of scientific discovery and innovation differently from those in the field of innovation processes. For instance, Bruno Latour (1987) focuses on the “inner making” of science and technology. Contrary to most innovation studies, Latour presents the study of science and technology in action instead of studying it from its output. To do this, he goes back in time, deconstructing scientific statements, articles and artifacts. This deconstruction shows that many other choices could have been made and other outcomes could have been delivered. In this way, he unfolds the

controversies in research and technology and the means (e.g. corporate interests) by which discoveries and inventions are accepted by others.

Many other research management studies address the impact of external sources of funding and practical demands in the organization of the research activity (e.g. Wilts, 2000; Greenberg, 2007). In their work, these external sources are some of the causes of the shift in research practices and goals. Research management studies also attempt to explain the managerial implications of these changes in research imperatives. In line with this purpose, Shantha Liyanage, Paul F. Greenfield, and Robert Don (1999) connect research management to “three important management requirements; creativity, network linkage and knowledge exploitation” (Liyanage, Greenfield, & Don, 1999: 378). Hans Siggaard Jensen addresses the managerial implications of the reliance on intellectual capital to secure firm’s capitalization. He claims that this transformation involves new management forms that foster creativity. Creativity demands “teams and work forms where problem-solving is different; not necessarily based on logical reasoning. Interpretation, ambiguity and multiple sense-making, characterize crucial periods in innovation projects” (Jensen, 2008: 134).

Within this context, the present chapter aims to contribute to the field of research management leading to an understanding of how research organizations deal with the tension between productivity (in the face of e.g. resources scarcity, external imperatives, and applied research orientations) and creativity. With this aim, the subjects this work aims to primarily introduce are: first, a summary of the contemporary approaches to managing science and research based on the methods of Project Management. Second, define the limitations of Project Management methods when dealing with projects that have ambiguous goals and require a significant contribution of creativity. And finally, based on the limitations of Project Management to manage ambiguous projects, suggest a new conceptualization of project. The results include the presentation of a wider notion of projects based on the introduction of two absolute types of projects (as opposed to one), which enable the inclusion of new forms of management.

## **1.2. Science Organized into Projects and Managed with the Methods of Project Management**

Since World War II, science and research has started to be massively organized into projects and managed with the methods of Project Management. The extensive use and rapid growth of Project Management in scientific organizations stems from its effective application in some important, large and complex military projects involving scientific research. For instance, in 1940, the “Radiation Laboratory”, commonly called “Rad Lab”, was responsible for the development of three key military projects during World War II. In 1942, there was also the “Manhattan Project”, whose name was a cover for the construction of the atomic bomb, another well-known example of a research project managed under the Project Management methodology (Carayannis et al., 2005) blooming in that period. Project Management’s rapid growth and influence soon expanded to include not only science and

research but also other creative and knowledge-based industries such as, consultancy firms, and film and design companies (Hodgson, 2002, 2004; Carayannis et al., 2005; Jensen, 2008).

Project management was inspired by Scientific Management whose purpose is to maximize productivity and with the use of empirical methods for decision-making increase efficiency of the production process by a rational organization of the work, in such a way that it involves dividing the production process into simple activities (F. W. Taylor, 1911). Scientific Management focused and improved the sequential organization of work and machines initiated in the context of the Industrial Revolution. This idea of management was preconceived since the beginning of industrial work and has been coined with the emergence of industrial assembly lines. With the aim of maximizing productivity through improving the sequential organization of work, operational tools were developed to increase accuracy and efficiency of “factories and clerical bureaucracies where tasks were largely manual and repetitive and where output was tangible” (Bailey & Barley, 2005: 737).

The Gantt charts were adopted as a scheduling tool very early in the development of Project Management. This operational tool was developed in the industrial context, in 1910, by Henry Laurence Gantt, a disciple of Frederic Wilson Taylor. This popular technique is a graphical representation of the flow of work that schedules activities or tasks. It requires the knowledge and measurement of all the activities involved in the production process to subsequently measure the amount of time needed to perform each activity. It also shows each activity’s dependence on, or relationship between, every other discrete activity in the process (Gantt, 1919). Under Project Management, Gantt charts evolved to show more information as they compared the project’s actual performance with the planned one.

Based on the principles of Scientific Management, Project Management introduced new tools to solve project scheduling problems and to increase the effectiveness of planning and controlling a project. For instance, the Critical Path Method (CPM), was developed by DuPont around 1940, and was successfully applied in the “Manhattan Project”. This visual and mathematically based algorithm had a significant impact on the completion time of a project as it determined the shortest path to a project’s completion. CPM therefore gave managers the ability to effectively plan, schedule, and evaluate the time variations on every activity within any given project (O’Brien & Plotnick, 1999).

This technique was fully developed in 1959 and the term *Critical Path* was coined by the developers of the Program Evaluation and Review Techniques (PERT). Also referred to as network diagrams, the PERT tool was developed by the U.S. Navy and applied in military projects. PERT is a decision-making tool that incorporates stochastic predictions for measuring and forecasting the progress of a project regardless of its context (Cook, 1966). PERT incorporated the simulation techniques leading to “pre-specifying and triggering actions based on signals” (Pich, Loch, & Meyer, 2002: 1009). With the introduction of such simulation techniques, Project Management involved “planning and re-planning in a continuous cycle to get from a present state to some future goal” (Jensen, 2011: 54).

In this way, the role of the project manager was to lead the project to completion, fulfilling certain requirements related to scope, schedule and costs. Therefore, the project

manager first had to design a detailed plan, which represented the sequential order of the actions or activities the project was to involve through its life cycle, and then define the *Critical Path*. Once the *Critical Path* had been determined, the project manager implemented the detailed plan. During the execution phase, the project manager followed the network diagram in order to guarantee the completion of the project plan. She was still required to modify and reschedule the project plan many times, partly as a result of schedule overruns, but also in case of any changes to the project's scope, schedule or budget. Changes in one or more of these parameters (scope, schedule and costs) would alter one or both of the other two. For example, a request to augment the performance after a project has been baselined, would affect the schedule and/or the scope (Kerzner, 2013; Gido & Clements, 2009; Carayannis et al., 2005; Frame, 1994; Cleland & King, 1988).

Research scientists, research organizations and research programs became increasingly interested in Project Management. With the use of Project Management methods, the projects were developed according to a logical framework and research scientists were involved in solving the scheduling and costs problems of the projects. However, they do not realize that the principles that led to the methods of Project Management are the same that led the creation of the assembly line because many researchers think that of their work as creative and that scientific research cannot be compared with the mechanical work of an assembly line. Indeed, research scientists are not aware of the idea of Project Management in scientific research is to specify the research operations with the same precision as the assembly line.

In the decades immediately following World War II, Project Management was attractive to research organizations for at least three reasons. First, it had proven to be successful. Second, the use of Project Management methods meant that researchers were able to obtain funds from a more diverse range of agents (i.e. not only governmental organizations but corporations). Funding agencies required applications to be formulated as projects and therefore follow the methods of Project Management because it would ensure comprehensive planning, accountability and productivity. Third, projects had the significance of being activities that work in parallel to the organization and which are independent from one another. They are unique endeavors that might not be aligned to the organizational structure. Due to the "independence" implicit in the notion of project, Project Management has played an important role in reinforcing temporary alliances which are very important in an era in which a company's competitive advantages depend on a strategy of speeding up the time-to market.

### **1.2.1. Implications of the Management of Research with the Methods of Project Management**

Despite the fact that Project Management is a very useful tool, its notion of project clearly disregards many other types of projects, which certainly do exist. The tools and techniques offered by Project Management suggest that the execution of the project is similar to the routine work in an organization. In research, projects can be very ambiguous and difficult to specify, therefore, creativity would not exclusively take place during the design phase of the project but also during its development.

In order to understand this situation, it is important to examine the following subjects, each of which has made important contributions to these conceptual differences: first, the conceptual difference and similarities between scientific research managed with the methods of Project Management and the work in an assembly line. Second, the different notion of a project that ranges from the flexibility of common intentional actions to the rigidity of Project Management. Third, the ways in which Project Management can offer creative spaces to foster discovery.

On the subject of the conceptual differences between scientific research organized into projects and production lines, the literature on Project Management makes the distinction between repetitive operations and projects. The production line is thought to repeat exactly the same tasks a large number of times to produce exactly the same item while a research project determines a complex activity that is performed only once (Obstfeld, 2012). Similarly, both Project Management and the production lines emphasize that creativity takes place during the design phase of the project or organization of work, emphasizing that this degree of customization is what makes the project unique and generates the routines that make possible the ongoing operations (Obstfeld, 2012).

On the concept of project, this notion was not introduced in Project Management but it existed before. The Latin etymology of project is “abjectus” which refers to “bring down”. It was not until the late eighteenth century that “projectio”, the early senses of the verb “to plan” as a “cause to move forward” appeared<sup>1</sup>. “Projectare”, to project, is an intersignification of “projicere” to carry on<sup>2</sup>. This is this context, in which the notion of project is taken from phenomenological and sociological theory. Alfred Schutz's (1953) theory of human intentional action which refers to “mental projects” as an elementary part of every human action that establishes future-oriented motives. Schutz emphasizes that a project is the mental rehearsal of a future act. The ubiquity of projects in the actions that actors undertake contributed to the acceptance of projects by the research scientists, who made no distinctions or recognize the different notions of project. In general, a project is defined as a “temporal endeavor”, built in a “unique” set of operations, and designed to accomplish a “singular” goal. This is a broad definition that clearly does not imply any constraints and admits different levels of project's specification. In contrast to this flexible notion of a “mental project” is the notion of projects in Project Management which implies “a well-defined objective stated in terms of scope, schedule and cost” (Cleland & King, 1988: 11).

On the subject of the creative spaces offered by Project Management, the focus is dependent on the ways in which a project can be executed, which even when using the thorough forms of the methods of Project Management require flexibility and judgment, in order words, the kind of cognitive process involved in any creative activity.

---

<sup>1</sup> *Oxford Etymology dictionary. Project*

<sup>2</sup> *Joan Coromines. Diccionari Etimològic de la Llengua Catalana. Project*

### **1.3. Limitations and Advantages of Project Management**

The introduction of project-based organizations and project work, and its influence in the way the work is organized, presents some discrepancies with the role conferred by modern management theories to the structure of an organization. These theories assumed that an organization structure precisely expresses the authority and communication lines of the organization, and can specifically define the requirements of the work activity. This approach clashes with the motive of organizing the work into projects, omits the interplay between the structure of the organization and the agency of the employees, and suggests the inquiry on subject of the tension between creativity and productivity in the management of projects, which is relevant in the management of the scientific activity.

#### **1.3.1. Project Management and its influence in the organization of work**

Project Management maintains a “discourse around particular ideologies and also at the level of specific practices or techniques” (Birkinshaw, Hamel, & Mol, 2008: 826) aligned to Scientific Management. At least two lines of thought are critique with the appealing but deterministic nature of Project Management and its methods. On the one hand, in terms of organizational structure inconsistencies (Hodgson, 2004). In this way, Project Management inherits a notion of management similar to a mechanistic activity that remains at the most “influential in the design of the production processes” (Vallas, 2012: 42). And on the other hand, in terms of the limits of the rational approach in managing ambiguous projects (H. S. Jensen, 2008; 2011) as for instance in Project Management knowledge is considered to be a factor of production rather than a central source of value-creation (H. S. Jensen, 2008).

The work of Damien E. Hodgson (2004) argues that project-based organizations and Project Management methods were developed to manage a number of “irregular assignments”, or *projects*, not alienable to the organizational structure, in which organizations are increasingly involved. Hodgson (2004) affirms that Project Management was promoted as the organizing form of the post-bureaucratic organization. But the avant-garde structural shift of flexibility, empowerment, and autonomy “was [neither] accompanied by a corresponding shift in the mode of control exercised over employees” (Hodgson, 2004: 84) nor by a change in the mode of coordinating and planning the production process.

Project-based work was designed to deal with interdependent, complex and uncertain environments of the kind often encountered in organizations dealing with innovative and creative activities. And it was found to be the optimal way of bypassing organization’s boundaries permitting the development of activities that work in parallel to the organizational structure in order to favor an environment for innovation and creativity. Despite this, the methods of Project Management propose an organizing form not distinct from the traditional one which attributes an enormous risk in a model which stands up for the decentralization of control, flexibility of action or activity planning, and self-organizing individuals or teams. Thus, Project Management methods seem to be grounded in an inconsistency between “bureaucratic and post-bureaucratic ethos” (Hodgson, 2004: 96).

The increasing involvement of projects in organizations and the use of Project Management in managing these number of “irregular assignments”, influences the way in which the work is organized and introduces important dilemmas which affects the primary significance of the structure of an organization. The subject of the tensions the structure creates among project work and employees dealing with projects, suggest a change on the implications of the organization’s structure. The introduction of project-based work ruled with the methods of Project Management stresses the contemporary debate on the meaning of organizational structures and the interplay with the agency of the employees.

It is commonly accepted that the concern of the structure of an organization relies on the designation of the lines of authority and communication of the organization, and specifies the requirements of the organization work activity. The introduction of project work implies the redefinition of the influence ascribed to organization’s structures as it presents new meanings in the interplay of the structure of the organizations and the agency of the employees. For instance, some aspects of the project work cannot be explained through the rigid and functional categorization of the bureaucratic organization which most common dimensions are: rational production, continuous planning, work centralization, clear division of labour. This approach to organizational structure neither considers the agency of the employees nor the extended variety of work forms resulting out of them.

Moreover, the image of an organization structure is fixed and predetermines the workflow of action. However, reality is very objective and workers need to find adequate interpretations for an unpredictable amount of circumstances, usually broader than the ones included and predetermined in the structure. Many times, the researchers’ everyday work is misled by the structure. Disagreement in the structural and governance models of the organizations which are constituted by and depend on large numbers of highly specialized members, affects the coordination function of the organization (Lawrence & Lorsch, 1967; Crémer, 1993; Crémer, Garicano, & Pratt, 2007). Organizations structures “dramatically reflect the myths of their institutional environments instead of the demands of their work activity” (Meyer & Rowan, 1977: 304 cited by Alvesson, 1993: 1003).

To coherently articulate the implications of the presence of Project Management in the organization’s structure, a contemporary approach on the subject of the organization’s structure which includes the ways in which actors’ conceive and implement their actions is required to consistently link “structure and agency”. According to the theory of human agency developed by Mustafa Emirbayer and Anne Mishe (1998), the structure demands an ontology and methodology that is sensitive to the fact that all kinds of action (or in our subject, all kinds of work) are performed in specific contexts and the relevant aspects of these contexts can be conceptualized around the extended notion of time and space. Therefore, the agency of actors, with their past experience, their conception of the present context and their vision of the future are determinant to understand the aspects considered in the creation of an organisation’s structure, as well as the resulting tensions.

Agency is more and more central theoretical task facing contemporary organization theory (Barley, 1996). Even though, some studies criticizes that organizational studies

disregard the role played by human agency in organizations and denounce their consequences in the work context (Vallas, 2006; 2012). In the line of sociology of work a central premise is to bringing together the study of organizational structures and the study of work and occupations (Orlikowsky, 1993; Barley, 1996; Barley & Kunda, 2001; Bailey & Barley, 2005; Adler, 2007). Recent debates in Labour Process Theory emphasize on the social tensions and the professional and labour conflicts that emerged with the change in the work place introduced with the “flexible specialization” or post-fordist forms of work organization (Piore & Sabel, 1984; Vallas, 1999, 2006). Influenced by Marxist theory of production, Labor Process Theory claims that skills are the fundamental construct in the study of the production process, with complexity and autonomy as its two main dimensions (Braverman, 1974 cited by Adler, 2007). Labour Process Theory has been critical of control based methods and largely on the debate of its impact on the workers’ de-skilling of work, normative controls, and the colonization of workers’ identities by the organization (Vallas, 2012) leaving room for a wider debate on the distinct aspects of workers resistance to obey the structure under certain work activities, i.e the high expertise required to producing research intangible assets and proposing solutions to research problems; leads to a very subtle relationship to solving the conflicts grounded in the structure.

Contrary to what is expected in Project Management, project-based organizations result in having an impact on employees’ work enhancing autonomous and self-managed work groups (Manz & Sims, 1987) to cope with the ambiguity and instability that characterizes everyday work (Alvesson, 1993). Managing projects not only requires developing contingency plans around predictable scenarios but also needs to rise an “independent point of view about tomorrow’s opportunities and how to exploit them” (Hamel & Prahalad, 1994: 22). The idea of managing projects in order to give a response to the ambiguous future is strongly connected with the idea of freedom and flexibility (H. S. Jensen, 2011). Considering this, studies on organizational theory appreciate more to account for the “image of largely autonomous, self-regulating and self-perpetuating institutions, the altruistic members of which are filled with a desire to work for the common good in the most efficient way” (Brante, 1988: 122).

### **1.3.2. The Influence of Project Management in Scientific Research**

The deterministic nature of Project Management conflicts with the idea of scientific research as a creative and “intensely personal activity, strongly dependent on the ideas and imagination of individuals or groups of individuals” (J. Taylor, 2006: 2). While the classical idea of scientific research explicitly contains the idea of unpredictability, experimentation and freedom, Project Management aligns scientific research with the specificity of the goals, method refinement, measurement and productivity. This reveals the following tension in the management of scientific research: on the one hand, there is a connection to creativity and freedom of choice to foster discovery; and on the other hand, there is an idea of management as being grounded in rational control, planning, and the coordination of the production of scientific outputs. This tension is the opening statement of this doctoral thesis, which suggests



approaching the misconception between the way research is actually managed and the way research is said to be managed.

The management of nothing other than predictable and accountable activities connects Project Management to a narrow conception of project and its management that does not apply for research projects. Hans Siggaard Jensen (2008) reinforces the limitations of the rational approach of Project Management emphasizing the idea that highly specified projects are difficult to find in everyday life, at best “it is only possible to give fairly abstract specifications of [their] goals” (Jensen, 2008: 133) and operations. In another significant study on this subject Hans S. Jensen (2011) challenges the subject of the form of management that addresses freedom and creativity to deal with project ambiguities. In his article Jensen asserts that the research projects are formulated in very ambiguous terms and therefore in order to make room for the new we need to keep situations open and ambiguous and resist early closure (H. S. Jensen, 2011). Here he distinguishes creative from productive work that characterizes established activities of a project. The creative process requires suspending early commitment and avoiding incorrect interpretations.

Project Management refers to a project as a “temporal endeavor”, which requires a precise goal and which is framed by a triple constraint. The triple constraint consists of “scope”, “time/schedule” and “cost”. The scope of a project refers to the specific activities required to achieve the goal; the time/schedule to the work effort required by each activity included in the project; and the costs what must be planned considering all resources needed to complete the project activities within the scheduled time (Kerzner, 2013; Frame, 1994; Cleland & King, 1988). The result is that the methods of Project Management suggest few limitations when dealing with activities strongly linked to creativity and freedom while creative work activities suggest different managerial forms beyond control, stability, and predictability.

Considering both the tension research organizations deal with and the idea that research projects often present difficulties in providing specific descriptions of the goals, time, and costs, this doctoral work introduces two suggestions. The first suggestion is to widen the notion of projects introducing two types of projects. “Type one” are projects characterized by goal concreteness and predictability in all the stages of the project development. Following this logic, on the other side of the axis lies the other archetype of projects. “Type two” is characterized by the ambiguity of the goals and the difficulty of framing the project scope, schedule and costs. The second suggestion is related to categorizing and defining a project by its degree of goal concreteness or ambiguity, which suddenly broadens not only the conceptualization of projects but also offers new managerial possibilities. In short, this new ideal type allows us to include new forms of management. This new form of management should consider the idea that often projects are not specific or concrete, and that their development suggests unexpected paths that might deviate from the initial planning or further more from the initial objective.

Since Project Management obviates the categorization of alternatives to highly specified projects; it does not only limit the notion of projects to “type one” but more importantly, it

undermines its management to a predictable and accountable activity. In the scientific and research arena, the use of Project Management methods has introduced the idea of the predictability of the research goals to the contrary of what important philosophers such as Karl Popper would ever claim. Karl Popper (1957), in his book *The Poverty of Historicism*, clearly states his notion of science and research by indicating that “we cannot predict, by rational or scientific methods, the future growth of our scientific knowledge” (Popper, 1957: vii). Nevertheless, the powerful thought of predictability has significantly contributed to the reduction of the idea of managing research to the idea of Project Management.

It is acknowledged that today’s conception of scientific research broadly includes basic research<sup>3</sup> and applied oriented science<sup>4</sup> whose goals, tasks and time delivery is never concrete, and also includes technological developments<sup>5</sup> whose findings are almost predictable. This conceptualization of science and research demands not only for enlarging the notion of project according to its degree of goal ambiguity but also that different types of research orientations require different forms of management (Nadal-Burgues & Bonet, 2012).

In reality, research organizations end up holding extended and diverse types of research projects whose differences are not considered in the management of the research. And researchers customize their research projects using Project Management techniques, which are partly useful to manage the administrative development of a research project. An example of the work developed in a basic research project for a project manager, is to remind the researcher that there are some deadlines to be met and that there are some financial and legal issues that must be followed during the life of a research project. The latter is a familiar activity or task that relies under the responsibility of the project manager’s and it is the main connection between research management and project management.

The use of Project Management in scientific research results to be inadequate and insufficient for an overall management of research projects, centers and programs. Understanding the limitations of Project Management when managing research projects, which often involve freedom and creativity to overcome the ambiguities of a research proposal and the research process, are indispensable to recognize the importance of extending

---

<sup>3</sup> **National Science Foundation. Basic Research.** It is the systematic study directed toward fuller knowledge or understanding of the fundamental aspects of phenomena and of observable facts without specific applications towards processes or products in mind. It generates new ideas, principles, and theories, which may not be immediately utilized but nonetheless form the basis of progress and development in different fields. (Retrieved on February 2015 <http://www.nsf.gov/statistics/nsb1003/definitions.htm>)

<sup>4</sup> **National Science Foundation. Applied Research.** It is the systematic study to gain knowledge or understanding necessary to determine the means by which a recognized and specific need may be met. It is the practical application of science that deals with solving practical problems. (Retrieved on February 2015 <http://www.nsf.gov/statistics/nsb1003/definitions.htm>)

<sup>5</sup> **National Science Foundation. Developments.** It is the systematic applications of knowledge or understanding directed toward the production of useful materials, devices, and systems or methods, including design, development and improvement of prototypes and new processes to meet specific requirements. (Retrieved on February 2015 <http://www.nsf.gov/statistics/nsb1003/definitions.htm>)

the notion of project and, -consequently the notion of its management (Nadal-Burgues & Bonet, 2012).

#### **1.4. Type of Research Projects and its Management**

The present doctoral work adds to recent conceptually-based perspectives on the tension and it builds on the management of ambiguity, creativity and unpredictability. The tension between creativity and productivity research organizations deal with has been studied considering the limitations the methods of Project Management have to deal with projects with ambiguous goals, as Project Management only includes these types of project which have very specified goals. This contemporary debate was introduced in James G. March (1991, 1994) studies on the difficulty and importance of “understanding the choices and improving the balance between exploration and exploitation” (March, 1994: 238). Any effort to enhance organizational performance and reinforce its competitive advantage “involves adaptation and a delicate trade-off between exploration and exploitation (March, 1991:85). The Institutional and cultural perspectives characterize the differences between the two phenomena.

Moreover and far from carrying through an exhaustive evaluation of managerial patterns, this doctoral thesis encourages the importance of shaping a management approach that addresses freedom and creativity for dealing with a project’s ambiguities. Consequently, it approaches the management of projects connecting the importance of distinguishing the type of research projects researchers carry out with how the different typologies determines the form of managing them.

On the subject of an understanding of the different types of project research organizations deal with and the differences in their forms of management, at least two academic works should be pointed out for its contribution. Shantha Liyanage, Paul F. Greenfield, and Robert Don (1999) claim that the nature of the research project’s selection influences the way in which the research is managed. They distinguish between intuitive, purposeful and market-pull project selection. Intuitive research projects selection is developed under the conception of scientific freedom and few formal management techniques are required for the selection and evaluation of the projects. Purposeful project selection links operational and strategic management methods in order to shift to a science and technology that yields economic returns. And market-pull project selection is developed using the methods of project management, control and accountability being fundamental (Liyanage et al., 1999).

Arnold Wilts’s (2000) approach to organized scientific research is that research is “constantly integrated into existing schemes of recognized problems and accepted problems solutions” that at the same time “are the basis for the distribution of the resources that are necessary for the identification of relevant research problems and the production of new problem solutions” (Wilts, 2000: 769). In the context of university and non-university publicly funded research, two groups of economists were inquired concerning the organization’s strategy, financial organization and intellectual research orientation. Wilts’s

results suggest that the institutional structures in which research is embedded explain the differences among research projects, distinguishing between theoretically oriented research, which is freely chosen, and applied research, which is defined with very specific goals.

At the actor-centered organizational level, Wilts distinguishes three organizational types: (1) *Knowledge seekers* are research organizations that are not dependent upon external relations because they have guaranteed access to the necessary resources and freedom for identifying organizational goals and priorities. Individuals can pursue their personal goals. These goals should be related to acquiring reputation through the publication of theoretically or methodologically advanced contributions. (2) *Research contractors* are research organizations that are application oriented due to their external resource dependency, therefore their research goals, decision-making process or individual works are constrained and oriented towards externally valued research and contractors and funders may influence the general direction of the research. (3) *Service providers* are research organizations that do not have institutional autonomy; therefore, their goals depend mostly or even wholly on the influence of external agents, so individuals have little room for orienting their research towards personal goals that would diverge from organizational priorities. This holds for instances of R&D divisions in industry and in-house research divisions of government bodies.

On the subject of how different types of projects lead to different management forms is grounded on the study developed by Trevor J. Pinch and Weibe E. Bijker (1984) where they develop the idea of open and closure rhetorical periods for the development of new ideas. Their social constructivist approach to scientific and technological developments suggests that scientific and technological developments occur in two stages. In the first stage, different actors can attribute different meanings to the physical or conceptual objects they are working with. “Interpretative flexibility” is displayed until “consensus” is reached in the second or closure stage of development, where the initial controversies are “terminated” or resolved (1984: 409). The paper introduces the concept of rhetorical closure in which the resolution of a controversy can have two scenarios. One scenario leads to the rhetorical closure by converging the initial variety of meanings into a single one. The other scenario is closure by redefinition of a problem in which the meaning was translated “to constitute a solution to quite another problem” (1984: 428). Their paper is a departing point to consider and introduce rhetoric as a fundamental aspect of the creativity required in the development of scientific research and the design and development of research projects.

## **1.5. Objectives, theoretical Research Questions, and Conceptual Framework**

It is a manifested fact that many scientific research projects cannot fulfill the requirements of Project Management. While scientific research projects require creativity to be developed, Project Management methods involves a meticulous specification of the goal, constrains and operations for executing the projects, whose ideal is a mechanical performance. This discrepancy suggests inquiring into the development of new aspects

related to the tension between creativity and productivity. The results of this inquiry aim to improve our understanding on how research can be developed in very restricted environments, such as the context of an organization managed using the methods of Project Management.

The aim of understanding how creativity occurs in precisely specified projects subjected to the requirements of Project Management led to the formulation of the following objectives and research questions:

**First Theoretical Research Question:** How the execution of precisely defined projects and specifically precisely defined research projects involve creativity?

For answering this question this dissertation introduces the following conceptual framework.

**Conceptual Framework:** The concept of project adopted is the concept of “mental project”, introduced by Alfred Schutz (1953) to establish the philosophical foundations of interpretative methods in social sciences. The application of his notion of “mental project” is unprecedented in the context of management and managing research projects.

**Development of the Conceptual Framework:** This dissertation develops Schutz’s notion of “metal project”, which is a kind of hypothesis that the execution of the project can corroborate or falsify; the notion of “repeated actions”, which are similar to previously performed actions, and the notion of subactions, which can be combined for executing completely new actions.

**Creativity in Projects:** This three concepts develop in the conceptual framework are related to spaces of creativity or opportunities for creating or even challenges of creativity in well-defined projects. All of them requiring judgment.

**Second Theoretical Research Question:** What is the role of judgment in creativity and routines?

For answering this question this dissertation emphasizes the role of judgment in creativity and in creating and developing a routine, and introduces the following conceptual framework.

**Conceptual Framework:** The notion of routine is connected to the notion of “repeated actions”. This approach views a routine as similar to another action already performed, which makes clear, first, its relation with creativity. And the Kantian notion of judgment relates judgment to the faculty to distinguish whether something falls under a given rule. His view makes clear its relation with creativity and routines.

**Development of the Conceptual Framework:** In this sense the development of the function of creative judgment determines all the operations of the project and if the project is flexible enough it allows to can make adjustments according to what actually occurs during the act.

**Project Specification:** The introduction of the function of creative judgment in the execution of precisely specified projects to determine the adequacy of all the operations involved in a project suggests that a project may be either precise or ambiguous, or might

either be complex or simple to specify, what is significant is that this choice depends on what the actor considers to be relevant in each particular case and that not all the circumstances can be specified a priori regardless of whether an action is familiar or elaborated.

## **1.6. Summary**

Building on the present approach of scientific research and its management, which is based on the logical framework provided by Project Management and its methods, the present research contributed to the development of the conceptual differences between Project Management and the scientific research activity. The basic idea that project-based work was introduced to manage an increasing number of irregular assignments, often encountered in environments where ambiguity, complexity and uncertainty could be high is aligned with the particular nature of scientific research and the outcomes it produces. However, the notion of project contained in Project Management clashes with the idea of scientific research as a creative activity strongly dependent on the agency and freedom of the researchers, and is also limiting the scope and influence of the managerial functions to deal with static, predictable and accountable activities. This tension is the opening statement of this doctoral thesis, which suggest that there is a misconception between the way research is actually managed and the way research is said to be managed.

This context suggested the development of a wider notion of project, which includes the variety of projects that we could encounter either in everyday life or in the context of scientific research, and that goes from very specified to very ambiguous. This early notion of project gives a new meaning of the tension between creativity and productivity. Since it distinguishes that the differences on the specificity or concreteness of the goal require different forms of management able to cope with the project ambiguities. This categorization not only includes all the spectrum of projects but it is in agreement with the form of management that considers rhetorical openness and closure as the manner to disambiguate and specify research projects. The idea of open and close rhetoric and stages of development introduces the manner in which projects are specified, where the means of rhetoric are used to specify the project's tasks and goal. This allows demarcating the application of Project Management and its methods when tasks and goals are specified and in the open stages of development creativity or flexible interpretation are involved to disambiguate the relevant project activities, tasks and operations.

## CHAPTER 2

### THE CREATIVE ASPECT OF ROUTINES

*“One cannot search for something unless one knows what one is searching for. But plausibly one cannot know what one is searching for until one has actually found it.”* .- Plato's Paradox

The following chapter retrieves and collects the relevant literature on the subject of creativity. The study of the literature on creativity includes two main perspectives that focus on the study of the components of creativity –the person, the process, the product and the place. The uniperspective view examines discretely the four components of creativity and the multiperspective view studies the interaction between some of the components.

The prominent increase in the number of creativity studies is linked to the idea that creativity in general is perceived to be crucial for economic growth and societal development, and concretely, is considered to be critical for organizational competitiveness and survival. Since 1980 there has been a notorious increase in the growth of scientific publications in creativity, across a variety of disciplines, “whole journals dedicated to the unpacking of the sources of innovativeness and creativity” (Salaman & Storey, 2002: 147) and also many new academic conferences (Paul & Kaufman, 2014). Besides the increase in the production of knowledge on creativity, the understanding and development of this subject remains inconsistent and highly fragmented within disciplines, methods, and perspectives which show in many cases either contradictory results or very complex models.

Several management disciplines, such as accounting and control management systems, seized on the importance of dealing with subjects implicit in the management of creativity. Without altering their foundations, they propose new methods to face a new organizational context. Their methods promote creativity and control simultaneously, ensuring the selection, development and efficient execution of new ideas. Other creativity studies have been challenging some of the core functions in management –specialization, authority and control. All of them have been stimulating the debate among the tension between creativity and productivity.

Different from previous studies, this chapter introduces new aspects of the tension between creativity and productivity by looking at organizational routines. Organizational routines are considered the fundamental unit of analysis in organization studies. The idea that routines are not mere mechanical actions, but they involve judgment to be created, accomplished, resisted or changed, allows aligning routines to creativity.

## 2.1. Approaches and Methods in the Study of Creativity

In the ancient times the concept of creativity was associated with the mystical power. During the Renaissance, the connection of creativity with supernatural powers was abandoned and initially creativity was ascribed to extraordinary genius and innate talent. Later it started to be linked to an educated talent. In the Enlightenment, intense debates about individual freedom and institutional authority led to coupling creativity with freedom. Thus, both talent and genius could only be advantageous in a society with free man. This shift of focus “grew out of discussions and arguments regarding the basic nature of the human being when released from institutional doctrine” (Runco & Robert, 2010: 4). The late nineteenth and twentieth centuries saw the study of creativity with the methods of natural sciences and its conceptualization spread towards many disciplines, as well as it has been enriched by a large variety of perspectives and methods.

The disciplines involved in the study of creativity ranges from psychology, cognitive science, education, philosophy of science, technology, sociology, linguistics, artificial intelligence, and economics to management. The study of creativity initially progresses towards measuring the individual and procedural aspects involved in such a complex phenomenon. Recently, new theoretical perspectives and some methodological changes have been introduced to handle the contradictory assessment of some studies in creativity by integrating some of the most relevant theoretical perspectives. The uniperspective views distinguish between the following components of the study of creativity: the person, the process, the product, and the place. And recent multiperspective views attempt to offer “a more promising study of creativity than do the uniperspective views” (Sternberg & Lubart, 1996: 667) as they study the interaction between several components of creativity. The diversity of perspectives and methods in the literature of creativity indicates the importance of the subject but also raises some controversies in the development of the field (Mumford, 2003).

However, broadening the fields, perspectives and methods of study of creativity also raised a controversy around its definition. Nowadays the most accepted and used definition of creativity in management research includes two key elements: originality/novelty and functionality/utility. Meaning that an object or an idea is creative if it is original and functional (Woodman, Sawyer, & Griffin, 1993; Amabile, 1996b; Mumford, 2003; Simonton, 2010; Feist, 2010). The functional element carries at least two epistemological controversies extensively discussed in philosophy of science. The first is that not all discoveries present obvious utilities at the time of their discovery. And the second is that many times the purpose of the creative person is not utility oriented. For instance, in this sense some researchers in the field claim that in science “any suspicion of utility would have restricted his [the scientist] restless curiosity” (Flexner, 1939: 546). Further research on the subject of functionality emphasizes that the value of a creative object or idea cannot be assessed without considering the time in which it is presented (Paul & Kaufman, 2014). The controversy generated by the definition of creativity introduces the fragmented views of creativity. The different views



increase, improve and refine the understanding of some of the aspects that are involved in the creativity phenomenon.

Theoretical approaches to creativity are organized in four main components that define their scope; they are referred as –the person, the process, the product and the place.

### *The person component*

The person component considers the personality traits “that might be indicative or contraindicative of creative potential” (Kozbelt, Beghetto, & Runco, 2010: 25). Psychology is the foremost scientific discipline inquiring into the creative phenomenon looks at the attributes or personality traits of creative individuals. Psychologists search for “the unique and relatively enduring set of behaviours, feelings, thoughts, and motives that characterize an individual” (Feist, 2010: 114). The primary method used by research on creativity was based on the study of famous individuals’ biographical material. These materials fairly assemble a set of core personality characteristics of creative individuals (e.g. MacKinnon, 1962).

Furthermore, the search for the correlation between personality and creativity led to the creation of instruments that attempt to measure the creative potential of individuals or the personality traits that promote creative thinking. The Intelligence Quotient (IQ) tests were introduced during World War I to select recruits for developing different tasks in the war. The creativity tests were introduced in World War II to recruit pilots able to react imaginatively to emergencies. Joy Paul Guilford was the psychologist who created, what in 1950 would be known as, the Divergent Thinking test (Csikszentmihalyi, 1996). The objective of psychometric tools is measuring the personality traits that distinguish creative people from non-creative ones. With this purpose, “The Torrance Tests of Creative Thinking” (TTCT), created in 1990 by Ellis Paul Torrance, correlates individuals’ personality to creativity. The TTCT provides a creative index (CI) scoring for the following dimensions: “flexibility, fluency, originality, elaboration, abstractness of titles, and resistance to premature closure” (Kim, 2006: 5).

In a meta-analysis of the literature of the personality-traits components associated with creativity, Gregory J. Feist (1998) concluded that “in general, creative people are more open to new experiences, less conventional and less conscientious, more self-confident, self-accepting, driven, ambitious, dominant, hostile, and impulsive” (1998: 290). The variety of methodologies attempting to produce a list of the creative personality-traits did not reduce the discrepancies in the field. Some of the differences were explained showing the differences across the fields associated with creative personality. For instance, according to Arnold M. Ludwig (1998) creative people in domains or “professions that require more logical, objective, and formal forms of expression tend to be more emotionally stable than those in professions that require more intuitive, subjective, and emotive forms” (1998: 93). Furthermore, he affirms that this pattern can be also applied when observing people from the same domain but performing different types of work. “Although [the] person-centered approach yielded important findings about the backgrounds, personality traits, and work styles of outstanding creative people (e.g. Barron, 1955, 1968; MacKinnon, 1962; 1965), it was limited and limiting” (Amabile, 1996b:1). The limitations of the personality-trait

approach are related to the fact that the list of traits that are unique and important at one place and time might be irrelevant at another place and time. Therefore, it is not suitable to focus on building a stable list of traits describing a creative person (Wallace & Gruber, 1989).

The difficulties that the personal-traits component encountered to offer a coherent inventory of attributes of the creative individual attracted new disciplines, approaches and methods to work in the field of creativity.

### *The process Component*

The process component has been largely studied in the field of cognitive sciences. Cognitive sciences focus on understanding the processes beyond the mechanism of thought - creative thinking, reasoning and problem solving. Thus the studies on the creative process aim either at understanding the sequence of actions or thoughts that leads to novel productions (Guilford, 1950; Kozbelt, Beghetto, & Runco, 2010). Since almost a century ago, Graham Wallas' (1926) book, *The Art of Thought*, has been the most influential scheme among scholars aiming to deliver a pattern of actions or stages of the creative process. Wallas (1926) supported the idea that the creative process involves seven stages: encounter, preparation, concentration, incubation, illumination, verification and persuasion. Wallas's model inspired many others models whose differences are either based on a reduction on the number of stages of the creative process (e.g. Barron, 1988) or a change on the name of the stages looking for analogical differences in the process of creativity (e.g. Koberg & Bagnall, 1981).

Cognitive studies also question whether creativity is only a function of the personality. They claim that since creativity is a product of the mind, cognitive studies also involve the search of an understanding of the roles of cognitive mechanisms in creative thinking. In this sense, former studies claimed that creative process involves divergent rather than convergent thinking mechanisms. Divergent thinking includes aspects like fluency, flexibility and originality to elaborate novel ideas while convergent thinking aims at finding a single solution using logical-deductive mode of thought (Guilford, 1950). Divergent thinking is a powerful tool, though not one exempt of controversy as they do not offer a mechanism to distinguish between a good or a bad idea (Csikszentmihalyi, 1996). Other scholars, building on the cognitive process of creativity, isolate "one specific aspect of the thinking and investigate it" (Dunbar & Fugelsang, 2005: 708). Cognitive studies also look intensively at the ability to associate distant ideas to achieve a creative solution (e.g. Mednick, 1962) and analogies. Analogies are the symbolic human ability to identifying patterns and relating them. Since the times of Plato and Aristotle, analogies have been considered an important aspect of human thinking in areas as diverse as problem solving, decision-making, explanation, and linguistic communication<sup>6</sup>. According to Douglas Hofstadter (2001) in his epilogue to *The Analogical Mind*, analogies are at the core of human cognition.

---

<sup>6</sup> *Stanford Encyclopedia of Philosophy. Cognitive sciences. Analogy.* Retrieved in February 2014 from <http://plato.stanford.edu/entries/cognitive-science/#ForLog>

Analogies are cognitive process, constantly used by scientists, which explains the accumulation and refinement of scientific development, or to put it in Kuhnian<sup>7</sup> terms, analogical processes are most used by scientists in periods of “normal science” as they are great instruments for reconfirming an existent paradigm. Kevin N. Dunbar's (1997) longitudinal and *In Vivo* study on cognitive creative processes in scientific laboratories contributes to the understanding that the small transformations of concepts that later on will lead to major scientific discoveries occur due to analogy and distributed reasoning. These mechanisms underlying creative cognition are involved not only in moments of conceptual change but they are also involved in more ordinary aspects of scientific activity. According to Dunbar, the conceptual change is the result of tinkering, which involves many incremental steps. Differing from other scholars in his field, he affirms that distant analogies, those that are not closely connected to the scientists' disciplines, are rarely used in scientific labs. And using *In Vitro* methodologies to study the creative process incorrectly foregrounds distant analogies and insights as an explanation of the creative process while simultaneously preventing the observation of the cumulative process of scientific discovery. Analogies, though, are then a well-known rhetorical tool and are placed at the core of our thought processes.

The common ground of the creativity literature focusing on the individual “tend[s] to locate creativity primarily in some special psychological processes or traits, or in some special creative act” (Briskman, 2008: 83). The shared point of view is to look at both approaches as significant sources of creativity but to accept that neither is sufficient to explain it. It seems that they can explain some of the fine aspects involved in creativity but when they attempt to get a more complete explanation its results are too complex to deal with.

#### *The product component*

Considering the limitations of the individual components, the advocates of the product component claim that the psychological processes and personal traits *per se* cannot show any creative output as it is only the product that provides objective evidence of what can be considered a creative process or person (Ford, 1996; Simonton, 2004; Kozbelt et al., 2010). The product component of creativity is strongly tied to the idea that creativity is attached to its functional value and considers the steps through which a product or service comes into existence (Busse & Mansfield, 1980; Mumford & Gustafson, 1988; Briskman, 2008). The product is considered a unit of cultural transmission which provides information about the creative ideas framed as successful and contributes “to create the psychological state of the creator” (Briskman, 2008: 93).

---

<sup>7</sup> *Thomas Samuel Kuhn (1922-1996)* was an American philosopher who in “*The Structure of Scientific Revolutions*” (1962) claims that scientific development consists of long periods of refinement, where scientific discoveries follow a predictable pattern initiated after a change in the scientific paradigm. These periods of *normal science* establish a set of norms and standards used for those studying a certain field. A “paradigm shift” open up new approaches to what is considered valid.

The product component has been frequently used as a link to innovation studies developed in the fields of management, technology and engineering. They focus on the fact that organizations might compete applying knowledge already existing in one field into another field, or they might be transforming organization's existing knowledge to matching customer needs or customer requirements (Horn & Salvendy, 2006). In both cases, the creative product is created and obtained through transforming the existing knowledge into something valuable for the customer. The product approach situated creative products as conceived from what it already exists (Briskman, 2008; Weisberg, 1992; Bailin, 1988). Moreover, the form in which we think is not what is creative, what is creative is what the thinker has produced (Weisberg, 1992). Hence, the product component strongly supports the idea of apprenticeship to being able to produce something creative, but it denies the connection of creativity with more abstracts views.

### *The place component*

The place component is the stream of the research in creativity that started to focus on the external determinants in which creativity is nurtured –degrees of autonomy and flexibility. They stressed the idea that the quality traits and cognitive processes of individuals do not fully explain the creative phenomenon as the social, cultural and work environment determine creative thought and action (Simonton, 1975). Consequently, creativity was then also considered a function of the social and physical environment (Amabile, 1983, 1988; 1996b), sometimes referred to as the place component. Dean Keith Simonton (1975), was the pioneer of this approach and with the use of historical data and historiometric method, he studied the social, cultural and political factors affecting creativity. These studies developed a macro theory of the social psychology of creativity while influencing many other scholars. Social psychologists argue that creativity is the result of an interactive process between environmental constraints, such as the availability of resources, the support of family and friends, social reward and recognition, flexibility and freedom. But also it is a result of a micro interactive process with other individuals, such as motivational orientation, peers, coworkers or evaluators that support your ideas (Amabile, 1983).

The environmental component of creativity led to the rise of instruments for assessing the work environment for high creativity performance (e.g. Amabile & Gryskiewicz, 1989; Amabile, Conti, Coon, Lazenby, & Herron, 1996). Since, 1990's, many management researchers were looking for environmental factors within the organization that might affect individuals' creative contribution. Creative studies in management suggest that key environmental factors to foster creativity are: freedom, positive support and challenging activities. And that intrinsic motivation is a mediator of creative performance (Amabile & Gryskiewicz, 1989; Amabile et al., 1996; Amabile & Conti, 1999).

### **2.1.1. Confluent approaches to creativity**

From the initial inclination of studying each of the creative components separately a new trend emerged and confluent approaches to creativity were introduced. The social psychology of creativity brought new possibilities to the study of creativity. In 1983, Teresa M. Amabile

was pioneering the introduction of an integrative approach to creativity known as “the componential theory of creativity and innovation” (Amabile, 1983; 1988). The componential theory of creativity links the social environmental component of creativity with three within individual components: (1) domain-relevant skills, such as knowledge, expertise, intelligence and talent associated with one’s area of work; (2) creativity-relevant processes or skills, such as suspend judgment, self-discipline, autonomy and risk-taking attitude; and (3) intrinsic task motivation or task orientated motivation. She considers intrinsic motivation as a mediator necessary for creative performance since the lack of motivation would kill both domain and creative skills (Amabile, 1983; 1988). Intrinsic motivation occurs when individuals perform an activity that is interesting and satisfying to them. It is feeling passionate about the tasks you are performing. Thus, individuals enrolled in tasks aligned to their intrinsic motivation are more creative. Hence, certain environments might nurture or inhibit individuals intrinsic motivation therefore, creativity (Amabile, 1983; 1988; 1996a; 1996b; 1997).

Richard W. Woodman & Lyle F. Schoenfeldt, in 1990, propose a multilevel model to creative outcomes. The “interactionist model of creative behavior” which “combines elements of personality, cognitive, and social psychology perspectives on creativity” (1990: 280). Different from Amabile’s componential model, their model assimilates the reciprocity aspect of social interaction. The interactionist orientation comprises elements of the past and the present situation of the individual such as individuals’ personal antecedents or biographical variables, the current gestalt of attitudes and the personality dimensions. The social interaction is contained in the feedback the individuals receive from any social context. Their model assesses that the individual component, the individual’s social experience and the contextual influences of the environment are the elements that facilitate or inhibit the accomplishment of the creative activity (Woodman & Schoenfeldt, 1990).

In 2004, Dean Keith Simonton, in his book *Creativity in Science: Chance, Logic, Genius and Zeitgeist*, differed from both the componential and integrative models. He did not aim at integrating several components but he took four different perspectives of creativity and tried to merge them into a single one. The four possible perspectives of scientific creativity offering a distinctive outlook on the scientific phenomenon are: first, the logic approach, which with the use of the hypothetico-deductive method assures scientific creativity because it depends on the scientist mastering the logic of science and the substance of a particular discipline. Here there is a small confusion between the logic of discovery and the logic of justification. Empirical sciences refer to logic of justification -that is confirmation or falsification of theories, not of this one of discoveries.

Second, the genius approach, which focuses on the idea that personality characteristics can operate as valid predictors of creative achievement and that there are cognitive processes that not everybody possesses. These processes are often more illogical than logical because they suggest big cross-cuts from the resulted using inductive or deductive methods. Third, the chance approach refers to discoveries that were unintended but that cannot occur without cognitive and dispositional attributes as the ones of the genius. Finally, the fourth approach is the “zeitgeist”. This approach is far from the sociocultural determinist idea of creativity, which claims that scientific discovery is contextually determined, hence that the individual

characteristics and talent does not count. Here “zeitgeist” is considered an important aspect of creativity in terms of the time ideas are socially accepted. But it does find the sociocultural determinism limiting as it does “reduce the being to a mere agent of zeitgeist” (Simonton, 2004: 11) and also it is contrary to chance. The integration of these four perspectives raises many difficulties as the approaches within themselves offer several controversies, and moreover, many discrepancies among them. In order to integrate them, Simonton proposes that “both genius and zeitgeist are contingent on chance” (2004: 96). Thus, “creativity functions as a random combinatorial process. Nonetheless, not every type of creativity is equally probabilistic” (2004: 100) due to the differences in the constraints, rules and standards of each field being scientific creativity has more constraints than artistic creativity.

### **2.1.2. Systems approach to creativity**

With the publication of *Society, Culture and Person: A Systems view of creativity*, in 1988, Mihaly Csikszentmihalyi introduced a systems theoretic view of creativity that represented an alternative analysis of the common components of creativity based on an evolutionary and holistic view of the phenomena (Csikszentmihalyi, 1988). In his model, he does not only examine the cognitive processes and the social milieu very present in previous models but he also includes the symbolic system or cultural domain. In his book, he defines creativity as an act, idea or product that modifies an existing domain into a new one and he focuses on individuals that have contributed to modifying certain aspects of our culture. He claims that “creativity is the result from the interaction of a system composed of three elements: a culture that contains symbolic rules, a person who brings novelty in the symbolic domain, and a field of experts who recognize and validate the innovation” (Csikszentmihalyi, 1996: 6). He concludes that an individual who is willing to be creative should internalize the rules of a domain (the cultural context), but at the same time the selection criteria and the preferences of the field (the social context) that understand the domain to which she is willing to creatively contribute. This evolutionary metaphor stresses the tension between the messages received from the individual’s intuitions, the preferences of the field and the evaluations of the domain.

Csikszentmihalyi’s study is a starting point for the development of the rhetoric of creativity as he describes the interaction between the creative individual and the field of experts that will evaluate the individual’s idea. The individual introduces a variation in the field and the experts from a familiar domain evaluate it, and finally, reject or select this variation. If it is selected it will be retained as part of the elaborations of the domain and becoming part of the repertoire of actions within the domain (Ford & Gioia, 2000). If it is rejected there will be no variation in the domain. In the same line of thought, Herbert A. Simon ironically claims that “from time to time, human beings arrive at ideas that are judged by their fellows to be both novel and valuable” (Simon, 1983: 4569). Csikszentmihalyi (1996), as well as other researchers on creativity (e.g. Amabile, 1983; Simon, 1983; Woodman & Schoenfeldt, 1990; Ford, 1996; Ford & Gioia, 2000; Simonton, 2004), place the concept of judgment as a social interaction taking part in the creative process.

The integrative approaches successfully merge the individual perspective with the social milieu. The social interaction is viewed as an evaluative stage in which the individual's creation meets with the group of experts who are going to evaluate and validate her creation. Whereas previous studies have usefully included the social evaluative aspect of judgment to better understand the creative act, there is room to further develop the incipient view of the rhetorical dimension of creativity at the individual level and broaden the notion of judgment. Hitherto, creative researchers have never fully disclosed the fact that the rhetorical and judgmental activities not only occur at the social level but also occur at the level of the individual. At the level of the individual the rhetorical and judgmental activity represents a fundamental source of creativity and contributes to the understanding of how creativity unfolds even in constrained environments.

## **2.2. Creativity in Management**

The increasing demand to develop new products, services and processes has dramatically diminished the product life cycles and has forced organizations to pursue creativity. Creativity is also considered an important asset for the development, performance, success and sustainability of organizations (Anderson, Potocnik, & Zhou, 2014). In the organizational context creativity is widely defined as the production of novel and useful ideas, products, processes or services by individuals (Woodman et al., 1993; Amabile, 1988) which are implemented through innovation (Amabile, 1996a; Ford, 1996). Innovation and entrepreneurship literature are linked to creativity since for innovation researchers, creativity is present in the alternative generation phase, but it can also occur during the adoption and retention phases (Woodman et al., 1993; Amabile, 1997; Ford, 1996). And also, due to the need of organizations and entrepreneurs to pursue opportunities beyond their resources at hand (Amabile, 1996a).

The study of creativity in management initially included the developments of organizational behaviorists, followed by social-psychological research, and most recently confluential perspectives, which entail the exploration of the set of factors that influence creative performance in the work place. This multilevel research, such as *the componential model for creativity and innovation* (Amabile, 1988) and *the interactionist model of organizational creativity* (Woodman & Schoenfeldt, 1990; Woodman et al., 1993), strongly influenced most of the research in the field. Evolutionary perspectives in management sciences were introduced by Cameron M. Ford (1996) with his theory of individual creative action in multiple social domains. He defines creativity as a domain-specific social construction “used to describe actions embedded within particular contexts” (Ford & Gioia, 2000:707). His theory is rooted in Csikszentmihalyi's (1988) systems approach of creativity that, as previously said, conceptualizes the interactions between individuals, field and domain subsystems. Ford includes a theory of action that expands Csikszentmihalyi's approach including the processes of an intentional individual. The individual's intentions are divided into creative acts and habitual acts. With this he finds an explanation to the introduction and

development of variations and also selection processes in multiple social domains (Ford, 1996).

According to the field development, in the first place, organizations engage in processes of employing individuals who have creative-related skills. Employees' creative-related skills are those of being "flexible, adaptive, imaginative, and able to tolerate ambiguity" (Puccio & Cabra, 2010: 147). In the second place, they concern about the effects of the social environment on creative performance. The effects of the organizational environment rapidly connected with the core subjects in management, such as employee supervision and leadership. Similarly to individual determinants, the effects of the organizational environment "have culminated in lists of attributes of the work environment that are believed to have profound influence on employee creativity" (Puccio & Cabra, 2010: 151). For instance, on the subject of employee supervision, creative studies suggest that organizational contexts that support trust, positive feedback, flexibility, and autonomy enhance employee self-determination, self-esteem, and personal initiative at work. These contextual traits are allied with intrinsic motivation, and they result in an increase in creative performance (Deci & Ryan, 1987; Amabile & Grysiewicz, 1989; Oldham & Cummings, 1996; Scott, 1995; Yahya & Goh, 2002). Studies on leadership emphasize the correlation between creative performance and leaders that nurture rich interpersonal relations, motivate learning and co-operation among the people in the organization. Creative leaders also allow subordinates frequent interaction while supporting their own decisions (Amabile, Schatzel, Moneta, & Kramer, 2004; Shalley & Gilson, 2004; Byrne, Mumford, Barrett, & Vessey, 2009).

These research studies reasonably introduced a set of core aspects related to the creative organization, which in many cases entail a curvilinear relationship, meaning that those aspects initially make creativity rise, and then fall. For instance, to enhance creative performance high levels of intrinsic motivation seem to be needed however, too much intrinsic motivation can produce "panic attempts at immediate solution" (Steiner, 1971: 19). Furthermore, freedom of choice and method of pursuit increases creativity performance however, too much freedom can put the "organization at odds with the demands of maximum creativity" (Steiner, 1971: 26). The U-shaped relationship shows the tension between creative and productive dynamics commonly found in organizational contexts and they consider the elements of the tension as competing with each other.

Despite this, creative studies are challenging and questioning traditional organizational and management approaches. For instance, decision-making studies are now connected to creativity through the benefits of intuition and trust. In traditional analytical decision-making environments, intuition and trust are not considered part of decision-making processes. But in some other contexts, intuition is often used and is ever an imperative when information and time are scarce, and ambiguity is high; this is a common situation in organizational settings. Intuition in this sense helps to take the decision by amassing the individual's experience to quickly give a reasonable answer to abstract situations (Barnard, 1938; Simon, 1987; March, 1994; Sarasvathy, 2001; Erik Dane & Pratt, 2007). As well as intuition, trust shows promising results in mitigating risk and facing ambiguity. Trust is often involved in



creative contexts in processes of idea generation and evaluation (Klimoski & Karol, 1976; Korsgaard, Schweiger, & Sapienza, 1995; Ford & Gioia, 2000).

Several management disciplines, such as accounting and control management systems, seized on the importance of dealing with subjects implicit in the management of creativity such as uncertainty, innovation and change. Without altering their foundations, they propose new methods to face a new organizational context. Management control systems literature affirms that their methods promote creativity and control simultaneously, ensuring the selection, development and efficient execution of new ideas (Simons, 1995; Ditillo, 2004; Davila & Ditillo, 2009; Adler & Chen, 2011). Within their framework, they provide evidence of the coexistence of creativity and productivity. Meanwhile the opposite stream of research rejects this idea and claims that these methods undermine the freedom required to perform under uncertainty (Argyris, 1990; Amabile et al., 1996; Amabile, 1998) as management control systems “are not able to account for the full complexity and uniqueness of a given context” (Argyris, 1990: 503).

The disconnection between the two streams of research led to an attempt by Paul S. Adler and Clara Xiaoling Chen (2011) to conciliate management control systems and the motivational mediator of creativity developed by Teresa M. Amabile (1988) by introducing an integrative model along 15 propositions. This integrative model suggests that management control systems can be facilitators of creative activities in an organization since they include the coexistence between intrinsic and identified forms of motivation and the coexistence between individual’s independent and interdependent self-construal. The combinations of every form and subject of motivation are fostered through an appropriate mix of policies and management control systems design (Adler & Chen, 2011).

The field of creativity management grew out considering organizational context and individual’s behavior as sometimes an inhibitor and sometimes an enabler of the creative act. The differences in the results are rooted in the differences in the research approach and target. While the management control systems literature focuses on efficiency and productivity, based on control, concrete task breakdown, and division of labor; the latter focuses on worker motivation and self-determination whose goal is to influence management processes. With such variability, the conciliation between both streams of research turns out to be difficult due to the differences in some fundamental management subjects, such as specialization, authority, and control.

### **2.2.1. Specialization, Authority and Control**

Specialization at work is commonly led by concrete task breakdown and division of labor facilitating the design of an organization’s structure or a project. During the industrial era specialization has been linked to efficiency and productivity maximization. However, the intensification of expertise in post-industrial organizations has led to important changes in the organization of work. Post-industrial organizations are commonly related to scientific and research expertise. Expertise refers to the technical, procedural and intellectual knowledge and it has been shown to be one of the three components of the creative function (Amabile,

1983, 1996, 1998). With this, the subject of specialization, which implies division of labor, is also bonded to the creation of something new, because expert knowledge or the knowledge of a domain is required to undertake not only complex, but also creative activities.

Critics of bureaucratic and structural approaches stand in an ambiguous relation to expert knowledge and this suggests that specialization is seen an inhibitor of creativity as highly specialized organizations are deficient on intra-organizational cross unit contact and the cross-fertilization of ideas (Cummings, 1965). In this line of thought, Matt Alvesson (1993) dismisses the possibility of linking expert or formal knowledge with creativity as organizations requiring formal knowledge are not looking for creativity because it is the absence of knowledge what requires individuals to be creative (Alvesson, 1993).

The difficulties of both critics and advocates in rejecting or including specialization as a component of the creative process points towards a never ending conflict. The division of labor, specialization, and expertise are connected to bureaucratic organization and hierarchical structures which at the same time are thought to maximize productivity rather than fostering creativity. In an attempt to reconcile the tension between creativity and productivity, organizational researchers have flattened out organizational structures providing experts with a greater responsibility for decision-making and facilitating creative spaces. Additionally, organizational structures allow experts to gather around in project teams to develop highly technical, procedural, and intellectual tasks (Knights, Murray, & Willmott, 1993) which are momentarily not aligned to the operational or structural goals. The shift in the distribution of knowledge within the organization suggests a shift in the common understanding and aim of organizational structures. Nevertheless, the increase in responsibility for decision-making does not correspond with being situated in the upper levels of the organization's structure. This mismatch provokes some tensions between organizational structures and the agency of the employees, which results in becoming empowered by the expertise of the employees. The way in which the work is organized and in the roles of the employees skirts around the need to deal with these changes as it affects the supervision patterns and meaning for action.

Organizational structures in knowledge-intensive or expert organizations, such as research organizations, have difficulties in capturing both a stable and clear repertoire of their work practices as well as a pattern of the distribution of knowledge. Since, "authority of expertise and authority of position would less seamlessly coincide" (Barley, 1996: 409), more complexity in the knowledge held by the actors in the work activity is readily aligned with more autonomy (Braverman, 1974). Accordingly, significant relationships are found between freedom, autonomy, and the development of challenging activities. Also, challenging activities have been strongly connected with motivation and employee creative performance (Amabile & Gryskiewicz, 1989). Research on creativity suggests that control and evaluation systems impede creativity as they are aligned to organizational structures, which are designed to provide stability and predictability in the production process. However, management control systems' literature emphasizes the importance of control and evaluation systems as they procure organization's strategic alignment, which is not at odds with creativity (Simons, 1995; Davila & Ditillo, 2009; Adler & Chen, 2011).

Far from being the objective of this doctoral research to advocate for one or other stream of research, we consider to progress in the line of Mats Alvesson (1993) who suggests that knowledge and expertise is “an element of many occupations, the focus of knowledge - rationality-predictability of outcomes distracts from the more important qualities of skill, creativity, judgment, and *savoir faire*” (Alvesson, 1993: 999). This idea underlines a fundamental subject behind the aspect of specialization and considers the fact that different types of the work result in different patterns of workers’ responses to authority and control which might require different management forms related with freedom and creativity. As suggested in the first chapter, rhetoric is a fundamental management function. Through the means of rhetoric we not only scope our goals and guide our actions but also interpret situations and communicate them to lead others’ actions regardless of the authority position given by an organizational structure. The rhetoric of management also copes with the uncertainties held in the dispersion of individual knowledge to lead expert teams and projects.

### **2.3. The Bond of Routines and Creativity**

Despite the intense academic interest in the study of the organizational aspects that foster creativity, few creative studies develop the subject of organizational routines and its function in creativity. Organizational routines are considered a central aspect in organized work and the fundamental resources through which organizations accomplish what they do (Cyert & March, 1963; Segerberg, 1985; Feldman & Pentland, 2003; Becker, 2004). Since the 1980’s, they have been viewed as a fundamental aspect to understanding organizational change (Nelson & Winter, 1982). Hence, initially evolutionary economics and organizational research have explained the role of routines on economic and organizational change and stimulated their study. These perspectives studied the variation of organizational routines through processes of adaptation (Cyert & March, 1963) and mutation (Nelson & Winter, 1982).

Routines were early referred to as “recurrent patterns of behavior” (Cyert & March, 1963; Nelson & Winter, 1982; Gersick & Hackman, 1990). Considering this, organizational routines are often regarded as including “the forms, rules, procedures, conventions, strategies, and technologies around which organizations are constructed and through which they operate. It also includes the structure of beliefs, frameworks, paradigms, codes, cultures, and knowledge that buttress, elaborate, and contradict the formal routines. Therefore, routines were considered “independent of the individual actors who execute them and are capable of surviving considerable turnover in individual actors” (Levitt & March, 1988: 320). Further research on this perspective introduced the flexibility effect of external factors and viewed routines as automatic functions, “preserved and perpetuated patterns of behavior until some extraordinary event occurs, they are self-sustained” (Gersick & Hackman, 1990:71).

This notion of routines suggests three specific features to “enable bureaucracies to organize expertise and exercise power efficiently” (Feldman & Pentland, 2003: 94). First, routines are relentlessly related to the coordination of task performance, standard operating

procedures and decision rules (Cyert & March, 1963). Second, they help to predict others' responses by perpetuating certain patterns of behavior (Cyert & March, 1963; Gersick & Hackman, 1990). And third, they have been viewed as based on scripted or mindless behavior (Ashforth & Fried, 1988). Consequently, they are viewed as a source of stability, inflexibility, predictability, and regularity appropriate in organizational contexts focusing on efficiency and productivity. As a consequence of this routine approach, researchers on creativity view routines as an obstacle to creativity, since they are inhibitors of the intrinsic motivation necessary for creative performance (Amabile et al., 1996; Amabile, 1997). Routines are thought to private the chances of experimentation or exploration; consequently, they can reduce innovation and the creativity of the members of the organization or group. Routine work is viewed as conflicting with creativity which is viewed as "nontraditional ways of responding to the group's task" (Gersick & Hackman, 1990:73)

It is implicit in each stream of research the idea that routines led to mere mechanical actions, similar to the work of a machine. This is analogous to affirming that individuals who engage in continuous and repetitive work are deprived of judgment, making it futile to look at those same individuals as a possible source of purposive change and creativity. The absence of judgment makes routines recognizable only when patterns are concretely specified and precisely replicable. Such an idea is consistent with the notion of projects in Project Management but it is inconsistent with a notion of projects that includes some level of ambiguity and requires creativity to be specified. These types of projects, introduced early in this doctoral thesis, comprise a notion of routines with some degree of incompleteness in their specification and development; therefore, they require judgment and suggest spaces for creativity.

In recent social theory, routines have received a rather different theoretical treatment than that of early management research. For instance, Anthony Giddens (1984), in his book *The Constitution of Society*, identifies routine and "the process of routinization, as grounded in practical consciousness" (1984: 60) and claims that they are "vital to the theory of structuration. Routine is integral both to the continuity of the personality of the agent, as he or she moves along the paths of daily activities, and to the institutions of society, which are such only through their continued reproduction" (*ibid.*: 60). Giddens's notion of routines considers the fundamentally transformational character of human action even in the most utterly routinized forms. With this, Giddens's view clashes with the Parsonsian's<sup>8</sup> view of social structure in which agents are basically mindless, mechanic, as their behavior is predetermined by the structure; and therefore routines are executed by agents without deliberation or will, discouraging creativity. Strengthened by Giddens's work, several organizational scholars have contributed to conceptually and empirically revisit the notion of routines. They have opened the *black box* and depicted the internal dynamics of routines. To do so, they grounded their work in significant social theories that reconciled the influences of

---

<sup>8</sup> *Talcott Parsons (1902-1979)* is an American sociologist and one of the key figures of the structural functionalism. This social theory holds that society tends to self-regulation and it assumes that the social structure determines the behavior of the individuals.

both social structures and subjective individual experience. Additionally, they assume that routines, like any other social phenomenon, embody a tension between structure and agency.

Considering this, Brian T. Pentland and Henry H. Rueter (1994) propose a new view of routines. They assume that routines elicit specific patterns in the minds of subjects as well as depict the troubles and improvisations of everyday life. Consequently, routines are a source of continuity over time or automatic responses to a defined stimulus but they also are “effortful accomplishments”<sup>9</sup> producing an extensive range of different outcomes that enable change. They suggest that “an organizational routine is not a single pattern but, rather, a set of possible patterns –enabled and constrained by a variety of organizational, social, physical, and cognitive structures- from which organizational members enact particular performances” (1994: 491). They conclude that organizational structures enact or constrain certain choices or repertoires of action, and that the final outcome is product of the subjects’ interactions in specific situations. The characteristic of the resulted pattern of action is that “the performances are functionally similar but not necessarily the same” (1994: 504). These distinctions capture the procreative aspects of organizational routines. Their article has paved the way to other researchers looking at the transformative character of agency.

Following this line of thought, Martha S. Feldman's (2000) “performative model of organizational routines” extends Pentland and Rueter (1994) work. Just as they do, she agrees that variation in performance of an action or activity is a common part of organizational routines because they are not mindless but “effortful accomplishments” (Pentland & Rueter, 1994: 488). However, Feldman adds that “change is more than choosing from a repertoire of responses, and that repertoire itself” (Feldman, 2000: 613). Therefore, she understands routines not only as effortful but also as emergent accomplishments. For instance, the activity of reproducing a routine, whether subtly or dramatically, alters the routine, as the “internal dynamics” of routines encompass continuous change. Her study lay emphasis on the importance of the agents performing the routines and how they promote the routines continuous change.

Based on Bourdieu’s<sup>10</sup> social theory of structure and agency as mutually constitutive, Feldman assumes that the agents continuously adjust their actions; they continuously reflect on and react to various outcomes. The agents performing the routines are not only using the available repertoire of actions, they also develop a new repertoire of actions, which would modify the previously established routine. Her dynamic model exposes that ideas enact action and action generates outcomes that generate new ideas. Feldman’s *performative model* is an outline of the importance of the role of the agents in the performance of routines.

---

<sup>9</sup> Anthony Giddens in the “*The Constitution of Society*” (1984) developed a theory of structuration in which he states that routines are “founded in tradition, custom and habit” but they cannot be considered “repetitive forms of behavior being carried mindlessly” (1984:86).

<sup>10</sup> Pierre-Félix Bourdieu (1930-2002) is a French sociologist whose theories are grounded on the structuralist constructivism approach. He assumes that objective structures exist independently of the consciousness and will of the agents, which are able of guiding and constraining their practices. And that constructivism brakes with the dichotomies of structure and agency and faces the social reality through a dispositional theory of action.

Martha S. Feldman and Brian T. Pentland (2003) adopted the notions of ostensive (abstract principles) and performative (practice) aspects of social bond, introduced by Bruno Latour (1986) in his paper *The Powers of Association*, to reconceptualize the notion of routines as the “repetitive, recognizable patterns of interdependent actions, carried out by multiple actors” (Feldman & Pentland, 2003: 93). Different from Bruno Latour<sup>11</sup>, in their paper, Feldman and Pentland assume that both “ostensive” and “performative” aspects of routines are mutually constitutive. The dichotomy between “ostensive” and “performative” aspects of routines is required to understand the potential for stability as well as change in organizational routines.

In Feldman and Pentland (2003), the ostensive aspect of organizational routines refers to the comprehensible and manageable part of a routine as it “guides” our perception, “accounts for” standard actions, and “refers to” recognizable patterns of activity. Despite the fact that it includes the subjective understanding of the participants, it does not encompass any aspect of the performance because “it is impossible to specify any routine in sufficient detail to carry it out” (2003: 101). Consequently, for them, the ostensive aspect of routines is mere subjective ideas, different from practice. On the other hand, the performative aspect of organizational routines refers to the particular courses of action that individuals chose to complete the routine. The participants’ choice of a particular course of action generates constant variations and affects the ostensive aspect of organizational routines by “creating” a new routine, or “maintaining or modifying” existing one. These variations originate in “the diversity of information, interpretative schemes, and goals of the [multiple] participants” (2003: 104).

Their paper develops three core subjects and relates them with their concept of routines: first, integrally related subjectivity and objectivity conditions of the routines as for practical reasons; second, the agency of individuals enacted in the context of an organization that defines a set of possibilities, as the active engagement in on-going practices. And third, the power dynamics go in two directions. For them, the ostensive aspect of routines is aligned with managerial control and dominance, as managers have the power to create and enforce organizational routines, whereas “the performative aspect of routines is aligned with the interests of labor” (Feldman & Pentland, 2003: 110); either to resist to actual patterns of action or to “improvise an effective variation” (2003: 111).

Their study led to the following contributions: first, it disengaged the evolutionary perspective that suggests that routines are a source of stability and inertia. Second, “provided a foundation for a new way of conceptualizing routines and a way of understanding the relationship between stability and change as a result of the internal (or endogenous) dynamics of the routine” (Feldman & Orlikowski, 2011: 1250). And third, disclosed the generative and iterative aspects of agency to account for the performance of routines. Their paper triggered for a vast amount of empirical studies building on the process of routines. Practice-based

---

<sup>11</sup> **Bruno Latour (1947)** is a French sociologist and philosopher whose paper “*The Powers of Association*” (1986), proposes a shift from ostensive to performative definition of society. The performative view is based on practice and allows us to understand society as continuously being constructed or “performed” by active social beings.

studies focus on the situated nature of human action and affirm that rules and routines are ever-changing, rather than being a deployment of rules, goals, and mental contents.

The iterative aspects of agency were further developed by Martha S. Feldman and Wanda J. Orlikowski's (2011) paper *Theorizing practice and practicing theory* which relates routines with the theory of practice. On theorizing and beholding routines as practices they emphasize “the consequentiality of the actions that people take while they are enacting routines” (2011: 1251), and the recursive and mutually constitutive relations between agency and structure. These aspects of the theory of practice produced significant studies about participants’ everyday interactions and actions to understand the temporality of organizational stability and change. Through practice; they meet the need to introduce an interplay between agency and structure (or the ostensive and performative aspects of routines) in order to explain routines variability.

This view bases its explanations on the outcomes provided by recognized routines but it circumvents the contribution to the understanding of how routines are constituted and sustained and how individuals recognize a routine. Based on George Herbert Mead’s symbolic interactionism<sup>12</sup>, a few studies inquire on what creates and recreates a routine (e.g. Dionysiou & Tsoukas, 2013). Mead's (1934) symbolic interactionism conceptualizes the individual’s act from the standpoint of a social process. He assumes that individuals’ actions have meaning, and that this meaning emerges out of, and varies through, social interaction. The “relational self” takes on the attitude [role] of others towards one’s self. A symbolic interaction is the result of the comprehension by the others of an individual’s meaning, which creates significant communication symbols making the social act possible. The individual and social action does not determine a particular performance, it is “open and flexible” (Blumer, 2004: 36) but anticipates mutually consistent patterns of behavior that have been “intersubjectively” established within the context of the joint activity.

Dionysios D. Dionysiou and Haradimos Tsoukas (2013) discuss the underlying mechanisms of routines creation and recreation. They include the relational aspect of agency and assume that routines are collective accomplishments formed out of situated actions and the participants’ understanding. Through interaction, the routines that participants engage in involve role taking with respect to the joint activity at hand (2013:200). The relational aspect of agency connects the performative and ostensive aspects of routines and accounts for an explanation of stability and change. Stability occurs when there is a shared schema for individual action (ostensive) whereas change occurs due to an assortment of possible actions

---

<sup>12</sup> **George Herbert Mead (1863-1931)** is the founder of the symbolic interactionist school of sociology and social psychology. He describes how the individual mind and self-arises out of the social process. Instead of approaching human experience in terms of individual psychology, he analyzes experience from the “standpoint of communication as essential to the social order.” In his book “*Mind, Self and Society*” (1934) the concept of mind refers to the ability of individuals to use symbols and create meanings through thought and language; the concept of self refers to the ability of individuals to reflect on the ways they are perceived by others, and the concept of society refers to the context in which these interactions take place.

(performative). Their paper is a first attempt to explain how the ostensive aspect of a routine is created out of a collective effort with structural properties.

Alex Wright (2014) connected the relational aspect of agency to rhetoric, introducing the role of language in the creation and recreation of routines. Wright (2014) suggests a new epistemology based on communication theory which assumes that organization is achieved through communication (e.g. J. R. Taylor, Cooren, Giroux, & Robichaud, 1996; Kuhn, 2008; Cooren, Kuhn, Cornelissen, & Clark, 2011). The communicative perspective highlights “the functions of, and relations between, ‘concrete’ and ‘figurative’ texts, paying particular attention to their participation in the construction of an authoritative (yet never monolithic) system for coordinated and distributed action” (Kuhn, 2008: 1227). In the line of communication theory, Wright (2014) adopts the view of communication as generative and constitutive of the organization and uses the theory of communicative acts to move away from the idea of duality and mutually constitutive aspects of routines. He suggests that routines are not performances of some overarching script but “embodied articulations of conversations and text” (2014: 12).

The developments of both the relational and rhetorical approaches of the creation and recreation of organizational routines connected and developed the transforming aspect of routines creation and recreation at the collective level. Routines are idealized, effortful, and dynamic “forms of recognizable and repetitive activity” (Wright, 2014: 1), “constituted and reconstituted through communication” (ibid.: 2).

David Obstfeld (2012), in his paper *Creative Projects: A Less Routine Approach towards Getting Things Done*, grounds also his research on the work of Emirbayer and Mishe’s (1998) theory of human agency, and Alfred Schutz (1967) study on *The Phenomenology of the Social World*. Obstfeld (2012) bridges routine and non-routine literature and focuses on the specific subject of creative projects which, for him, are functionally different from organizational routines. He claims that the creative projects trace a unique form of action that attempts to innovation and spawn, while organizational routines does not have this connotation as variation unfold through schemes. And concludes that the “combinatorial action, knowledge articulation, and contingency management, unfold differentially in organizational routines and creative projects” (2012: 1571).

Departing from the same phenomenological framework this doctoral work obtains other findings. Even considering relevant to introduce the distinction between a finite sequence of routines (or projects) or an endless process (or organizational routines, operations or activities) (Seegerberg, 1985) in which Obstfeld (2012) grounds his work, this does not influence the fact that a routine is a creative activity that involves judgment. Judgment enables to combine the routines available at a given time to change the current state of affairs to another state of affairs (Schutz, 1953).



## 2.4. Conclusion

Creativity pervades human life. It is the mark of individuality, the vehicle of self-expression, and the engine of progress in every human endeavor (Paul & Kaufman, 2014). Creativity involves all the components of the life experience. Through creativity we created the foundation for art, philosophy, science, and technology, and we not only adapt to but also transform our environment and circumstances (Chávez-Eakle, 2004). The creativity implicit in routines permeates all human endeavors and involves all components of the life experience: the cognitive, the social, and the tacit.

Differently from previous studies, this chapter introduces new aspects of the tension between creativity and productivity by looking at organizational routines and connecting them to creativity. This relation is grounded on the idea that routines are not mere mechanical actions but involve judgment to be created, accomplished, resisted, or changed. Since the creation and development of a routine involves judgment, routine work can be considered as a creative activity.

The judgment contained in a routine establishes a base for creativity in every recognize activity or operation, such as scientific activity. Since Descartes, research scientists work following his method<sup>13</sup>. The method application is part of the practices and routines of the researchers. This method has been connected to the efficiency and the productivity of its outcomes however, far from transforming the scientific activity into a mechanical activity what we omitted is that every human endeavor requires judgment and that makes it certainly creative. Individuals' judgment responds to the demands and contingencies of the present time and it can be seen in the everyday "procedures and uses"<sup>14</sup> of individuals (Emirbayer & Mishe, 1998: 1001). Individual's judgment releases the emergence and development of routines, it anchors them in the participant's agency and creativity.

The following chapter of this doctoral work sketches the possibility to link the notion of routine to creativity, enlarging the notion of routine and bonding it with the possibilities they offer for opening creative spaces, contributes in the management of projects and

---

<sup>13</sup> *René Descartes (1596-1650)*. He attempted to apply mathematical methods to all fields of human inquiry. With this aim in "*Discourse on the Method*" he established a method that includes the four following rules: "The first was never to accept anything as true [starting from the universal doubt]... The second, to divide each of the difficulties that I was examining into as many parts as might be possible and necessary in order best to solve it. The third, to conduct my thoughts in an orderly way, beginning with the simplest and the easiest to know,... And the last, everywhere to make such complete enumerations and such general reviews that I would be sure to have omitted nothing." (Descartes, 1637/1968: 40)

<sup>14</sup> *Mustafa Emirbayer and Anne Mishe (1998)* quoted *Michel De Certeau (1925-1986)* a French philosopher who wrote "*The Practice of Everyday Life*" (1984), translated by Steven Rendall. Berkeley and Los Angeles: University of California Press. In his book, he claims that social sciences lack of formal means by which to examine the ways in which individuals use and interact with social institutions, such as tradition, rules and language, in everyday situations. Individual's everyday practices provide an element of constant creative resistance to social institutions.

organizations. The concepts of project, actions, subactions, and routines involve judgment and allow formulating other aspects of the subject of creativity. In order to theoretically contribute to the understanding of this subject the following phenomenological theories are considered: Alfred Schutz's (1953) theory of human intentional action, and Mustafa Emirbayer and Anne Mishe's (1998) theory of human agency.

## CHAPTER 3

### THE PHILOSOPHY OF HUMAN ACTION IN MANAGING CREATIVE PROJECTS

*“If existence really does precede essence, there is no explaining thing away by reference to a fixed and given human nature. In other words, there is no determinism, man is free, man is freedom.”* .- Jean Paul Sartre, October, 1945 lecture "Existentialism is a Humanism"

Inquiring into how routines are created and recreated increases our understanding of how creativity is possible even in very restricted environments, ruled by either the rigid forms of Project Management or the recurrent rules of the Cartesian Scientific Method. Based on a phenomenological approach to the philosophy of human action and human agency, this chapter develops a notion of project and routine that can involve creativity. Since “to be able to do something”, to be creative, is to run a routine and to deliberate is “to search for a routine to run” (Segerberg, 1985: 196), a project can be seen as a combination of two or more routines or similar actions, and a routine require judgment to be created, accomplished, resisted, or changed. The notion of project and routine developed in this chapter introduce a new perspective to understand how we do manage the process of developing projects.

The contemporary social theory on human action and human agency contains three main perspectives studying the emergence, reproduction and transformation of structures: methodological individualism, structuralism and the theory of structuration. Methodological individualism considers that structure is an aggregate effect of individual actions, a product of the activity of the individuals. This perspective places the subject before the structure but presents a model of agent motivated exclusively by her own interests, as such of rational choice theory. This perspective has a problem of upward conflation (Archer, 2003; Aguilar, 2008). Contrarily, structuralism considers individual actions as mere products of social structures and disregards the role played by human agency in creating and shaping the societal and organizational structures. These perspectives are in line with the social sciences that suppose that their purpose is to discover the laws of the human behavior and social activity (Giddens, 1984). The theory of structuration has been developed in recent debates. In it the role of human agency comprises many other perspectives and attempts to develop an analytical framework that coherently integrates structure and agency (e.g. Giddens, 1984; Archer, 1995, 2003), with the purpose to develop a theory of social change avoiding the problem of their precedents on conflation and reification.

Hence, a larger amount of organization studies consider supporting the role of agency to be essential in developing contemporary organizational theory (e.g. Barley, 1996; Barley & Tolbert, 1997; Vallas, 2006; 2012; Feldman, 2000; Feldman & Pentland, 2003; Howard-

Grenville, 2005; Obstfeld, 2012). In particular, human agency is influencing and contributing to organizational theory looking at innovation and change in organizations. In this line of thought, this doctoral work recognizes that the way agents understand their circumstances plays a crucial role in management.

The phenomenology and philosophy of “human intentional action” introduced by Alfred Schutz (1953) and the conceptualization of human agency developed by Mustafa Emirbayer and Anne Mishe (1998) allow understanding how research can be developed even in a restricted environment, such as the context of an organization or under the methods of Project Management. Therefore, this doctoral work will focus on how creativity emerges despite the lack of support of traditional management approaches to freedom and agency. Within this frame, concepts profoundly rooted in management literature such as routines and projects will be revisited and enlarged upon.

Schutz’s (1953) work focuses on the experience and mental constructs of the actors. His study includes a notion of project that is more flexible than the one used in Project Management. From it, our work, will propose a notion of routines, which considers that they are not mere mechanical actions, but involve interpretations and judgment. It comprehends the recuperation and raise of the importance of the agent intentions and its meanings. Emirbayer and Mishe (1998) in their paper *What is Agency?*, conceptualize agency as the “temporally embedded process of social engagement, informed by the past but also oriented towards the future and towards the present” (1998: 963). Their theory of agency captures the complexity of the human experience by interpenetrating the “habitual and repetitive” role of agents, their reflexive activity recognized in their creative judgmental acts, and their purposivity or goal oriented component.

The subjects of reflection and judgment are related to rhetoric and are considered to be a mental activity in which the actor presents arguments to herself, evaluates them, and then finally persuades herself in order to make decisions and specify projects. In common life, many of the activities we perform might seem almost mechanical but doing research can involve complex arguments and counterarguments, which make clear the rhetorical character of the research activity. The role of rhetoric in scientific research can be considered at the level of social discussions in research teams, groups and communities but also at the level of the individual interpretations and judgment of the researchers, which forces to focusing on the structures of subjective experience.

### **3.1. Alfred Schutz’s Theory of Human Intentional Action**

Alfred Schutz (1953) in his paper *Common Sense and Scientific Interpretation of Human Action* established the foundations of interpretative methods of social sciences, based on the interpretative sociology of Max Weber<sup>15</sup>, and the phenomenological approach to philosophy

---

<sup>15</sup> *Max Weber (1864-1920)* is considered the father of modern sociology. In his book “*The protestant ethic and the spirit of capitalism*” (1905), he supports some important developments for methodological perspectivism of

of Edmund Husserl<sup>16</sup>. His theory focuses on the purposes and meanings of human actions. He claims that human actions have a purpose, a mental project, and the physical act, and that only the physical act of people's actions can be directly observed. Therefore, the social sciences have the right, and many times the obligation, to use interpretative methods (Pons, Bonet, & Iglesias, 2003; Bonet, Jensen, & Sauquet, 2007). Schutz's theory of the human intentional action develops a broader notion of "action", "mental project", "subaction" and "repeated action". His notions of mental project, repeated actions, and subactions allow making important contributions for managing projects.

Schutz (1953) emphasizes that each action is considered from the life experience of the actor. At each particular moment, the life experience provides the actor with the knowledge and skills that she can apply (knowledge at hand), as well as a vision of the future that allows her to introduce her purposes (purposes at hand). He emphasizes that any "intentional action" changes a present state of affairs into a future state and involves a purpose, a mental project and the performance of the act.

The concept of "mental project" is defined as a mental rehearsal of the future act (Schutz, 1953). This notion of projects is more flexible than the notion of Project Management. To specify it can be more or less difficult, but a "mental project" always involves imagination and judgment. The project can be very precisely defined or very ambiguous, and it can require a very long or very short time. Furthermore, during the performance of the project, or the act, judgment is required for assessing whether its development follows the patterns established in the project or not. Some kinds of projects are rigid and cannot be adapted to unexpected circumstances, and other kinds of projects are flexible and permit a greater degree of adaptation.

From another point of view, the "mental project" of a single action can be seen as a hypothesis of what will happen during the performance of the act, which depending on the context can or cannot work. Therefore, the *mental project* has a hypothetical character, which is influenced by our expectations and involves imagination. But what is important for us is that, if the plan is flexible enough, the actor can make adjustments according to what actually occurs during the act.

---

interpretative sociology. Such as, "ideal types" and "Verstehen". The "ideal types" are idea-constructs or abstractions helpful to understand any social phenomena, which not only describe the actions of the participants in the social phenomena but also interpret them. The notion of "Verstehen", aims at understanding people's action and the rational motives of people's actions through two levels: observation and interpretation of the phenomena.

<sup>16</sup> **Edmund Husserl (1859-1938)** is the founder of the phenomenological philosophy. The phenomenological approach assumes the task of unfolding the meaning and structure of experienced phenomena. He was not interested in what the actual nature of things is but in how we think about them. Therefore, his interest was centered on the experience of each person and the content of their consciousness. He introduced the notion of "eidetic intuition" which was his solution to the classical problem of the generation of concepts. He claims that when we perceive a fact or an object, at the same time our consciousness captures its essence.

Schutz's (1953) approach to projects introduces a critical analysis of the common notion of "repeated action" in which the actor does not have to rethink the mental project: the actor considers that the first and the second actions are equal. But this is not the case, as the second action differs from the first in the experience, knowledge and skills of the actor and the circumstances of execution are also different. Therefore, repeated actions are different actions, whose differences are not considered relevant by the actor. Schutz emphasizes that they are similar actions. The performance of the second action involves judgment also, as the actor must first consider whether or not it is equivalent to the first action and then, the extent to which that similarity can be applied to the execution.

Differently, Project Management focuses on efficiency and productivity and its concept of projects implies the concrete specification of goals, tasks, and resources. Its methods must ensure an equilibrium among what is called the "Triple Constraint" which contains the specification of the scope, schedule, and costs of the project (Gido & Clements, 2009). In this line of thought, management control systems literature explains how control systems enable creativity while considering productivity in projects (Simons, 1995; Cardinal, 2001; Davila & Ditillo, 2009; Adler & Chen, 2011). This stream of research relates creativity with Project Management and claims that, when projects are large and complex, it is essential for the project development to consider a clear division of the work and the interdependence of the tasks but that the success of creative tasks will rely on intrinsic motivation (Adler & Chen, 2011).

In spite of the importance of their studies, their notion of project conceives the design and development of the activities in a project as a way to achieve the maximum utility. Their notion supposes that there is a unique and reliable explanation of the project plan that relies on the known causal laws that will rule of the project goal, allowing the control and coordination of the future action as it is predictable and appears to be perfectly rational. Their notion of projects includes in this type of projects all the other possible types. This not only narrows down the notion of project but also the notion of its management. The managerial activity is then related to the strict control and coordination of a predictable plan. The deviations a project that will undergo during its lifetime will be solved in the same terms.

Considering Schutz's notion of "metal projects", "repeated" or similar actions, and "subactions", this doctoral work reconceptualizes the notion of project consequently, its management, to understand how creativity is possible even in very restricted environments. Assuming that a project may be either very precise or very ambiguous, or might either be very complex or simple to specify, what is significant though is that this choice depends on other aspects such as what the actor considers to be relevant in each particular case. This is considered a creative activity that involves judgment. In any case, not all the circumstances can be specified *a priori* regardless of whether the action is a very familiar one, such as going for lunch, or an elaborated one, such as research project, subjected to the requirements of Project Management.

Additionally, some research projects can be planned and executed following the logical framework of Project Management but, in a certain way, this implies that research scientists

are mostly involved in solving the scheduling problems of the research project since the research project has been specified and the risk relies on the fine scheduling of its time and costs. But the deviations relate to complex scientific problems or questions, which the researcher is committed to unravel, cannot be solved using this logic. When, they solve these unexpected and intellectual difficulties, they engage in a period of open rhetoric, make the project plan more flexible, thus being open to many other possible meanings to the physical or conceptual objects they are working with. This activity involves interpretative flexibility and judgment, to appropriately make choices, according to the researcher experience, the situation at hand and the projected aim.

This doctoral work relates the critical analysis of the notion of “repeated actions” as similar actions to the notion of routines. In a project there are several activities or operations that are repetitive (e.g. the scientific method and the research program rules). The performance of a routine always involves judgment, not only because of the variability in the performance of an action or activity but also because the actor must first consider whether or not the second action is similar to the first action and then the extent to which that similarity can be applied to the execution. The idea of routines as a non-repetitive, different or similar establishes the base of a creative activity as well as for innovation through the judgment implicit on the adjustment of the state of the affairs. When an actor performs the second action, she can follow the lines of the project without surprise; but in many cases judgment obliges her to introduce modifications, to solve new problems or to think about other possible developments. Working with similar actions opens a space for creativity because the execution of the second action may suggest new ideas or produce unexpected problems that then have to be solved.

Schutz’s (1953) concept of “subaction”, which is part of a more general action, offers another notion for understanding how creativity is possible within very specific projects. Completely new activities and projects could be organized combining several or sometimes a large number of subactions that are similar to actions already performed by the researcher. Creativity takes place in imagining the activity or project, in organizing it with “known” subactions and solving the problems that appear in the performance of the full acts.

### **3.2. Phenomenology of Agency Theory**

There are different conceptions of agency, in the current sense of rational choice theory, which presents human action and decision-making as in search of the most effective relationship between the cost and the benefit of pursuing a goal. The rational approach comprises the theory of the principal and the agent. This agency theory describe the relationship between the parties (the principal and the agent), as a contract to delegate some work, assuming that both are utility maximizers and have different interests (M. C. Jensen & Meckling, 1976). In the line of rational choice theory, the methods of Project Management consider individual actions rational and mere products of social structures, disregarding the role played by human agency in shaping a project or any other human endeavor. This

approach considers that all agentic performance involves maximizing utility, relegating the “homo economicus” to be driven exclusively by economic motives at the expense of all others.

The concept and terminology of the principal and agent theory have created some confusions, because several decades before, some theories in philosophy of science introduced the expression “agency theory” meaning, the phenomenology of human agency that focuses on the ways the actors conceive, decide, and implement their actions over time. The conception of agency theory introduced in this study is in line with the phenomenology and philosophy of action of Alfred Schutz (1953). Specifically, Mustafa Emirbayer and Anne Mishe (1998) approach to human agency is sensitive to the fact that “temporal-relational context supports particular agentic orientations, which in turn constitute different structuring relationships of actors toward their environments. It is the constitution of such orientations within particular structural contexts that gives form to effort and allows actors to assume greater or lesser degrees of transformative leverage in relation to the structuring context of action” (Emirbayer & Mishe, 1998: 1004). With this, human agency theory reflects that the agentic processes contain three components: intersubjectivity, social interaction, and communication, which are intimately related with creativity. Considering this approach, this doctoral thesis frames the future understanding of how research is developed even in a restricted environment.

Mustafa Emirbayer and Anne Mishe (1998) conceptualize agency as a “temporally embedded process of social engagement”, informed by the past (in its “iterational” or habitual aspect) but also oriented towards the future (as a “projective” capacity of imaginative alternative possibilities) and towards the present (as a “practical evaluative” capacity to contextualize past habits and future projects within the contingencies of the moment)” (1998: 962-970-971).

They introduce the “iterational”, the “projective” and the “practical evaluative” elements of action, which, respectively, deal with the past, the future and the present, even if each of them take into account the other temporary stages. Following this line of thought, the function of “project” in any kind of intentional action results in a broader concept of “project” which includes the continuous reconstruction of the actors’ orientations “towards the past and future in response to emergent events” (1998: 971). The agency of actors, with their past experience, their conception of the present context and their vision of the future, are determinant in understanding the forms in which work is organized. We can introduce this approach as the study of the ways in which the faculties of the actor, such as, cognition and affection make possible imagining, deciding and executing an action.

The “iterational” element corresponds to repetition, routines and habitudes as forms of action that are taken for granted and are associated with rules. Habitude, in many modern sociological and psychological theories, is almost reduced to mechanical responses to stimuli.



But theories of practice, such as those of Pierre Bourdieu (1977)<sup>17</sup> and Antony Giddens (1984)<sup>18</sup> emphasize its reflexive aspects. At this point, Aristotle's view<sup>19</sup> that *habitudes* constitute a disposition towards appropriate wise action and Aquinas' view<sup>20</sup> that they are associated with moral virtues which characterizes a broader sense of habits and routines than the one emphasized in modern times. In this line of thought, *What is Agency?* emphasizes that actors select and categorize actions, thus the agentic dimension of "iteration" lies in "how actors selectively recognize, locate, and implement such schemas in their ongoing and situated transactions" (1998:975).

These ideas on "iterational" routinized action were the first stage of their theory of agency and complete it with two more stages. The second stage introduces the "projective" element, which corresponds to the imaginative creation in the mind of the actors of possible future trajectories that are associated to their hopes, fears and desires for the future. The words for describing this "projective" ability have ranged from "strongly purposive terminology of goals, plans and objectives to the more ephemeral language of dreams, wishes, desires, anxieties, hopes, fears and aspirations". "The locus of agency here lies in the *hypothesization* of experience, as actors attempt to reconfigure received schemas by generating alternative possible responses to the problematic situation they confront in their lives" (1998: 984).

The third stage of their theory of human agency focuses on the "practical evaluative" element of action, which responds to the contingencies of the performance. Independently of the degree of ambiguity, variety, and complexity of a given situation, it will imply finely tuned judgments and interpretations. They divide the practical evaluative element in three dominant tones: "problematization, decision and execution" (1998: 997). It comes out from the idea that action cannot be completely determined by rules and requires situational judgment or practical wisdom for *contextualization* of future projects and habitual practices.

The time dimension Emribayer and Mishe develop connects with the judgmental activity and adds a new perspective to the work activity that has neither been considered by Project

---

<sup>17</sup> **Pierre Bourdieu (1930-2002)** his theory of practice was grounded in the criticism of rational choice theory. He claims that social agents are not viewed as rationally able to determine objective changes but they operate according their practical logic and this is how social structure is produced and reproduced by the social agents. In the "*Outline of a theory of Practice*" (1977) he developed a theory of action, around the concept of *habitus*, to capture the permanent internalization of the social order in the human body.

<sup>18</sup> **Antony Giddens** in his works "*Central Problems in Social Theory*" (1979) and "*The Constitution of Society*" (1984) developed a theory of structuration, an analysis of agency and structure, in which primacy is not granted to any of them. He demonstrates how principles of order could both produce and be reproduced at the level of practice itself and not through some 'ordering' society impinging upon individual actors from above.

<sup>19</sup> **Mustafa Emirbayer and Anne Mishe (1998)** refer to Aristotle's view of habits. **Aristotle (1985)** translated by Terence Irwin. Indianapolis, Ind: Hackett.

<sup>20</sup> **Mustafa Emirbayer and Anne Mishe (1998)** refer to Thomas Aquinas's view of habit. **Thomas Aquinas (1948). Summa Theologica.** 3 Vols. Translated by Fathers of the English Dominican Province. Westminster, Md: Christian Classic.

Management. This feature introduces the importance of the role of agency in projects and the existing approaches to projects and work organization “have often elided the role played by human agency” (Vallas, 2006: 1678).

### **3.3. Judgment as a Potential Source of Creativity**

Up to this point, this doctoral work has emphasized the importance of the judgmental activity involved in the constitutive elements of human agency (iteration, projectivity and practical evaluation) and of human intentional actions. Judgment mediates the structuring context in which action unfolds. However, the consequences of re-conceptualizing the notion of routine and connect it to creativity, first assumes that even the most specified or simplified action or activity “requires a certain degree of maneuverability in order to assure the appropriateness at hand” (Emirbayer & Mishe, 1998: 980), and second designates judgment as mediator of the structuring context. These assumptions result in a view of the creative activity that occurs even in routinized or restricted environments, such as an organization or a project.

Moreover, in line with the studies that point at rhetoric as a common function in management, this chapter, first introduces the rhetoric of judgment as a source of creativity, which supports the relevance of the role and relation of rhetoric not only in management studies but also in scientific research. Focusing on the importance of rhetoric to understand science and research development (Pinch and Bijker, 1984; H. S. Jensen, 2011). And second, presents the rhetorical aspect of judgment which introduces the actors’ mental activity to interpret the situation and make appropriate judgments as the basis for defining and developing scientific projects, and considering it a creative activity that goes far beyond the designing phase as it is also present during its execution (Nadal-Burgues, 2014).

Lastly, the contributions in the study of creativity have reached a high level of refinement and complexity. This refinement positively shows a high level of maturity of the field but also reveals a certain level of stagnation, which contributes to the perception of this field as intractable. However, we cannot deny that these studies are remarkably valuable and they have made outstanding contributions to the accumulation of a great body of knowledge and, since then, we have all assumed that both the individual and environmental components can foster or inhibit creativity. It is though the aim of scientific research to attempt to simplify the understanding of any phenomena. And inquiring further into the philosophy of human action and human agency brought new conceptualizations of important aspects in the management of research projects.

In general, human agency is a source of organizational change, innovation, and creativity. In particular, judgment pervades, in many levels, all the human activities. Judgment involves reflections, comparisons, choices, and decisions, which can go from everyday life to the very complex, or to the very specific to the abstract. In terms of scientific projects, it is clear that the creativity involved in designing, as well as, executing well-defined research projects, involves and requires the interpretations and judgment of the researchers.

Some of the studies that have worked on the subject of either creativity or routines are situated on the same conceptual line (e.g. Feldman & Pentland, 2003; Feldman & Orlikowski, 2011; Obstfeld, 2012; Dionysiou & Tsoukas, 2013). In contrast to them, the concepts of mental project, repeated or similar actions, and subactions involving judgment allow the formulation of other aspects of the subject of routines and show that creativity is possible even in constrained environments. Otherwise, human activities could only be seen as mere mechanical activities.

Some studies on creativity (e.g. Simon, 1983; Csikszentmihalyi, 1996) have introduced the rhetorical dimension of judgment at the deliberative or collective level due to its evaluative power. However, they lack of analysis of the self-reflective dimension of the rhetoric and judgment, which explains not only how routines are recreated but also signifies the prelude to any creative act. The subjective experience implicit in the rhetoric of judgment, is a creative endeavor, and it is constitutive of the elements and supports the act of any given routine.

### **3.3.1. The Concept of Judgment and Rhetoric in the Management of Research Projects**

The concept of judgment has been defined in several ways allowing to point out that “judgment is the mental correlate of a proposition” and “judgment is the mediate knowledge of an object”<sup>21</sup>. Immanuel Kant in the *Critique of Judgment* claims that judgment is the faculty “for thinking the particular under the universal”<sup>22</sup> or, in other terms, the capacity “to distinguishing whether something falls under a given rule”<sup>23</sup>. For him, judgment has two roles: the “determining” judgment subsumes the particular under the universal, and the “reflexive” judgment finds the universal for a given particular<sup>24</sup>. Therefore, judgment has an important function in making cognition possible. Kant relates judgment to aesthetics and teleology. In teleology he defends that organisms have a finality and that the paradigm of finalities and purposes is a human artifact (and a theory), which comes into being as a result of artisans (and researchers) having a concept of the object they plan to produce (Ginsborg, 2013).

Judgment is a very creative and complex human faculty which conclusions cannot be the object of a predictive theory. But it can be highlighted its rhetorical aspect. An idea similar to Kant’s adequacy between the particular and the general is presented by Aristotle in his book “On Rhetoric”. Aristotle, in order to justify rhetoric in legal processes, claimed “it is

---

<sup>21</sup> Ferrater Mora, José (1979). *Diccionario de Filosofía*. Madrid: Alianza Editorial, Madrid. *Judgment*.

<sup>22</sup> *Stanford Encyclopedia of Philosophy. Immanuel Kant (1790). Critique of Judgment*. (Introduction IV, 5:179). Reviewed in 2014 from <http://plato.stanford.edu/entries/kant-aesthetics/>

<sup>23</sup> *Stanford Encyclopedia of Philosophy. Immanuel Kant (1781). Critique of Pure Reason, Kritik der reinen Vernunft* (rV A132/B171). Reviewed in 2014 from <http://plato.stanford.edu/entries/kant-aesthetics/>

<sup>24</sup> *Stanford Encyclopedia of Philosophy. Immanuel Kant (1790). Critique of Judgment*, (Introduction IV, 5:179). Reviewed in 2014 from <http://plato.stanford.edu/entries/kant-aesthetics/>

highly appropriate for well-enacted laws to define everything as exact as possible to be left to the judges... legislation results from consideration over much time, while judgments are made at the moment (of a trial or debate)... But it is necessary to leave to the judges the question of whether something has happened or has not happened, will or will not be, as the lawmakers cannot foresee these things” (Aristotle, translated by George A. Kennedy, 1991: 31). Projects cannot foresee everything; therefore, even if rhetoric is usually associated to public speeches, it is also involved on mental judgments.

The logical view of judgment has neglected the fact that human activities involve persuasion, and that the rhetorical activity of self-persuasion is always present in judgment (Bonet, 2014). For instance, Isocrates<sup>25</sup>, a contemporary of Plato, already emphasized that the means for persuading other people are the same for persuading ourselves. In this way, the agentic dimension of rhetorical judgment is a mental activity in which the actor presents arguments to herself and evaluates them, and in which she persuades herself in order to make decisions and specify projects. Delivering appropriate responses to a poorly defined project, developing an idea or crafting the future is an essentially rhetorical and profoundly managerial activity that involves self-persuasion and judgment. Thus the relationship between judgment and rhetoric gives a new meaning to the subject of routine and creativity. Following Kant, the rhetoric of judgment is not only important in the creation of new meanings but also in the adequacy of the rules for a specific activity and for the ways in which these rules can be adapted to each specific case.

At the social level, Pinch and Bijker (1984) emphasize that different actors can give different meanings to the physical or conceptual objects they are working with, influencing in a way their lines of research. Their paper introduces the concept of rhetorical closure in which these various meanings converge into a single one. Their ideas are very influential in the study of research projects. Many projects involve a long period of ambiguity about the object of research. After this period, the research group obtains a single meaning and the rhetoric is closed. The project can then be, more or less, specified but trying to limit the time devoted to this period of rhetorical openness can reduce creativity and the possibilities of the project. These properties make it evident that in many cases there is not a clear separation between designing the project and executing it and that, even in well-defined projects there is feedback between them.

At the individual level, there are several mental processes that involve interpretation and judgment, and that are also rhetorical. When an actor tries to categorize a future action as similar to or as a repetition of a past action, she engages in rhetorical reflections. In many everyday activities, such rhetorical reflections can be almost mechanical, for instance ordering a meal is not an intricate activity, but in scientific research they can involve complex arguments, counterarguments and doubts, which manifest its rhetorical character. When an actor performs the second action, she can follow the lines of the project without surprise, but

---

<sup>25</sup> *Isocrates (Athens, 436 - ibid. 338 B.C.)*. In *Against the Sophists* distinguishes his pedagogy from the current state of sophism.

in many cases judgment obliges her to introduce modifications, to solve new problems or to think on other possible developments. The subjective experience will result in something intelligible, accompanied by a judgmental act, considered in this doctoral study to be the constitutive element of creativity.

On the subject of the rhetoric of management, it is important to outline that its classic notion is introduced in the seminal works of some renowned academics. Since ancient times, rhetoric has been considered a singularly human activity and has been referred to as the art of speaking and persuading people with words. This preliminary notion of rhetoric illustrated in Plato's dialogue *Gorgias*<sup>26</sup> discerns rhetoric from logic or dialectics. In spite of its misfortune, rhetoric was first considered as "the discipline for training citizens on the values and virtues of civic life" (Bonet & Sauquet, 2010: 122).

In the field of management, many works showed that important aspects of managerial activity include subjects that are core to or have been developed in the field of rhetoric. For instance, Chester I. Barnard's (1938)<sup>27</sup> best-known contribution to management theory is related to the rhetoric of power and authority. The "acceptance theory of authority" supposes a shift in the rationale of the employer and employee relationship and introduces a rhetorical dimension to the manager's authority as it depends on the subordinate's acceptance of the manager's right to give orders. Peter Drucker (1954)<sup>28</sup> argued that "management is not just passive, adaptive behavior; it means taking action to make the desired results come to pass". Henry Mintzberg (1973)<sup>29</sup> points at the frenetic conversational activity of managers; words are used by managers to make decisions, to negotiate, to give orders, and to inform; moreover, they are also used to build their network.

"Contemporary rhetoric includes all kinds of situations in which there is persuasion by words, making possible the study of the rhetoric of management" (Bonet, 2014: 2). Antecedents of the introduction and expansion of rhetoric of economics are led by Deirdre McCloskey, who in 1983 published in the *Journal of Economic Literature* *The Rhetoric of Economics* claiming that is our duty to "have a standard of Truth beyond persuasive rhetoric to which to aspire" (McCloskey, 1983: 510). According to John A. A. Sillince, (1999) human communication cannot avoid being rhetorical and most of our activities include communication and point at an organizational theory of argumentation. He suggests that organizations institutionalize specialized repertoires to increase their power and influence. Tony J. Watson (1995) goes beyond the manipulative view of rhetoric. His analysis on sense-

---

<sup>26</sup> *Plato (429–347 B.C.)* *Stanford Encyclopedia of Philosophy*. The *Gorgias* is one of Plato's dialogues in that the exchanges are at times full of anger, uncompromising disagreement, considerable misunderstanding, and cutting rhetoric. The quarrel between philosophy and rhetoric shows itself as an crude fight in the *Gorgias*.

<sup>27</sup> *Chester I. Barnard (1886-1961)* in "*The Functions of the Executive*" (Cambridge, MA, Harvard University Press, 1938).

<sup>28</sup> *Peter Drucker (1909-2005)* in "*The Practice of Management*" (New York, 1954), 11.

<sup>29</sup> *Henry Mintzberg* in "*The Nature of Managerial Work*" (New York, 1973).

making of managers of their work and in pursuing their interests extends the definition and scope of rhetoric. In his own words: “rhetoric is involved in all processes of human communication and reality construction” (1995: 807). In this line of thought other scholars highlight the importance of managers’ communication skills at the strategic and entrepreneurial level. Steven W. Floyd and Bill Woodridge (1994, 1997) analyze the role of middle managers and how their interpretations of everyday issues provide innovative ideas to top management consideration. Entrepreneurs’ rhetorical skills are fundamental to transfer broad or abstract concepts. Metaphors are a useful communication tool for both sense-making and sense-giving to cope with significant ambiguities. “Through metaphor(s) an organization develops common language, an understanding of the task environment and a means of interpreting events” (Hill & Levenhagen, 1995:1057).

The introduction of judgment as a source of creativity gives evidence of the relevance of the role and relation of rhetoric in management studies and in scientific research. This study introduces the actors’ mental activity to interpret the situation and make appropriate judgments as the basis for defining and developing scientific projects and their creativity.

Thus, rhetoric of judgment is as important in everyday mundane communication endeavors as it is for the innovative and creative ones. Through the means of rhetoric we create meaning to reach our goals; furthermore rhetoric guides our actions and influences our interpretations. Creative management and creative managers are rhetorical and projects are the frame to develop their creativity. Consequently, the importance of the rhetoric of judgment is that it is a constructive aspect of managing projects since it is through it that managers are able to create a situation and therefore, the solution. Through rhetoric of judgment, they construct a project, disambiguate the project constraints, and identify two discrete stages; the first fosters rhetorical openness and the second which works with more precise aims (Pinch & Bijker, 1984), which are managed in sophisticated ways.

### **3.4. Implications of the Theory of Human Agency and Human Intentional Actions in Managing Projects and Research**

This point of the conceptual framework aims to include human agency in our organizational models as it recognizes “our capacity to shape the conditions in which [we] live” (Emirbayer & Mishe, 1998: 965), and the ways in which we act and interact with our environment, in order to understand the cultural tensions in the organizations. The phenomenological theory of human agency focuses in the ways we think, reflect, make judgments, interpret situations, and create meanings. It brings our imagination into the world, overcoming the constraints we find there and enables us to undertake and guide our actions and projects. The role of judgment in guiding our actions clearly reconceptualizes the notion of routines, as similar actions. A routine or similar action involves interpretations and judgments on the adequacy of the rules to the specific activity and on the ways in which these rules are adapted to each specific situation. The judgmental activity procures a creative

outcome in any constraint framework an individual deals with. This claim clarifies several previous misunderstandings and identifies new creative spaces.

The role of judgment in guiding our actions and in finding new interpretations of our problems is clearly appreciated when dealing with highly abstract knowledge, concepts or ideas but is also contained in routine work. In this sense, Project Management distinguishes itself from the common image of an organization structure and its operations, which are viewed as fixed and predetermines of the workflow of action. Project Management clearly distinguishes between ongoing and repetitive organizational routines or operations, and projects (Duncan, 1996).

Differently from Project Management this doctoral work wants to emphasize that this distinction is dubious and that the distinctive feature between organizations and projects relies not in the unlimited repetitiveness of routines that some projects also can display, but in that a project, in a broad sense is “a temporary endeavor”. The time dimension adds a new perspective to the work activity, we create organizations to last forever but a project has an end. Already introduced in the theory of human agency, time interacts with the ambiguity of the project goals and purposes and associates them to the interpretations and judgment of the agents undertaking them; this gives to the endeavor a human dimension. Judgment pervades many levels of the human activities and it is a source of organizational change, innovation and creativity. Specification of the projects comes after long periods of rhetorical openness in which the researcher reflects on the activity, she is willing to contribute. After a long period of self-reflection she is willing to present her thoughts and arrive to a consensus with her peers.

With the claim that managing creative projects -ideating and executing them, involves judgment because we are interpreting the adequacy of our actions. The rhetoric of judgment or self-reflection offers the possibility to specify a project, as it focuses on determining the adequacy of the activities involved in the project. But it also reduces the diversity of meanings involved in a given problem or project. And finally, this process can include a large number of many modifications that redefine the problem. The tensions between concrete and ambiguous projects are managed through the means of rhetoric within two stages, in Pinch and Bijker (ibid.) words, rhetorical openness and rhetorical closure stages.

The tension between creativity and productivity is that creativity introduces an extensive range of properties, which makes its management dubious. The studies of creativity and routines covered in the second chapter are significantly oriented to the search of a concrete pattern of actions. The pattern of actions have to be clear, and the criterion of concreteness and “clearness is connected to the possibility of operationalization, that is the specification of operations that will be able to give answers to the question of whether a goal – or sub-goal – has been reached or not” (Jensen, 2011: 53). But since a repetitive pattern of action involves judgment, the link to productivity, efficiency, and exploitation is not direct. Management is no longer only related to the willingness of the creation of a unique pattern of actions that will lead to the creation of a competitive advantage and finally to the design of a routinized pattern of actions suitable for exploitation (Cyert & March, 1963; March, 1991). The

reconceptualization of the routines, as similar actions that require judgment, present new spaces for creativity that have not been considered before and affects the management of organizations and projects. The management of creativity resides in managing the distinctiveness between actions that occur at the individual level in each organization.



## **PART II**

### **Methodology, Empirical Research, and Findings**

This part falls into two main sections, each of which outlines the methodology and the empirical research, which includes several cases that I consider to be relevant to my goals.

# CHAPTER 4

## EMPIRICAL RESEARCH AND METHODOLOGY

### 4.1. Research Questions

The theoretical part of this doctoral research has introduced a conceptual framework based on a phenomenological approach to the theory of human action therefore, it does not include hypothesis that can be tested with statistical methods. This approach is completed with an empirical research based on qualitative-interpretative methods with the aim of obtaining factual knowledge in the way that researchers actually develop their projects, in relation to the subjects and claims of the conceptual framework.

With this aim, the empirical work developed at the Barcelona Supercomputing Center (BSC) uncovers the way researchers consider the tension between creativity and productivity in managing research projects, and how they think through the conceptual framework developed in this dissertation.

The researchers' work experience present some important facts that reveal important differences between what they do, what they think they do, and what research institutions say that they do. These facts inform on some important misconceptions about the management of research and research projects. This content led to the formulation of the following research questions that focus on what researchers think and what researchers do.

- 1) What do researchers think of the concepts of project management and managing research? And how do researchers actually manage their research work? What are the main problems they identify?
- 2) What do researchers think of the tension between creativity and productivity? And how is it managed?
- 3) How do they understand the function of routine and creativity? How are routines identified at the workplace? How creativity identified at the workplace? How is judgment identified at the workplace?
- 4) The researchers view on the utility of the conceptual framework of this dissertation

Before studying the cases that give response to these questions, the empirical research includes a case study of the creation of the Barcelona Supercomputing Center (BSC). This case study results to be important because it gives a full historical context of the agents involved in the creation of the research organization. Based on their experience, it manifests the particular conceptualizations of science and research, and its management, which is finally represented in the structure of the organization. Their particular view occasioned some tensions among the researchers who decided to disobey or resist the structure and proceed

according to their own view of the research activity. The new structure affected the career development, the scientific prestige, and the organization of work of other researchers within the organization. This case study aggregates some findings to the subject of the tension between structure and agency and gives some answers of how research organizations are dealing with it.

## **4.2. Methodology**

The choice of the research methodology is aligned with the theoretical and epistemological approach presented in the conceptual section based on the phenomenology of the human intentional action. The phenomenological approach considers the interdependence among people, institutions, events, and beliefs. The understanding of their relationships follows by focusing on people's subjective experiences and interpretations of the phenomenon under study (Weiss, 1998). The use of interpretative methods aims towards understanding the purpose of other people's actions. Social scientists interpret people's action which are not solely composed of properties (the physical act) but also having purposes and meanings. People interpret the social world, elicit meanings to guide their actions, the analysis of the peoples' interpretations and meanings by the researchers involves double-hermeneutic. Alfred Schutz's (1953) presents the philosophical foundations of Social Sciences and emphasizes the concept of double-hermeneutic, which distinguishes between two levels, common sense level and scientific interpretation level of human actions. People interpret reality for the undertaking of their actions, and the researchers use scientific methods for interpreting them. Anthony Giddens (1984) also explains the method of double hermeneutic in his presentation of the phenomenological hermeneutic approach of Social Sciences.

From the perspective of hermeneutic phenomenology, "telling a story" allows describing the phenomenon of interest in great detail, even it is different from what any individual interviewee might tell, it addresses the question of interest and builds understanding about the subject of study. The narrative interpretative approach focuses on the study of human action and how individuals make sense of their lived experiences "because one assumes that is the same perception that informs their actions" (Czarniawska, 2004: 49). Narratives involve storytelling methodology, "understood as a spoken or written text giving an account of an event/action or series of events/actions, chronologically connected" (Czarniawska, 2004: 17). According to the type of "narrative analysis" the empirical research configured the stories using a plot line which gives meaning to the events and then I include them within a more general framework that makes sense (Creswell, 2013: 54).

The data contained in these stories has been collected through formal and informal interviews, carried out between 2010 and 2014, where researchers offered their personal insight into the reality of their research practice. This data has been complemented with observations, along with web and text material. From those "significant statements", sentence or quotes from the participants have been used to finally, compose the narratives that will bring understanding about the subject under study (Creswell, 2013: 61). Moreover, the

narratives reveal the misconceptions of the researchers on the concepts of project, routines and the management of research.

#### **4.2.1. The choice of the sample**

In quantitative research, samples are chosen at random (random sampling), so as to give the element of the population the same probability to be chosen. This method has the purpose that the samples would be representative in the sense that the numerical values of the sample, such as, frequencies and means, will approach the corresponding values of the population. But in qualitative research, we do not have a similar concept of representative sample, and researchers who claim that we have to choose a representative sample by random methods are wrong. In qualitative research the choice of the cases is ruled by the method of theoretical sampling, which initially was coupled with theory building methods of Grounded Theory as its early goal was to “choose the cases that are likely to be replicated or extend the emergent theory” (Eisenhardt, 1989: 537). Broadly, Grounded Theory can be described as a research approach for the collection and analysis of qualitative data for the purpose of generating explanatory theory and uses continuous comparative method to analyze the data collected (Glaser & Strauss, 1967).

The concept of theoretical sampling, which is closely related to Grounded Theory, has originated the method of purposeful sampling, which looks at the potential scientific relevance of the sample in relation to the research questions and purposes. Therefore, the choice of the this case has considered the type of generalization and analytic indications of research organizations, in which, “extreme situations and polar types” were presented and in which the process of interest is “transparently observable” (Eisenhardt, 1989: 537). But differently, it requires paying attention to the purpose of the research. Therefore, the criteria of choice of the case in purposeful sampling relies on “what type of case study is most promising and useful” (Creswell, 2013: 74). Identifying a case that will be relevant and accessible is a priority when conducting qualitative research to allow inquiry into and understanding of a phenomenon in depth (Patton, 1990; Creswell, 2013).

The case studies are associated to the context of the Barcelona Supercomputing Center (BSC), which is the Spanish supercomputing facility. From the set of Singular Scientific and Technological Research Infrastructures (ICTS) in Spain, the features that make BSC a good sample choice to carry through the research are: first, its importance, the BSC is one of the most renowned research and technology infrastructures of Spain as well as being an internationally recognized research organization. BSC hosts one of the most powerful supercomputers in Europe, and holds institutional autonomy to independently decide and choose its research goals and orientate its priorities. Second, its diversity on research aims, research projects and research communities. And third, its openness to my observations.

The later principle to choosing this case is that I can offer a useful manifestation of the phenomenon studied due to my proximity to the research organization under study. I have easy access to this research organization; and moreover, I have a personal experience working at BSC for over three years as a project manager. My experience procures not only a profound

knowledge of the institution but to easily access many documents from and about the organization. The insights this experience brought are important not only to comparing with Project Management and its methods but to elicit other important subjects on managing research and research projects. For the purpose of this doctoral work, it is important to clarify that the name given to my position is misleading because the practice of my position as a research project manager does not follow the functions advocated by the principles of Project Management. Following the terminology introduced by the European Commission in its research programs, this name essentially refers to the person in charge of the administrative affairs of the projects. This terminology is not the same as rationally designing, developing, and leading a project's activities and goals. The project management activity, at BSC, is about generating work timesheets to justify the deviations of time, cost or scope, at the end of each period. In case of time and/or cost deviations an explanation of the deviations on the scientific work must be delivered. This explanation sometimes cannot be fully written by the project manager, for this reason the researchers involved in the project are also involved in delivering a congruent explanation of the deviations.

#### **4.2.2. Data collection**

Empirical research is intensively developed in gathering information through methods such as, participant observation, analysis of documents –newspapers and organization's internal documents, periodic informal meetings, and in-depth interviews. The data sources' triangulation enhances confidence in the subsequent findings on the questions under study (Dezin, 1989; Patton, 1990, 1999). The "Triangulation across data sources (multiple informants at different levels of the firm, from different functional affiliations, and across sites) and across data collection methods (interviews, documentation, and observation)" (Orlikowski, 1993: 319) enables cross-data validity check, ensures credibility of the qualitative analysis, and strengthens the consistency of outcomes generated (Patton, 1999).

For instance, the in-depth interviews were carried out in different time scales over four years –from 2010 to 2014, on at least twenty-five different occasions. More than twenty hours of interviews were recorded and twelve researchers were interviewed, ten of them being researchers at the BSC and two of them not belonging to BSC, but often collaborating with the researchers at BSC and belonging to other equally important research institutions. With this, triangulation across data sources was based on covering all major research positions from Ph.D. students, group leaders and department directors. The director of the research organization who was the first to be involved in the study got an interview that lasted for more than 45 minutes. The triangulation across the data collected methods from the in-depth interviews was intensively validated through newspapers, organization's internal documents, and informal meetings with the interviewees or other researchers who were relevant to the topic.

Similar to the in-depth interview the granted informal meetings or interviews were carried during the four years that this research was carried through, at least once a month. The participants of the informal meetings are part of the twelve researchers interviewed, and some other researchers from the BSC, external collaborators and other researcher from other

research organizations that are directly or indirectly related to the BSC. The informal meetings strengthen the consistency of the subjects of research and were crossed with the data obtained from the in-depth interviews. In these informal settings the interviewees openly expressed their lived work experiences, work developments and validate some of the data obtained through other data sources.

The data obtained from web and text documents have been reviewed aiming to improve, validate and give consistency to the research. With this aim some of the documents reviewed give consistency to the context of the Barcelona Supercomputing Center. Some other web and text documents have been reviewed to extend my understanding on the aims of some of the projects and programs the research organizations and researchers are dealing with, some others inform publicly about the development of the Barcelona Supercomputing Center, and finally, some other documents have been reviewed to inform about the relevance of the subject of research<sup>30</sup>.

The data on particular observations was collected while I was working at the BSC as a research project manager. My responsibilities as a project manager were to take care of the administrative affairs of several research projects. During the preparation of projects' reports, I have been working close to the BSC researchers, group leaders and department directors. This work experience permitted me having direct evidence of the process of managing research projects and during the interviews being familiar with some of the subjects and expert language of the interviewees.

#### **4.2.3. Analysis of the data collected**

In Grounded Theory, the analytical method used is based on the constant comparison method (Patton, 1990). This method considers that the similarities among the cases chosen permit to compare the cases; and the differences among cases chosen permit to highlight the differential aspects. Therefore, it focuses on detecting similarities and comparing the differences among the cases (Straus & Corbin, 1988; Orlikowski, 1993). Similarly, this empirical research delivers an analytical sample with the criteria of similarities and differences between research disciplines, departments, and projects but combines it with an embedded analysis of specific aspects of the cases (Creswell, 2013). Comparing the different views researchers have of the research activity -the similarities and differences of the diversity of research aims, research projects, and research communities that converge at BSC.

However, the phenomenological approach also focuses on specific aspects of the research activity to align it with the theories developed in conceptual framework. With this purpose the empirical research focuses on revealing the meanings and understandings of the researchers about the subjects developed in the conceptual framework, and with the use of the double hermeneutic method, the ideas developed conceptually are observed. Additionally, the case studies introduce new ideas about the subjects developed.

---

<sup>30</sup> *Annex 4: The data Source Collection: Web and Text Documents*

The close insight into the researchers' practices and motivations brought the events and the context of the creation of the research organization and the stories of the interviewees about their view of research. The first case resulted from an in-depth interview with the director of the BSC and with the director of the BSC management department, direct participation and analysis of written documents. It focuses on the scientific development that made possible the creation of this research organization and emphasizes the scientific policy undertaken by the Spanish Ministry of Education and Science and the administrative steps leading to the creation of this research organization. Based on this context the case study develops the tensions produced by the given organizational structure with the departments and some researchers.

Different from this first case study, the remainder of the cases were developed inquiring into several researchers, group leaders and director departments work experience. The case studies focused on developing the research questions arising out of this context and based on the conceptual framework. Their analysis reveals how the variety of the research goals and the variety of research projects was connected to the management of the tension between creativity and productivity through different forms of management. This distinction previously not foreseen by Project Management and its methods introduces the possibility to enlarge the notion of project and include other forms of management aligned with the management of research. The cases also focused on the way researchers ideate, create and develop their research projects based on the theory of action developed in the conceptual framework. The researchers' creativity allows coping with the difficulties of their activity, of defining and developing research projects. The idea of creating and developing projects is linked to the notion of routine involving judgment within even the most restricted environments. This notion of routine offers spaces for creativity in order to mediate the emergence of constraints and problems, but also to appropriately choose the possibilities offered by the action.



## CHAPTER 5

### THE CREATION OF THE BARCELONA SUPERCOMPUTING CENTER AND THE TENSION BETWEEN ITS STRUCTURE AND AGENCY

*“La ciencia debe de tener continuidad. Crear un grupo de investigación cuesta muchísimo. Y cuanto más fuerte es el árbol más agua necesita, y si dejas de regarlo, este árbol se muere.”* .- Dr. Mateo Valero, BSC Director

This chapter presents two case studies that complement one another. The first, The Creation of the Barcelona Supercomputing Center (BSC), emphasizes the political decisions and the institutions that led to create it, as well as the scientific mentality of the main actors and the history and forms of work of the preceding scientific institutions on which the BSC was built. Those characteristics are essential for situating the second case study, The Tension between its Structure and Agency, presents the mission and structure of the BSC as well as the ways that groups of researchers reacted to this structure and, in an informal way, transformed it along with their work conditions.

The case studies reveal the information gathered during several long, in-depth interviews undertaken with the director of the BSC and the director of the Management Department at BSC, for the subject of the creation of the BSC, and some researchers of the Computer Applications Department for the subject on the tensions. The empirical research is intensively developed in triangulation methods using different information sources, such as in-depth formal and informal interviews, participant observations, and analysis of internal and external documents, such as, the book of the Spanish roadmap for unique research and technology infrastructures book, and the websites of the Faculty of Informatics, the BSC, the Ministry of Science and Innovation (MICIN), and Scientific Research Council (CSIC).

The first case study about the creation of the BSC emphasizes the important role of the people involved in the creation of the research organization and the political decisions that led to its creation. The two interviews focus in the role of two of the main characters involved in the creation of the BSC, the director of the BSC and the director of the Management Department. Their stories reflect their personal character, the important aspects of their personal experience, and their particular vision of the future organization. The story reveals how their previous scientific and managerial experience, their particular view of scientific research, and their individual interest and motivations towards the future of scientific

research, were the underlying aspects that determine the particular organizational structure of the BSC.

The agency of the founders of the BSC is central for developing the second story about the tensions elicited by the organizational structure, represented on the organizational chart. The story reveals some of the reasons for the resistance of researchers to obey the structure and presents the idiosyncratic ways in which these conflicts were solved. The categorical distinction reflected in the organizational structure between scientific research and technological applications as different types of activities, provoked the resistance of some researchers from the Computer Applications Department. The new organization of work influenced the work activity of the researchers. The distinction between science and support affected the scientific prestige of the researchers developing technological applications and the way they cooperate with external and internal research groups, and private companies requiring the development of technological applications.

## **5.1. The Creation of Barcelona Supercomputing Center**

The concurrence of three circumstances triggered the creation of BSC: the successful initiatives of the Department of Computer Architecture in the Faculty of Informatics at the Polytechnic University of Catalonia, the governmental investment on research facilities through the program on Singular Scientific and Technical Infrastructures (ICTS), and IBM interested in finding the appropriate locations to place four supercomputers.

The origins and the particular organizational structure of the BSC brings us back to 1976 when the Ministry of Science and Education publically announced the order to launch a degree on computer education. The Ministerial order was sent to fill up the gap of research in computer sciences and to supply the demand of professionals for the technological industry development. Previous to the date, back to 1969, Spain had but a single professional school of informatics, located in Madrid, vaguely situated within the educational system, with a syllabus structured to a 5 years period. And not until 1973, did a young industrial engineer and professor of the Calculus and Mechanics Laboratory of the School of Industrial Engineers of Barcelona head the initiative to establish a Computer Center in the Polytechnic University of Catalonia. The Ministerial order and the circumstances above provoked the forthcoming Informatics Faculties of Madrid, Barcelona, and San Sebastian, in 1976, whose objective was to promote research, the training of people, and the creation of a new university based profession (Puig Rovira, 2002).

At the Informatics Faculty of Barcelona an initial commission formed by professors of other schools of the Polytechnic University of Catalonia, professionals, and foreign professors on computer sciences, took care of organizing the Faculty, designing a five-year degree, and running the courses (Puig Rovira, 2002). They attracted recent graduates from other disciplines and offered the possibility to obtain a Ph.D. in computer sciences and be trained for taking up the responsibilities of the Faculty. Mateo Valero, who had a degree in Telecommunications Engineering, foresaw the possibilities of this initiative, and in 1980, he

obtained his Ph.D. in computer sciences, which was the first conferred by the Faculty and started to work hard towards its success by fostering the scientific culture within the Faculty, and above all, the Computer Architecture Department<sup>31</sup>.

Another important aspect of the creation of the BSC is connected to an ambitious and central program promoted by the Spanish Ministry of Science and Education on constructing Singular Scientific and Technical Infrastructures (ICTS) “for the development of a scientific and technological research unique or exceptional in its genre, with a very high cost of investment and maintenance, and whose importance and strategic nature justifies their availability for the whole R&D collective” (MICIN, 2010). The third circumstance that led to the creation of the BSC is the fact that in 2003 IBM was looking for the appropriate location and the appropriate partners to host one of its four supercomputers. The requisite for hosting one of the four supercomputers was to continuing investigating on developing faster supercomputers and improving supercomputing technologies.

In 2004 the three public institutions involved in the negotiation process, the Spanish Ministry of Education and Science (nowadays a department of the Ministry of Economy and Competence), the Catalan Government, and the Polytechnic University of Catalonia, reach an agreement with IBM. And then in March 2005 a public consortium was formally constituted and the three institutions agreed to one hundred per cent funding of the resources needed to buy and implement one of IBM’s supercomputers (BSC, 2010a).

Later, during the exploitation phase, they agree to provide the structural funds needed to run the supercomputer. Extra funds are acquired from the cooperation with industrial partners and from successfully participating in other European and Spanish research programs. The diversified channels that the BSC uses to obtain funding and resources are in line with the double nature of its mission which, on the one hand, aims to investigate, develop, and manage the supercomputing technology to facilitate scientific progress. And, on the other hand, it aims to take advantage of the infrastructure to develop its own research in the fields that are using information technologies for the development of their own research, such as, Computational Sciences, Life Sciences, and Earth Sciences.

The history of the creation of the BSC is the product of several events already highlighted in the literature: First, the importance for governments on fostering the merger between industry and science to accelerate and promote economic growth through the creation of new knowledge and technologies. Second, the will of some corporations to externalize some of its in house research and development (R&D). Third, the interest of the three institutions that their merger will bring new clients to the R&D sector (Jacob, 1997). Within this context, science and research introduced terms as applicability, efficiency, and productivity which introduce some constraints on the development of the research activity, traditionally concerned with the freedom and creativity of the researcher who have no constrains.

---

<sup>31</sup> *BSC Definition of Computer Architecture* is the design and internal organization of a computer systems’ hardware.

### 5.1.1. An Agentic History of the Creation of the Barcelona Supercomputing Center

The first part of the interviews with the directors extensively focused on the story of the creation of the research organization, which brilliantly reflects how its founders overcame the difficulties, took advantage of the opportunities of the context, and imprinted their particular view of the research activity considering their experience and circumstances.

*The story told by the Director of the BSC* explains the main conditions, events and developments of the creation process of this research organization. It is a story told with both rigor and passion, by the director of the BSC. He finds himself in a very challenging situation that he takes up with an exceptional effort, willingness, and with the appropriate decisions to nurture both the development of basic scientific research but also the field of practical applications.

The story includes three episodes; the first, is the creation and development of the Computers' Architecture department, the second, is the creation and development of the European Center for Parallelism of Barcelona (CEPBA), and the last, is the creation and development of the BSC. In all of them his strategy is successful. The story also uncovers many aspects of the mentality of an important type of researcher and academic.

The story I was told started in 1980. At that time, the Barcelona Faculty of Informatics, together with the Faculty of Informatics of Madrid and San Sebastian, was newly created, in 1976. In this context, the storyteller was a young researcher, who soon got a full professorship and became the chairman of the Computers' Architecture Department. It did not take him long, as in his early thirties he was named Dean of the Faculty of Informatics of Barcelona.

When he got there, the Computers' Architecture Department did not have any scientific tradition, moreover, at that time, the Spanish and European industrial environment was limited, inexistent, and uninterested in the production of computers. He took the situation as a challenge, and started working on a way to overcome these difficult circumstances. To get over this situation, he decided to stimulate the cooperation with private companies, working with them as sponsors of his research projects. At the same time, he encouraged himself and his researchers to pursue theoretical research with the aim of publishing in the most recognized journals.

His strategy was wrapped in his extraordinary will; he worked, with the support of his family, more than 4000 hours a year. Since then, he has never lost this intensity. The fruits of his activity were important, especially in the context of the Spanish university: he attracted doctoral students and researchers to the university department, and he was able to pay them with money from industrial partners, and, this way he consolidated a research group. Shortly after, the Computers' Architecture Department became a success and his group was playing in the international league, participating in important conferences and seminars, and attracting important researchers from all over the world.

In 1991, he strove to create the European Center for Parallelism of Barcelona (CEPBA). This institution belongs to the Polytechnic University of Catalonia and has the support of the Spanish Ministry of Education and Science, the Catalan Government and the Polytechnic University of Catalonia. It was created to develop computers' parallelism techniques<sup>32</sup>, which extraordinarily, improve computers capacity and speed. Additionally, the center brought those techniques closer to small and medium-sized enterprises by offering them, not just access to the computer, but training as well.

The CEPBA not only collaborated with key private partners but also with the Polytechnic University of Catalonia, while jointly developing research projects to improve the parallelization techniques. In this period, Compaq Computer Corporation, an American company founded in 1982, was known for producing some of the first IBM-compatible personal computers. In 2002, Compaq was acquired by Hewlett Packard and Intel. Intel acquired the Compaq processors design branch and decided to maintain the lab that Compaq had in Barcelona and continued the cooperation with the CEPBA. The CEPBA success and development was accompanied by the capacity and vision of its director to attract doctoral students and researchers from his university department, as well as, other university researchers to develop important research on information technologies.

At that time, another important fact concerned him. The entrance of Spain into the European Community opened the doors to new research funds. The CEPBA and his university Department on Computer Architecture were extraordinary instruments to get some of those resources. He obtained more than forty million Euros from this new source of research funding. These new resources were determinant for the consolidation and development of CEPBA and also essential in ensuring the continuity of his research. These substantial and thriving events drove him to think about new challenges and developments, and then IBM crossed on his path.

IBM was looking for the appropriate locations to place four supercomputers. He convinced IBM to build one of the supercomputers in Barcelona, together with his partners, the Ministry of Education and Science, the Catalan Government, and the Polytechnic University of Catalonia. He imagined the new research center, as a powerful institution developing and applying supercomputing technologies for the industry and whole scientific community.

After a year of prosperous negotiations, in March 2005, the BSC was created. The institution is a public consortium formed by the Ministry of Education and Science, which owns a 51%, the Catalan Government with a 35%, and the Polytechnic University of

---

<sup>32</sup> **Parallel computing definition:** Traditionally, software has been written for *serial* computation, differently parallel computing is a form of computation in which many calculations are carried out simultaneously. Operating on the principle that large problems can often be divided into smaller ones, each part is further broken down to a series of instructions, the instructions from each part are execute *simultaneously* on different processors and an overall control/coordination mechanism is employed. (Retrieved in 2014 from the website of the Lawrence Livermore National Laboratory "Introduction to Parallel Computing". Author: Blaise Barney,)

Catalonia with a 14%, respectively. With this agreement, IBM established a permanent laboratory at BSC and together they improve and develop supercomputing technologies.

However, for him the reason to create the BSC was more than to investigate, develop, and manage information technology in order to give supercomputing services to the scientific community. His will now then is to create a bridge between technology or computer sciences and scientist from different field and backgrounds; to create a place where multidisciplinary science takes place. He thinks this is the future of science. This is why together with a computer sciences research department, he also included a Life Sciences and an Earth Sciences' Department. The will, the hard work, and the right decisions again placed him on a successful path. He, now, emphasizes that he is proud of being a renowned and awarded researcher and the director of one of the most important research organizations in Spain.

***The story told by the Director of the Management Department at BSC*** leans towards explaining the important role of the Spanish Ministry of Education and Science and the decisions that lead to the creation of the BSC.

This story is close to a technical or administrative report, in which the main characters are the Ministry, its departments, its experts, and the storyteller, who, at that time was the Deputy of the Ministry. They were in charge of designing and implementing a new scientific policy. The storyteller presents himself as a member of the ministerial team whose management is based on making rational decisions and establishing fixed procedures. He tells the story in an objective way avoiding many references about his feelings, interests, and involvement.

The story starts around 1990, when, due to his long and successful experience in Germany, as a director of marketing, sales, and distribution of an important pharmaceutical company, he came back to Spain to lead the Center of Technology Transfer of the Polytechnic University of Catalonia which was created in 1987. Some years later, the Spanish Ministry asked him to participate in the design and development of a new research and technology policy.

The new research program, called “Singular Scientific and Technological Infrastructures”, (ICTS)<sup>33</sup>, aimed to create some important centers, which would offer research services to a large number of groups and would contribute to the technological development. That program made possible the creation of the BSC, with which this story ends.

His story tells about the important role the Ministry played in the creation of the BSC. He explains how the Ministry introduced changes to the scientific policies so as to prioritize the construction of several important scientific infrastructures and ensure enhancement of Spanish research. The type of infrastructures included in this program should accomplish

---

<sup>33</sup> ***Annex 3: The Spanish Roadmap for Unique Research and Technology Infrastructures (ICTS)***

several requirements: first, to be singular, referring to the need of being unique in their gender. Second, to be too expensive to be built by the current research organizations. And third, to be placed where the knowledge is, to ensure the success of the scientific infrastructure (MICIN, 2010). The Ministry also aimed to achieve certain rationality and uniformity in the management model of the infrastructures and it ensured its economic and legal control.

He also explains that the BSC was created due to the confluence of two important facts, which are the existence of a strong computer sciences group in Polytechnic University of Catalonia, and the fact that, IBM was looking for the appropriate place for one of its supercomputers.

At that time, the storyteller was in charge of the design, implementation, and execution of the Ministry ICTS program. He was involved in the design and development of the policies that will ensure the success of the projects. He obtained a meaningful amount of knowledge on the ICTS research program and gathered support from key decision makers, who were opposed to building up this research infrastructure in Barcelona. He took advantage of the situation, his knowledge and his experience, in ministerial policies, private industry and research, resulting in him being selected to be part of the executive board of the BSC.

It was in 2007, when he took the control of the Management Department at the BSC. He introduced administrative policies based on his long experience as head of production departments and as a Deputy Director in the Ministry. He brought the sense of the administration techniques, controlling finances, and developing projects through implementing processes and assigning concrete tasks to each unit. He supports Project Management methodologies and processes to ensure the success of the administration of the research projects. He is aware of the importance of administrating the projects following the rules frequently established by the European Commission and the Spanish Ministry in order to get funding. Having this in mind he lead with the equilibrium between basic research, applied research, and the fact that the BSC provides supercomputing services to a broad community of scientists.

Nowadays, after the extraordinary growth of people and projects hold by the BSC, he is focusing in the implementation of new policies related with the career development and educational plans of the researchers and staff. He claims that a strategic plan is being developed with the aim to move away from the work vices acquired from the university and to build a research center with its own culture.

## **5.2. The tension between its Structure and Agency**

The stories about the creation of the BSC described the context and circumstances in which the BSC was created and focused on the particular experience and conceptualization of science and research of the founders of the organization. The resulting view of the

founders of the BSC about scientific research and its management is manifested in the organization structure. The BSC organizational design clearly distinguishes between scientific research and the development of technological applications. This distinction elicited some tensions among the members of the organization. The resulting product of this tension questioned the former organization's structure and triggered the reconfiguration of some departments.

The theoretical research about the tensions between the structure of the organization and the agency of its members together with the phenomenological approach to agency theory introduced in the conceptual part, is been used to expand the understanding on the subject of the impact of work structure, or research processes, with this particular case, in two ways: first, it builds on the distinct aspects of workers resistance to obeying the structure, and second, it describes the very subtle manner of solving the conflicts grounded in the structure.

The following stories recognize the tension created by the organization structure which relegated some of the important aspects of the work and research activity of the previous organization and provoke the resistance of the researchers affected by this decision. The researchers' resistance to obeying the structure resulted in other practices and procedures oriented to successfully cope with the demand of their work activity. However, the tension the structure creates also affected the researchers' identity, careers, and scientific prestige.

### **5.2.1. Mission, Structure, and Types of Work**

The subject of the tensions between structure and agency is introduced through the analysis of the mission, the structure, and the different work activities that the organization is enrolled in.

The scientific determination of the BSC is reflected in its mission, which is stated in the following way: "the mission of BSC is to investigate, manage, and develop supercomputing services for the whole scientific community to foster scientific progress. With this aim special attention has been taken to areas such as Computer Sciences, Life Sciences, and Earth Sciences" (BSC, 2010b). In this text, "the whole scientific community" puts no limits on the type of research discipline that can be used by the BSC supercomputing services and encourage both internal and external researchers to access to them. The aim of "fostering scientific progress" involves all scientific disciplines, from which the wide open fields of Computational, Life, and Earth Sciences are the starting points. To achieving these aims, a strong constraint is taken for granted and even if, it is not explicitly specified in the mission: the BSC, its directors, and its researchers, have to ensure that the supercomputer "Mare Nostrum", which at that time was one of the most powerful supercomputers in Europe, will work at full capacity. This condition almost determines the kinds of research, the way of doing them, and the exertion of pressure on the activities of the researchers.

Based on these considerations, the BSC was organized in two divisions: the Scientific Division and the Support Division. The Scientific Division is formed by the Computer Sciences Department, which includes a group of researchers from the Center of Parallelism,



the Life Sciences Department, and the Earth Sciences Department, led by new groups of top researchers in those disciplines. The Support Division is formed by the Management Department, in charge of the general administration and the project management department; the Operations Department, with the functions of giving access to the supercomputer to internal and external researchers and to take care of the maintenance of the supercomputer, and the Computer Applications Department formed by a group of researchers coming from the Center of Parallelism, whose mission was to give support to internal and external researchers in the development of their applications (BSC, 2010c).

This resultant organizational chart (*see Figure 1*) accordingly to the founders' view of scientific research, distinguishes between the scientific and the support divisions and their departments. At this moment this distinction was more relevant than the work activities developed at the BSC, which are: scientific research, technological applications, and offering access to the supercomputing services for both internal and external researchers. This triad of activities involves a very complex variety of forms, norms, and methods of work. For instance, the theoretical research on Computer Sciences involves theories, methods, competences, and skills associated with this field. The theoretical research on Life and Earth Sciences requires an intense use of the supercomputer, and therefore, involves not only practical skills on computer programming but also theoretical knowledge on biology or physics. As a result, a full project on technological applications requires profound interdisciplinary knowledge and expertise in specific technical fields, on building mathematical models, and rewriting them in computer language.

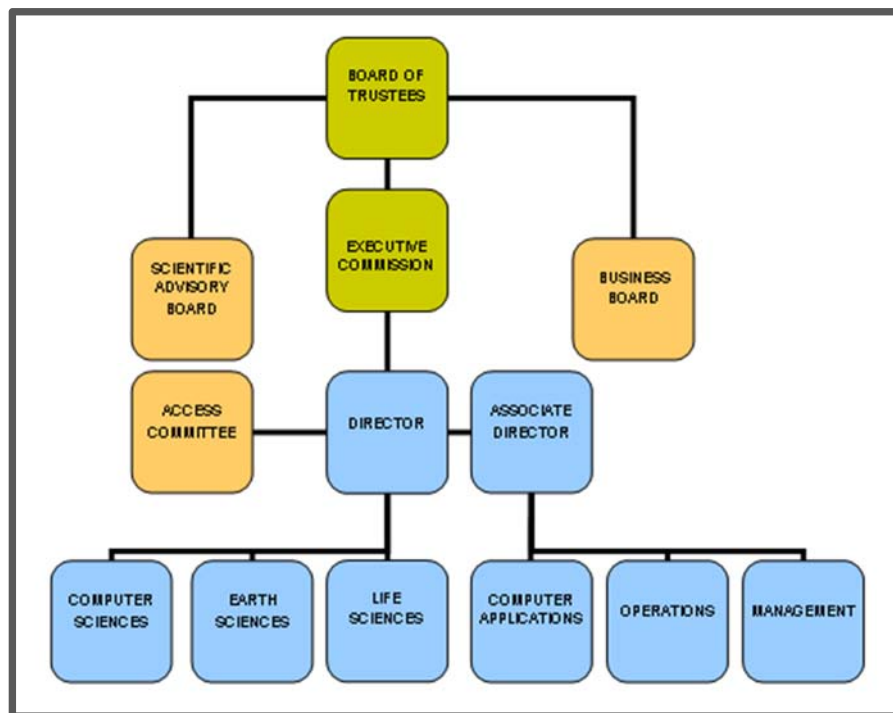


Figure1: BSC Organization's Chart  
 Source: retrieved in January 2010 from [www.bsc.com](http://www.bsc.com)

The structure of the BSC could seem conventional, but a careful examination reveals many peculiarities and the origin of important labor problems. The influence of the categorizations and views of science and research of the main actors, determined the organizational structure. In particular, the director's successful career experience led him to decide that the BSC would carry on research on computers' architecture, research on other scientific disciplines oriented to publish in top scientific journals, and research on the development of technological applications for public and private organizations, which is rarely publishable. His severe categorization of the scientific work considers that scientific research has high scientific value and prestige, whereas technological applications, whatever their importance, have not these qualities. As the BSC had to be a world leading research center, he discriminated against technological applications, from the beginning. The director also considered that the Center of Parallelism, from which many projects and researchers were to be transferred to the BSC, was a small institution whose structure, culture, and work conditions had not to be taken into account when creating the structure of BSC. But the previous structure, culture, and work conditions had a strong influence on the expectations of researchers coming from the Center of Parallelism.

### **5.2.2. The Tensions and their Resolutions**

If we accept the categories and judgments that guided the process of planning the structure of the BSC and think that they are the basic criteria, then we could say that this structure is the rational consequence of them. But there are other aspects that we have to consider. Science and research are an "intensely personal activity, strongly dependent on the ideas and imagination of individuals or groups of individuals" (J. Taylor, 2006). This feature inevitably projects that agency plays a distinctive role in organizations. Not only because "authority of expertise and authority of position would less seamlessly coincide" (Barley, 1996:409) but also because of the difficulty to accurately describe and include the goals, the functions, and the work practices of the researchers concerned with successfully handling the demand of their work activity. Furthermore, these characteristics also reflect the particularity of how in this type of organizations conflicts are resolved.

In the transfer of researchers and projects from the Center of Parallelism to the BSC, it was neither considered the profound changes to the new organization's structure inferred in the functions of researchers nor in the new relation between theoretical and applied research. The new organizational structure directly affected the group of researchers who came from technological application development, and indirectly the whole organization. The presented structure of the BSC not only weakens their scientific prestige, but also altered their collaboration with external projects on technological applications and their collaboration with internal research groups.

On scientific prestige, the Center of Parallelism has a loose structure and the groups of researchers working on computers' architecture and on technological applications formed a single scientific community who considered themselves as peers of the same status. But the institutional adjustment at the BSC affected their relationship. The first group constituted

the Computer Science Department of the Scientific Division, while the second group formed the Application Department of the Support Division. This decision introduced important discriminations and the researchers on technological applications considered that they had lost both scientific status and prestige. The tension produced by this situation and the ways of solving it were also related to the work conditions that we will point out. Let's say for the moment that the BSC director realized that the capacities of the group were not fully exploited and soon introduced some changes into the structure of the organization. From this, it resulted that the department was given a scientific name, the Computer Applications for Science and Engineering (CASE) and appointed professor Cela as its director, and two researchers as group leaders, but it continued to be linked to the Support Division.

On the collaboration of researchers of technological applications with external company projects, in the Center of Parallelism, the group of researchers developed many capacities on interdisciplinary and applied research and hold many functions. They collaborated with private companies creating mathematical models and writing computer programmes. These activities required not only mathematical and computational skills but also a deep knowledge on specific subjects of research. Some projects required hiring researchers who have this specific knowledge and build multidisciplinary teams. This kind of research is very creative and gives to the researchers a high prestige. In the BSC the philosophy of work changed: external companies and researchers have direct access to the supercomputer and the functions of the researchers on technological applications were reduced to give support on computation. But objective conditions of work are very stubborn. One of the first and most important applications developed at BSC was the Airbus project. On it, this line of work proved to be impossible, external researchers were going on striving for modelling the problem and writing in the computer language, and, after a year, they asked for the collaboration of the researchers on technological applications. In this way, the Computer Applications group recuperated their important research functions and status.

On the collaboration of researchers of technological applications with internal research groups, on the line of the philosophy of work we have mentioned, the functions of these researchers were to give support to the three Scientific Departments of the BSC. On this point, the following story of a meeting with the group leaders from Computer Applications and the Earth Science Departments, tells about the emergence of tensions created by the difficulties the structure has to properly assign the functions of the researchers and how this conflict was managed. The computer applications researchers claimed that they would develop very quickly the software of the model on which earth science researchers were spending considerable amounts of time. The earth science researchers emphasized the importance of working cautiously on the models and expressed their interest on the task. The researchers developing computer applications were afraid of being submitted to the earth science researchers, and the earth science researchers were not interested in the earth science approach of the researcher on computer applications. So, they did not collaborate and the Computer Applications Department subtly rejected working as technical support for the research undertaken in the Computer, Life, and Earth Sciences Departments.

The resolution of the conflicts never implied arguments of authority position, they were very subtle. The applications department compensated for the difficulties to collaborate with the Earth Science department developing their own scientific projects, many times far from Life Science and Earth Sciences research subjects. At an institutional level, this decision was more or less tolerated. Even though the researchers disobeyed the planned structural functions, the director knew that enforcing the planned structural functions at this level will go against the scientific output. At a practical level, the problem of the planned internal support for the Scientific Division was solved on a lower plane. Each of the Scientific Division Departments contracted their own research technicians, who are very skillful at writing programs run in the supercomputer. The general lines of the story also display empirical evidence on how the agency of researchers and the imperatives of their work opposed the formal structure, and even the organizational chart reminds the same, in practice it was constantly modified according to the agents involved in the activity.

This infers on the difficulty of organizations' structure to accurately orientate through its functions and division the work activities and practices of an organization. According to the literature that deals with the tension between structure and agency this reflects, on the one hand, the degree of difficulty to rationally define the functions and the work activities of this organization will lead to differences, with other type of organizations, in the constant modification of the organization's structure due to its impossibility to capture at a very concrete level the intricacies of the work practices. On the other hand, the degree of difficulty to rationally define the authority and communication lines of an organization will lead to differences, with other type of organizations, in the conflict resolution mechanisms, which do not obey the authority lines described in the structure, but to the imperatives of the work activity and its practices.

The authority lines are not obvious, as often the researchers or experts, have more knowledge on their subjects of work than their directors. Managers "may have specific forms of specialist knowledge, but in general [they do not] possess the knowledge of the employees" (Jensen, 2008: 135). This new relationship between managers and scientific or professional manpower redefines central management topics such as control and authority and points at creativity and freedom to obtain the engagement and mastery of the workers. The conflicts that emerged due to this new relationship are solved by the researchers and directors in a way that avoid forms of coercive authority. Therefore, the way these tensions are approached relies on each organization.

Also, the case outlines the importance of the attitude of researchers of the computer applications department towards their work activity and how this was determinant to change the view of the founders towards their work activity. They acknowledged that the given organizational structure relegated some important aspects of their research activity. They resisted reducing their work activity to what the founders of the organization thought was their work activity. Their resistance was based on demonstrating with objective facts how important and valuable their work was. The researchers' resistance to obeying the structure resulted in other practices and procedures oriented to successfully coping with their work

requirements that were neither reflected nor determined by the structure of the organization. Moreover, the misconception of their work activity affected the researchers' identity, careers, and scientific prestige. Their case shows that research could not be managed with conventional methods and approaches but requires other management forms.

The objective and good results of their work, could not only demonstrate that their work was as important and valuable as the one developed in the scientific division but that they deserved an appropriate distinction oriented towards preserving their significant work, and recuperating their damaged identity and prestige inside and outside of the organization. As a result they did not obtain a place in the scientific division but they were given a scientific name, Computer Applications for Science and Engineering (CASE) and an internal department structure comparable to other scientific departments. Nevertheless, in 2012 some changes in the BSC organizational chart appearance were introduced but they omitted the modification of the new name given to the Computer Applications Department. The new chart kept the wrong department name (*see Figure 2*).

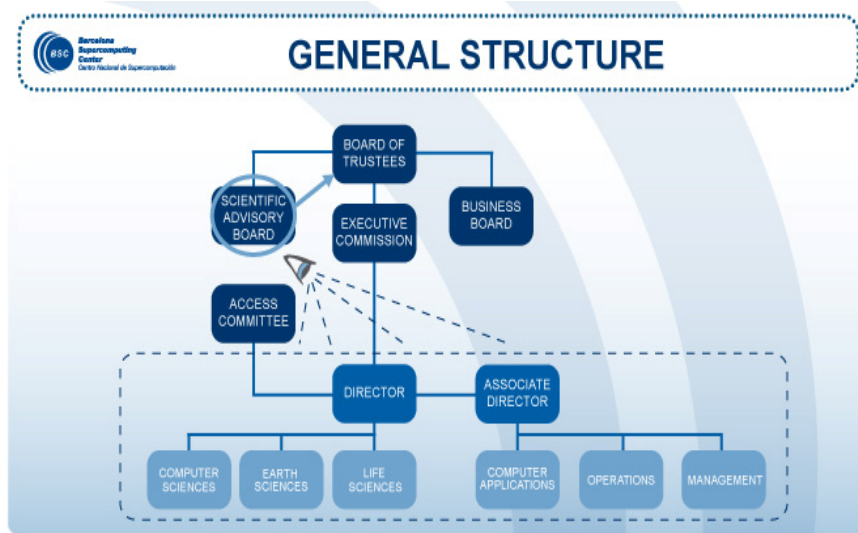
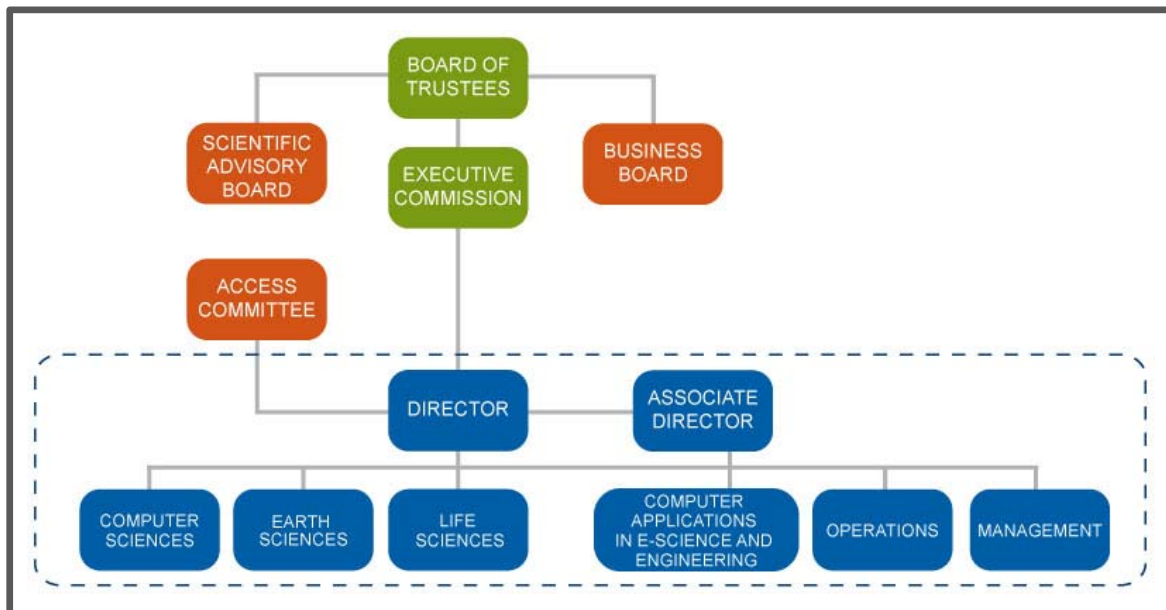


Figure2: BSC Organization's Chart  
 Source: retrieved in September 2012 from the [www.bsc.es](http://www.bsc.es)  
<http://www.bsc.es/about-bsc/organization>

This carelessness with the subject of distinguishing them, which was very important for the identity and prestige of the researcher, was not repaired until late 2014, when the new BSC organizational chart showed the new name of the Computer Applications in Science and Engineering Department (*see Figure 3*).



*Figure3: BSC Organization's Chart*  
 Source: retrieved in October 2014 from the [www.bsc.es](http://www.bsc.es)  
<http://www.bsc.es/about-bsc/organization>

For instance, managers “may have specific forms of specialist knowledge, but in general [they do not] possess the knowledge of the employees” (Jensen, 2008: 135). This new relationship between managers and scientific or professional manpower redefines central management topics such as control and authority and points at creativity and freedom to obtain the engagement and mastery of the workers. The conflicts that emerged due to this new relationship are solved by the researchers and directors in a way that avoid forms of coercive authority.

# CHAPTER 6

## MANAGING RESEARCH PROJECTS

This chapter presents seven case studies on the way researchers manage research projects, which in a direct or indirect way are related to the Barcelona Supercomputing Center (BSC). The first case introduces the vision of the tension between creativity and productivity of the directors of this institution, which influence the mentality of the researchers and it is reduced to some interviews with their interpretations. The other cases involve in-depth interviews, informal conversations, analysis of internal and external documents, field participant direct observation, and feedbacks in long periods of time. The cases are classified in two groups. The first group focuses on the tension between creativity and productivity researchers in organizations deal with. The second group concentrates on the conceptual spaces in which creativity can be developed and on how researchers take advantage of them. Both groups of subjects are related and each case study leads to findings in several topics. This empirical research shows the interest of the conceptual framework of this doctoral work for understanding the ways of doing research following the method of proposing and developing research projects.

### **6.1. Tensions between Creativity and Productivity, Categorization of Projects and Forms of Management**

On the first subject, the tensions between creativity and productivity, many researchers are not aware of this problem and when it is presented to them, they are not interested in it. In the first case study on the view of the directors of the BSC, they do not recognize its importance and concede that the profession of researchers allows experts to overcome these kinds of difficulties. The cases on the Grid Computing group manager and on the group leader on High Performance in Computational Mechanics show that these researchers deal implicitly and unconsciously with the tension focusing on the degree of specification of the projects. They manage distinctive projects that they consider well specified and, therefore, they consider that they require low levels of creativity, and projects that are ambiguous and involve a high degree of creativity.

A common feature of research institutions, such as the BSC, is that they consider managing projects to deal with the administrative tasks of the projects by research project managers and not by researchers. This misconception of the management of research and its projects discloses important organizational facts that affect the practice of Project Management. Only on the case of an Associate Research Scientists at Columbia University, is there recognition of the problem of the tension between creativity and productivity and of

the idea that, managing research projects involves all scientific decisions and operations along the execution of the project.

### **6.1.1. Case Study on the View of the Directors of the BSC on the Tensions Between Creativity and Productivity**

This first case study shows the view of the directors of the BSC regarding the tensions between creativity and productivity.

*The BSC Director's point of view* about the paradox between creativity and productivity is related to the fact that he has been successful in developing theoretical and applied research, and also in creating thriving research groups and organizations. Therefore, he did not directly perceive any problem or tension between creativity and productivity. He had not reflected on it. Based on his experience he explained his vision of the paradox. He emphasized that to attract good researchers it is necessary to give them a lot of freedom and this must be counter balanced by several requirements, such as, producing important results and getting new projects, that should provide with a sufficient financial contribution, for both covering all direct and indirect expenses and bringing money to the institution. For him, how researchers manage freedom and productivity is a competence that they develop in their professional training as researchers. His model is based on his experience and researchers are persuaded to do it his way.

*Interpretation of the case:* The BSC Director's research policy gives a lot of freedom to the researchers in undertaking and developing their own research projects, with the sole requirement that they produce results, such as publishing in prestigious journals, or getting research funding from either public or private institutions. His reference to the experience acquired in professional training of the researchers for dealing with the tension between creativity and productivity, a subject in which he had not thought before, to him means that this competence is acquired through practice and cannot or it is not worth to make it explicit. Therefore, in his view the expertise each researcher acquires during his/her training is already related with all the aspects of managing research projects.

His view of research and its management places in the forefront the conceptual developments of this doctoral work as they contribute to dismiss this misunderstanding on how research and its management is carried on. A lot of things can be said about managing research, as it will be found in the following cases.

*The Director of the Management Department's point of view* about the paradox between creativity and productivity is related to the problems that he considered important when managing research which are close to classical management theories. Possibly his point of view was shared by many experts of the Ministry as it resulted to be very administrative and this type of discourse is very close to this kind of institution.

The problems he accentuates emphasize that Spanish researchers in public institutions give priority to problems related to scientific policy and financial resources instead of those



related with the tension between freedom and control. In the interview, he commented on the following general problems and situated some of them in the context of the BSC.

The first problem relates to research policy makers. Traditionally, the research policy is made up by scientists who are distinguished in their own fields; however, they do not have a global vision and over evaluate their fields of research and interest. For this reason they make many wrong decisions. The second problem is connected with the hybridism of organization's mission that work on basic research and, at the same time, provide services to a variety of clients -the scientific community and the industry. The BSC is looking for the equilibrium between those aims. And it is necessary to establish explicit criteria for the projects choice. The third problem is related with the second and is about the resource acquisition and allocation from a variety of research projects, both theoretically and practically oriented. The fourth problem explains that many research organizations, like the BSC, inherit the traditional research and management vices from the university. This is a common topic; he refers to it without giving any indication about those vices; rather, he takes them for granted.

Finally, the director of the Management Department adopts a very constructive position for the future of the BSC and, makes references to general instruments, brought up in some meetings, which could improve the ways of managing research, creativity and productivity. For him, it is necessary to establish a career plan, a training plan, for the researchers, and a control plan, which would let them know how to perform in their activities. All the aforementioned plans are to be contained in an overarching strategic plan.

***Interpretation of the case:*** The Director of the Management Department suggests that the idea of the developing a training plan for the researchers could be very positive as it is linked to the subject of doing and managing research. But the form in which he describes and conceives research and its management is very aligned to classical concepts of human resource management and bureaucratic organizations, and are also grounded in the Spanish Ministry and European Commission conceptualizations of research management.

The case shows how the tension between creativity and productivity only includes administrative functions and does not consider the fact that managing research implies a continuous judgment for the realization of a project. He is detached from the researchers' practices and work activity as he reduces the management of research to the notion of the governmental institutions. Therefore, it would be important to extend and complement his view on managing research with specific subjects developed in this doctoral work.

### **6.1.2. Case Study of the Grid Computing Group Manager**

This second case study describes the role, experience, and developments of a young researcher who leads the Grid computing research groups of the Computer Sciences Department at BSC. She describes her experience on how she, as a group leader, leads with the tension between creativity and productivity, the way she categorizes the different projects her group deals with and how these distinctions lead to different management forms.

Her view of the tension and the management of research connects with her career development. This young researcher was a doctoral student who, in 1994, obtained her Ph.D. in Computer Sciences at the Polytechnic University (UPC). During her Ph.D. the scarcity of resources and the ambiguity of the research topics, proposed by her advisor, on circuit design, took her to head towards new research areas and groups on computational sciences. Some years later, in 1999, she then joined the Center of Parallelization where she was nominated to be in charge of the investigation of an emerging topic on parallel computing, called Grid computing. Grid Computing is a variation of the conventional high performance computing systems where each of the computer resources that form the network can be in different locations. The computer resources are connected in a way that allow to distribute the different computational tasks and deliver the calculations.

She took to this situation bravely and was contented with the new challenges. In line with the vision of the director of the Center her research development was accompanied by a strong determination to promote and increase her network among different industrial and academic partners. This strategy would ensure the necessary resources for her research. At the Center of Parallelization, she increased her expertise in this area and soon started promoting and lobbying around Europe. Some years after, the BSC was created and her alignment, determination, and success took her to be selected as the manager of the Grid group when BSC was created. The concreteness of her research subject and the fact that she knew how to obtain funding out of both the National and European research instruments made her a very efficient researcher in getting resources. This was early rewarded with a lot of freedom to manage her research group.

Her research topic is significant and attracts both doctoral students and researchers. She holds a wide spectrum of research projects from basic and applied research that she develops with four Ph.D., two post-docs, and several technical support engineers. She is aware that every project type has to be managed differently as the goal specificity is lower when dealing with basic research compared to applied research projects. She concretely highlights the differences in the researchers' profiles depending on the type of project.

*... [The differences in the management of different projects can be observed in] the management of people. In basic research usually you hire Ph.D. students, because you are looking for the development of a new topic, which requires certain degrees of freedom. On the other hand, there are projects where you have deadlines, you have to deliver concrete documentation with in a term, you have to coordinate and interact with other members of a consortium,... these projects have higher managerial requirements, therefore it is more adequate to hire a senior researchers.*

The group leader is successful in submitting both theoretical and applied research projects and getting resources from different public funders. She also emphasizes that she has enough freedom to choose the topics of her research and orientate it towards a practical demand. Her research group works under her supervision and control. She is the one that takes the decisions on the design and development of the projects the group is involved in, leaving little room for orientating researchers' research towards personal goals and

objectives. She controls her group very closely to ensure the success of the research projects; her team must work under deadlines and she monitors the decisions at two different levels.

*I control the work development of the Ph.D. students because their lack of experience might cause irreversible mistakes when making decisions at the research level. The researchers with experience are monitored not in an everyday basis but when an important decision –managerial or economical, has to be made. So, the type of supervision is different as well as the type of research projects.*

When speaking about creativity and productivity, she recognized and connected the topic with the differences among basic and applied research projects management. On the one hand, the ambiguity of the goal and openness of the results, when managing basic research projects and, on the other hand, the specificity of the goal and result when managing applied research projects. However, she herself recognizes that research is being produced on the basis of convenient and situational logics. The identification of the research topics is done by the distribution of the resources.

She emphasizes her idea of Project Management aligned with the view of European Commission, and related it to project managers who are in charge of the project at the administration level. However, she is aware of some of the methods of Project Management developed by Project Management, such as Gantt charts that she uses to plan her work. These ideas are reinforced when she explains how the cooperation with the administration department helps her to develop her projects. And make the distinction between what she does and what the project managers do. While she emphasizes that:

*... Good research managers do not necessarily have to be experts; being experts they might be better to evaluate the progress of the project but nothing else.*

She also added that the necessary traits researchers should have, to manage research, are innate; they cannot be learned.

Based on her experience, the group leader highlights the differences in research projects and the differences in their managerial approach as a way to solve the tension between creativity and productivity. She emphasized the differences on the management of the projects through a strong distinction on the researchers' profile. Her understanding of Project Management is connected to the control of the administrative tasks of the project such as scheduling and budgeting and justifying in these terms the project development. She thinks this is an important task developed by the Project Management Office with whom she collaborates often.

**Interpretation of the case:** The case suggests that the group leader identifies managing research projects with the administrative affairs of scheduling and budgeting, and finally justifying these administrative objectives, alike to the view of the BSC directors. Nevertheless, during the interviews she shows a deeper understanding of the subject as she includes elements that are not administrative such as, a strategy and making decisions. Probably the expression “project manager” introduced by the European Commission which clearly refers to the administrative affairs and the lack of more specific concepts and terms

for conceptualizing research and its management, introduces some terminological misunderstandings.

However, she emphasizes other aspects, which show her recognition of the tension between creativity and productivity. She emphasizes the differences between very specified and ambiguous projects, which she identifies as technological developments and basic research. Her sense of the tension between creativity and productivity anchored in the formal constraints of research and funding institutions, makes her to assign basic creative research to doctoral students because their work conditions are not rigidly regulated by attaining findings in concrete periods of time. She finds this freedom very suitable when developing creative projects. In the academic world, it is usually accepted that doctoral research is the beginning of future and more sophisticated research works. If it be so, the case proves that doctoral research is very important. The research strategy of the leader of the Grid group is that new ideas are worked by doctoral students and when there are sufficient findings, then are introduced in competitive projects.

The doctoral students solve the problems developing theories and methods that later can form a research project. The research project includes these newly developed theories or methods, combining them in a way that is attractive to the funding agencies. According to the researcher this type of projects does not require high creativity levels, as the level of specification of the operations is very high.

### **6.1.3. Case Study of the Group Leader on High Performance Computational Mechanics**

The third case study describes the role, experience and developments of a young physicist who is the group leader of the computational mechanics research group in the Computer Applications Department. Computational Mechanics is the discipline that introduces computational methods to study phenomena ruled by the principles of mechanics. Its developments are considered a specialty of physics introduced to solve problems in through high performance computers. The case describes how he leads with the tension between creativity and productivity, his particular way of categorizing the different projects his group deals with and how these distinctions lead to different management forms.

The researcher's experience and his career development reveal his view on the subjects of research and its management. The researcher graduate on physics in Argentina and was a doctoral student at the International Center of Numeric Methods and Engineering (CIMNE) of the Polytechnic University of Catalonia from 1992. After 6 years at CIMNE he went to France as a post-doc. There, he first worked in a project funded by an aviation company and the Paris 6 University, and after it he moved to the National Institute of Research in Information Technology and Automation (INRIA), in Toulouse. The difficulties he was experiencing to find a research position in Spain took him to adjust his expectations and started to work in a software company in Mallorca. He tried hard but never enjoyed working for a company, partly because of the lack of freedom. After two years he was able to move on to the University of Girona and worked there as a lecturer. At the same time, the BSC was

just being created and he together with his Ph.D. colleague who, different from him, stayed at CIMNE after he finished his Ph.D., they ended up leading two of the research groups created at the Computer Applications Department of the BSC.

They arrived at the BSC with the vision and freedom of Ph.Ds. who develop numerical methods to solve engineering problems in a global context. The two researchers' mentality was not only to program and translate the problem in a mathematical equation but to develop their own research lines and interests. Their determination has been rewarded with a lot of freedom to manage, chose, and develop their own projects. At the present time, the Computer Applications Department holds a wide spectrum of research projects and important commercial contracts. The department director and group leaders are very successful at getting money from very important and large private companies for whom they develop significant applications. An important role specified in the mission of the organization and very appreciated by the top management at BSC. Their works attract numerous doctoral students, researchers, and information systems technicians. They are aware of the differences in the management of either research or commercial projects:

*[On of the differences in categorization and the management of the projects relies on] Different from the internal research projects, the commercial projects have a validation of the results very distinct from the research projects. The latter require intensive control and monitoring of the project development. The companies want to find petrol or want their race boats win boat races. Differently, the internal research projects that we develop, require reflection, thoughtfulness,... and you have the luxury of going backwards or changing things at any time.*

The computer applications' group leaders have a lot of freedom in choosing the topics of their research and orientating it towards a practical demand. Most of the projects involve three different types of activities: understanding the physics of the problem, translating it into numerical methods, and programming. The group and project leaders work on the two first levels, as they are physicists or engineers on telecommunications, the last activity is usually developed by computer engineers who are experts on programing but are neither able to understand the physical problem nor translate it into numerical methods. Therefore, the leaders take the decisions on the type of projects the group is involved in, leaving little room for orientating other researchers' research and programmers toward personal goals and objectives.

*... [Speaking about the internal research projects] Our own research projects are freely chosen with Guillaume (the other group leader and his colleague). We decide that we need to develop something that we may need in the future... for this type of developments often there is no funding. Those projects are developed under very different conditions [than the industrial ones], you develop it on your own or you try to attract a Ph.D. student with a grant to develop it. I would really like that this type of research could be more easily funded!*

When speaking about the tension between creativity and productivity, they did not recognize it immediately because they are free to choose internal research projects and writing

papers, which will be the most creative activity in their department. The internal research projects are not framed by any research program or industrial contract, they are developed at the researchers own interest and will.

*... In our particular case there is no tension, because writing a paper is something creative, and when we are writing a paper is about something new you find out... We together with our director, every year, agree on the objectives, we establish our own objectives... with the exception on the quantity of funding that we have to obtain, which is delirious!,... while the quantity of papers that must get published could be achieved without problems!*

Moreover, their view of Project Management highlights the important role of the Project Management Department and its support in writing the administrative part of research projects and industrial contracts because they have lots of specifications and requirements, which without the department's supervision could negatively affect the scientific part of the project.

*... I always work with Marta (a senior project manager). The projects department is something very useful for us. And with the time it becomes more and more efficient. The research projects (sights) with these never ending and awkward application forms... They (the project management department) truly simplify this interactive work. It is great!*

**The interpretation of the case:** In the line with previous cases, this case identifies managing research projects with the administrative affairs of the project only, and it does not involves all scientific decisions and operations along the execution of the project. Specific from this department is that they include an important aspect of the administrative functions of the project omitted in the previous cases, which is the importance of the legal assessment they get from the Project Management Department. This particular support is because they hold a large number of important commercial projects while other departments do not. Nevertheless, they end relegating the notion of Project Management to dealing with administrative affairs, a misconception which is aligned with this one of the public funding institutions, such as the European Commission. However, understanding of what it does mean to manage research projects involves a richer approach but it is not related with Project Management.

Similar to the interpretations highlighted in the previous case, they have their particular categorization of their own projects and its management. This categorization explains the identification of the tension between creativity and productivity and the way they deal with it. For instance, they are very clear in making the distinction between research projects chosen by them and commercial projects. The former are very creative projects, freely chosen, and are not committed to a certain level to the conditions of productivity. The commercial projects, in his opinion, do not involve creativity and are submitted to conditions of quality and productivity and involve higher levels of specification and monitoring. The commercial projects can be specified as they involve the combination of previously tested theories or methods. Furthermore, he points out that the opportunities for obtaining funding for creative projects are scarce; therefore, they are developed by Ph.Ds. students. The group

leaders at the Computer Applications Department use a strategy previously seen which is to hire Ph.Ds. to carry out with the development of very creative and unpredictable research works.

Besides this, they recognize that research is being produced on the basis of convenient and situational logics, which is to consider the appropriate elements of your past experience and the concrete elements of the present situation to deal with the difficulties. This implies that creativity occurs during the development of very specified projects and implies judgment to overcome the difficulties that arise. This fact converges with the notion of project developed in the conceptual framework of this doctoral work.

The mental project is a hypothesis of what is going to occur but the fact that the researchers can go backwards explains that they are judging if the resulting act or activity performed is alienated with their mental project and purpose of the project. The idea of trial and error is a common routine in the development of their research projects from which their judgmental activity helps them determine whether the act performed is aligned to the project goal. This is a highly creative activity requiring judgment, as it might trigger a change in the development of the project or might change the initial proposal or projected plan.

#### **6.1.4. Case Study of an Associate Research Scientist at Columbia University and the NASA Goddard Institute for Space Studies**

The fourth case study describes the role, experience, and developments of a young researcher who was leading the mineral dust research group in the Earth Science Department at BSC. His distinctive view of science and research took him to leave the BSC but remains actively collaborating with them. He describes how he as a group leader leads with the tension between creativity and productivity by categorizing the differences between the research projects his group deals with, but more importantly he introduces significant distinctions in the form of managing them.

The experience and career development of the researcher reflects his view on managing research. The researcher has been a doctoral student in the Industrial Engineering School at the Polytechnic University of Catalonia since 2002. In 2006, the Earth Science Department of the BSC was created and by way of its Director, and Ph.D. tutor, was appointed leader of research on mineral dust. He found the situation thrilling and carried it out exceptionally. He developed important research projects, published in top research journals, and the World Meteorological Organization has used his research developments on mineral dust models. He is often called upon for his expertise in research conferences and panels all over the world.

In 2009, after a successful career at the BSC and publishing his findings with the help of the supercomputer, he decided to start out on a post-doctoral position at the Earth Institute, in New York. With this, he was expecting to have more freedom to drive all his effort and determination towards a multidisciplinary project on climate and meningitis. At BSC he was pushed to develop projects that require the intensive use of the supercomputer. And this time, the project he had in mind required time for developing basic theories and concepts; and its ambiguities led him to look for a research institution that could offer access to a

supercomputer without being conditioned to its use. Additionally, he could work with experts in the different fields adding greatly to the proposed project.

He is aware of the ambiguous process of the research projects, and the impossibility ex-ante to determine all the operations, but more importantly he is aware of the variety of possibilities each project offers and how these possibilities interfere in its development.

*... [On the management of a research project and the ambiguity of its development] I could have just provided climate and dust model data [his field of expertise] to epidemiologists. But then your interest interferes! And your interest takes you far beyond. I had not planned how far beyond my field of expertise I would like to go, I just could not hold it! Epidemiology is an extremely exciting subject and the Earth Institute has created a space for these interactions to take place... The project suggested deepening into the interaction between the two fields [meningitis and climate] but I could have decided to reduce my contribution on the interaction, and stay in the comfort zone of my field. What I mean is that the level of depth you reach is completely subjective, and it depends on your curiosity and interest.*

*... Another researcher trying to develop the same project would probably have come out with a very different output and the development would have been presented in a very different way. But... this is the way things are in science!*

Therefore, since the very beginning, he was able to get a foothold to freely develop his research.

*... [On the subject of freedom] What I value the most is the freedom to develop, while contributing to what I have committed to. Freedom in research is very important. Also if around you researchers are not free, you cannot be free. It is a culture.*

*Freedom might be frightening... you might prefer to feel that somebody expects something from you and tells you what he is willing you to do. But for me it is not like this! Freedom of choice is crucial for me to be creative.*

*We should not value a scientist only by the amount of publications he delivers in a year. There are other subtle things that should be also valued, and these are the ones that make the difference!*

His view of research and its management strongly outlined the importance of trust and consensus more than strictly controlling researchers work. Through trust and consensus the researchers obtain and evaluate what is appropriate at every particular moment.

*... [On the management of freedom] The manager does not need to strictly control the researcher. The manager has to be flexible to foresee what is convenient in each moment and for each person, and evaluate what each researcher is giving in return to science.*

*... [On the management of trust] Looking at the work... it is obvious in the results delivered, the ideas provided to the group, the type of articles you write, the*



*entrepreneurial attitude towards the subjects chosen, the scope of the research, the research peers' feedback,... this is how we know who works well and who does not!*

*... [The role of consensus in research with the funding agencies] When writing projects you are trying to match your own interests with the interests of a research program. This is not obvious!*

*... [The role of consensus in research with peers] You exchange your own views of a subject with your peers and try to convince them; therefore, reach a consensus to approach a certain problem of your field in a certain way.*

**Interpretation of the case:** Different from the previous cases, in this case the researcher outlines some significant differences in the management of research projects based on some distinctive managerial functions. He suggests that the type of projects he is most interested in, are the ones that are freely chosen where he can freely follow his interests and passion. He introduces forms of management based on freedom, trust, consensus, and flexibility to be able to freely present a project proposition. He reflects on it, and finally, disambiguates the uncertainties all research projects have. This way, he finds, is the appropriate way to lead and develop any research project.

His notion of managing research projects is neither related to the administrative aspects of the project nor to the use of the methods of Project Management. His notion of managing research projects expresses his love and passion for his work. He emphasizes how interest and curiosity interferes with the development of his projects. His ideas are aligned with the ideas developed in the conceptual frame, as the creative moments are grounded in the judgment required to determine if the development of the project lines up with the initial purpose. These qualities refer to the moral character and virtue demanded in the research work.

## **6.2. Judgment and Creativity in Managing Research Projects**

The second subject, judgment and creativity in managing research projects, focuses on the following points, introduced in the conceptual framework, and related to Alfred Schutz's theory of human intentional action. First, the role of judgment on creating research projects with the method of combining subactions many of them considered routines or "repeated" actions, similar to the actions performed before in other contexts. Second, the role of judgment on identifying an action as similar to other actions. Third, the role of judgment on checking if the execution of the project (or performance of the act) corresponds to the provisions formulated in the project. This last point introduces some possibilities for creativity on the following developments:

- 1) When the performance of an activity suggests the researchers new ideas, which can be explored or disregarded.
- 2) When unforeseen difficulties and problems arise and have to be solved.

- 3) When researchers find themselves in a situation in which they do not know what to do and have to get a way out of it.

This approach that emphasizes judgment allows understanding that, even in extremely well defined projects, there are spaces for creativity, and thus creativity does play an important role.

The case study on A Project on Social Agent Simulations, shows that a mere idea is considered as project and that the researcher, provided with a high expertise on statistical methods and on parallelism techniques, cannot define her project until the moment that she knows other research works and findings that can be a guide for her. The case study on A Project on Archeological Simulations makes clear that in some aspects the project seems very well defined, until the point that it even specifies the papers each research group will be able to publish out of their work. But then the researchers begin to work and they need a year for getting acquainted with the work methods of the respective disciplinary groups. The case study on A group of Scientists Modelling the Atmospheric Transport of Particles is the only one in which the leader realizes the full extent of the concept of managing research projects and the function of judgment in its execution.

#### **6.2.1. Case Study on A Project on Social Agents Simulations**

The fifth case study describes the role, experience, and developments of a young Ph.D. student who obtained her degree on information systems, in 2006, and decided to start a Ph.D. Her experience is important to show the difficulties of this young researcher to build a project out of a mere political objective and how she finally succeeded.

When she decided to start the Ph.D. her interest in research was not in the line of computer architecture, therefore she contacted several professors of other departments of the Polytechnic University. Finally, she joined the Statistics and Operations Research Department, a department adscript to different faculties at Polytechnic University of Catalonia. She started to work on simulations applied to industrial logistics with the Chair of the Department. To develop this work they used both the methodology of statistics together with computational tools to simulate scenarios, such as an industrial process or the movement of persons, called “event discrete simulation”. At this moment she needed some training to develop the computer tools using statistical methods to simulate scenarios. Therefore, she took courses on statistics for a year and a half. The statistic lessons she took during her degree were not sufficient to develop those tools, as they required expertise in both statistics and computer programming areas.

She started her Ph.D. under the umbrella of a contract of personnel of technical support that the Polytechnic University of Catalonia Department ascribed to the Faculty of Informatics obtained from a R&D project of the Spanish Ministry. She was trained in statistics and operative research and developing computer applications for transportation. And the type of project and department looked to her like an appropriate place to develop her Ph.D. thesis. But an important event occurred and changed the direction of her Ph.D. and research. Her Ph.D. tutor as Vice-rector of Polytechnic University had close contact with other research

institutions and universities. And in one of the meetings he had with other directors and rectors of other faculties, the BSC Associate Director suggested to him the possibility of using some of the BSC resources with the aim of approaching the supercomputing technologies to the social sciences. The proposition of the BSC Associate Director is strictly aligned with mission of the organization, his aim is to promote the use of supercomputer technologies to all the scientific fields.

In order to advance in his purpose, the BSC Associate Director contacted a Professor at the Barcelona University that he knew was interested in sharing her data and taking advantage of computer parallelization to improve the outcomes of her research. And then, the Ph.D. student's tutor, proposed she to take advantage of this opportunity. His argument was that simulation programs in transportation topics were already mature compared with social sciences studies, and the transport topics she already was already familiar with had a social component.

In 2007, after a meeting with the BSC Associate Director and her tutor, she accepted the challenge to approaching supercomputer technologies to social sciences. And agrees to work together with her tutor -the chair of the Statistics and Operations Research Department at Polytechnic University of Catalonia, a professor who is the Director of Computer Applications Department at BSC, and a professor of the Anthropology Department of the Autonomous University of Barcelona. Additionally, the BSC Associate Director offered her a BSC research grant and a place in the Computer Applications Department at BSC in order to develop their work. This triad looked very consistent to carry out the project on developing parallel computation programs for social agents' simulation. They gave her their ideas but could not help her to develop them.

The interaction with the anthropology professor was not successful. The professor did not have any experience in Supercomputing and had not foreseen that the statistical data that she had could not be run in this type of machine. Finally, the young researcher desperate started to study the state of the art of the field of anthropology related to informatics. The different logics between the two disciplines become a challenge that could not be solved immediately. She found out that neither the census data nor the descriptive data gathered by the anthropologist to study the patterns that cause the migration flow in several Gambian villages, were rich enough to run a simulation in a parallel computer. The loneliness she felt in handling these difficulties made her feel overly anxious. With many difficulties, and a year after, at the end of 2007, she managed to accomplish and defend her master thesis.

However, this was not the only problem, she had to develop a program of simulation based on agents, -an application to simulate the human behavior, and there is not previous platform based on agents that works in a parallel architecture. This was again another discouraging situation but she was resolved to find the solution. Sometime later, she found other groups developing what is called social simulation. This area of research emerged in 1990; most of the groups were developing software to do experiments, based on statistical parameters to simulate demographic movements. The software was not prepared to run in parallel computers and to simulate the behavior of big populations. Coincidentally, she found

out that there was a Professor in Lancaster University that is developing a prototype in parallel architecture not in migration simulation but in demographic simulation. The Lancaster professor took advantage of a library already developed that looked appropriate for his purpose. She contacted him and reached an agreement to collaborate. They agreed to ask for funding to co-develop the software. In 2009, she moved to Lancaster and started to develop a parallel project based on an interface to enter demographic data. It was later that they obtained funding from the Royal Society and started to develop the software capable of running in parallel computers.

After this long, tough, and anguished time she is almost finishing her Ph.D., she could obtain a research project out of the purpose of connecting supercomputing technologies to the field of demography, and she is publishing her results in research journals. And more importantly, she has consolidated a research line at the BSC based on social agent simulations.

***Interpretation of the case:*** The case shows how the researcher overcame the challenge she was proposed and from this mere political proposition or purpose she was able to build a project. After a long period of search and reflection she found something relevant and oriented to fulfill the purpose of the BSC, based on the research of a Professor of Lancaster University, his work on the field of social simulations can be parameterized to run in parallel computers and enlarge the amount of data analyzed.

The fact that what she has been proposed is a mere idea or political purpose adds more difficulty to determining whether the strategies and decisions being made is aligned to the purpose; as it is very difficult to find the routines that will allow her to create a project. This situation in which she is free and has to be very creative, make her anxious, as she is deliberating with herself, making judgments, and searching for the appropriate routines that will finally demonstrate that she has a project that meets the political purpose.

The introduction of the conceptual framework of this doctoral work is significantly accepted by the researcher. But then the misconception of managing research projects emerges again when she emphasizes her involvement in the development of a software concerned with controlling and coordinating the project, at the administrative level, and she obviates the fundamental type of work that she has done in order to progress on her Ph.D. thesis which involved continuous judgment to overcome the difficulties she has been immersed in which required a tremendous effort and stress her out. She does not relate managing research projects to creativity and judgment but carries out her activity.

A second phase of the empirical work on this case study focused on the concept of projects and routines developed on the conceptual part of this doctoral work. Therefore, I interview her again in 2012 but this time the interview was a bit different and instead of open questions about their experience managing research projects, the aim was to support and help her on the development of her research project by introducing to her the conceptual framework of this doctoral work. Subsequently, I had asked her whether or not she found it adequate and helpful to managing her research project.

She was fascinated with the explanations and we agreed that she could work on writing down a list of her daily routines for a period of time. After some months, some of the listed routines were very simple -attending phone calls, reading and answering emails, planning a trip to go to a conference, attending meetings, checking the latest articles on related research subjects, but some other were very complex -analysis of the result of the simulation run in the supercomputer, programming, preparing a publication. Her list of routines clearly shows that her notion of routines involves very simple but also very complex routines that she does not describes, such as programming. These routines are part of other routines that she did not identify as routines, such as, the use of multivariate statistics or other mathematical models she considers to solve the problems she confronts. As a result it is observed that her concept of routine involves repetition but it is somehow an effortless action.

Some months after gathering her view on routines, I conducted another interview in which I introduced to her the notions of project and routine. Out of these notions accompanied with three different scenarios, she brought three different experiences on the development of a project, which for us is the combination of two or more routines, which in the best of the cases are similar. She is being very creative and judgment is at the center of her creativity. The first was about moments in her life where, while developing an activity other ideas or possibilities come to her mind. And how these new possibilities will be included or disregarded. The second was about a moment in her life where, while developing an activity, other unforeseen problems arise and she had to reflect in order to introduce adequate changes. The third was about a moment in her life where, while developing an activity she did not know how to react to what she sees, and she gets mentally blocked.

The interview ended with an informal chat about the subject of my research and how this long experience together had directed her to accept participating in the development of software on managing research projects with a group of researchers at the Polytechnic University of Catalonia. She emphatically told me about how what they were developing was similar to other software on Project Management. This software was thought to control and coordinate the administrative task of the research projects. And it aimed at fulfilling the new European Commission requirements on scheduling projects. The European commission was getting more demanding in the way research projects were being justified, and they started requesting the inclusion and generation of daily reports of the tasks the researchers or the people involved in the projects were undertaking and how much time was needed to end each task.

### **6.2.2. Case Study on A Project on Archeological Simulations**

The sixth case study describes the role, experience, and developments of researcher A, an archeobotanist at the Institute Mila i Fontanals, at the Spanish National Research Council (CSIC). He is experienced in both theoretical and field work on archeological studies, and was concerned in situating his discipline in a higher research level involving computer simulations. As when data is scarce their methods cannot easily develop original results. His experience is important as it displays the difficulties this researcher has in executing his project, even when the design phase and the project plan was clear and well defined.

The purpose and concern of this researcher involved expanding of his field towards computer simulations. His ambitious aim seemed to be aligned to a Spanish research program called CONSOLIDER. This research program aims at funding high level scientific activities which are promoting a significant move forward in the state of the art or establishing new scientific lines.

He commented on his idea and the research program framework to his colleague, researcher A', and wrote half a page with the main points. Soon after this meeting, they visited another colleague, researcher B, at the archeology department of the University of Barcelona, who "thinks out of the box", to test that their idea was significantly challenging in their field. The colleague reacted positively and encouraged them to look for the appropriate partners at a national level. They conducted an extensive search on the internet, looking for archeologists, physicists, and engineers. They then prepared a list of the groups that were aligned with the proposal, and contacted them on the phone or per email.

Meanwhile, they organized a meeting with the groups that were closer to the idea. In the meeting there was a group of six researchers: four of them from the group of researcher A, researcher B, and researcher C, an information systems engineer that did his PhD in didactics in Social Sciences and works at BSC. Researcher C was already working on social sciences simulations. He, together with the archeologists, started to identify the synergies that would facilitate the creation of mathematical models to simulate ancient societies and their relationship with environmental transformations. The draft resulting from this meeting was distributed to the fourteen partners responded positively to the blurb they had first sent. Finally, the resulted consortium was formed by eleven groups mostly coming from social sciences -archeology, sociology and history, and even included a group of physicists and two groups of engineers.

The project was granted and the following meetings were oriented toward thoughtfully structuring the work. They should develop a work program, deeply thinking about how to get to the work to achieve their goals, how to monitor the steps chosen, in order to obtain evidence of an appropriate guidance to the final objective. Some of the brilliant ideas that came to specify the project were to spend the half of the year to create and strengthen the synergies and channels to achieve the goals suggested in the proposal. The groups should create a network of partners and work development of each of the groups. They come from varying work backgrounds, habitually apply different methods, and this implied a division of the consortium into smaller teams. They should define how to develop the applications, which are to exploit the archeologists' data.

Their structuring of their work brought up another relevant idea on the practice of routines that was the development of a publication policy based on their previous experience. In two months they have managed to write down all possible publication cases, which have a previously observed solution to avoid future publication conflicts between the researchers.

The archeology project presents a high level of specification and a precise work flow. It is divided into seven cases and includes a publication policy for the resulting publications. Behind the primary aim of the publication policy book glimpses the work flow specification

of the project, initially rooted in the data already gathered in the archaeological site which presented seven different cases. However, this was not enough to lead them to a complete specification of the project parts and they spent almost the first year of the project customizing the groups of work and identifying the synergies that will make it possible to create mathematical models to simulate ancient societies and their relationship with the environmental transformations. But the differences between the disciplines, work experience, and methods suggested the division of the consortium into smaller teams.

The project proposal indicates that during the first phase of the project they should spend this time defining how to develop the computer applications that will exploit the archeologists' data. This differs from what they are doing and the answer cannot be found in the project proposal. To solve these difficulties new actions are being undertaken and another level of judgment is used to transform the environment.

***Interpretation of the case:*** It is worth emphasizing that even if the approved project was well specified, it included an initial period for creating and strengthening the collaboration between the experts on the different disciplines. They were organized into different groups and worked on creating the necessary synergies for crafting the mathematical models to run simulations on archeological data.

This first phase was misconceived but the project still looked clearly specified and divided into simpler tasks, for as the strength of the project work flow was placed on the seven cases and their potential publications. But, when they started to work they realized that they needed some time to learn how to interact in order to reach the intended outcome, they all had in mind. They spent more than a year learning how to interact and sharing a language to progress. This is a common problem in transdisciplinary research.

### **6.2.3. Case Study on a Group of Scientists Modelling the Atmospheric Transport of Particles**

The seventh case study describes the tensions and problems experienced by a group of scientists during the development of a research project and presents the difficulties this group of scientists encountered in agreeing on the specification of hypotheses and activities during the development of the project and their choices out of many possibilities. This process shows the role of judgment to choose the combination of the similar operations or activities relevant to face with the difficulties aroused. In this particular case, the judgment involved in the specification of the project hampered the achievement of the main goal of the project proposal, but resulted in a novel theoretical method initially not foreseen by the researchers.

In the year 2011, a group of scientists working at the Goddard Institute for Space Studies of NASA and Columbia University, obtained a research grant from the US Department of Energy (DoE) for the development of a project related to atmospheric aerosols. Research scientists at Columbia University are only supported by “soft” funds derived from research grants and projects. Therefore, obtaining research grants and projects are necessary to ensure their salaries and continuity in the organization, which imposes a significant pressure upon researchers.

The group of researchers from the Department of Applied Physics and Applied Math that obtained the grant was formed by a NASA civil servant and two research scientists from Columbia University. One of the two research scientists was the Principal Investigator or leader of the project. He is an expert on modelling and simulating the life cycle of natural dust and suggested to the other members of the group to submit a project that challenges the effects upon the carbon cycle of soluble iron contained in dust particles deposition. His idea was relevant for the other members of the group and they agreed to submit a proposal as they thought it had a high chance of being granted. Then, he wrote the proposal with the support of the two other scientists. The main reason is that while climate models are able to simulate the life cycle of natural dust (emission, transport and deposition) reasonably well, there are large uncertainties regarding the deposition of soluble iron contained in these particles, along with the effects upon the carbon cycle and climate.

The project was divided into two main phases. The first phase involved the identification of different mineral types in dust aerosols. Traditionally, climate models have assumed that natural dust particles are homogeneous, a simplification that is reasonable for the study of certain aspects of the climate system, but inadequate for the study of soluble iron. The activities within this first phase were fundamentally conceived as technical rather than scientific. As other research groups had done previous work on the distinction of minerals, the novelty was to apply the previously developed technique to the estimation of soluble iron. The second phase of the project was expected to be the challenging scientific part as it involved understanding and testing the uncertain iron chemistry processes within dust particles during atmospheric transport.

The first phase of the proposal was supposed to take one year and was mostly developed by one of the research scientists of the group (not the Principal Investigator). It involved the implementation of mineral tracers within the modeling system and the specification of their emission based on a map that provides the fractions of the different minerals in soils around the globe. Additionally, it involved the compilation of measurements of mineral concentrations in the atmosphere and the evaluation of the model using these measurements. An important journal paper was expected from this activity.

After a first implementation, the results were very unsatisfactory when compared to observations. The model was not able to capture essential processes such as the size distribution and the long-range transport of iron-containing minerals. In view of the results, the group decided to revisit the basic assumptions of the method used to specify the emission of minerals and, after time-consuming tests and discussions, the team progressively realized that the problem was more complex than anticipated. They understood that there was a significant lack of knowledge on how to specify the emission of minerals from the currently available soil mineral maps. Previous studies on this subject had briefly discussed the limitations of using such an approach, but these were never identified as critical because the results hadn't been evaluated in detail. The detailed evaluation of the model clearly showed the need for new approaches in order to address the model deficiencies. Therefore, the first phase, which had been designed as an implementation of previous work, needed much more time than anticipated.



The research scientist in charge of this first phase proposed an empirical approach in order to address the problem in a reasonable amount of time. He worked on the formulation of the assumptions of the new empirical method and presented them to the group. At this moment, the approach seemed very reasonable to the rest of the team, taking into account the unexpected gap in knowledge and the time constraints of the project. Therefore, the team agreed to attempt the empirical approach, which basically used observations over dust source regions to empirically adjust the size distribution of the emitted minerals. With the new approach, the results improved significantly. Given the good results, the rest of the team accepted the method and promoted the preparation of a paper illustrating the new method and the related results.

In parallel, the Principal Investigator of the project addressed his efforts on addressing the problem theoretically. The rationale behind this attempt was that even if the results obtained with the empirical approach were apparently acceptable, he had in mind to develop a theoretical method, a more elegant and universal approach that could evolve and improve over time. The work behind his idea was not obvious but a great improvement to develop it came after a recent publication by another research group. This publication provided to him with some new theoretical ground on the size distribution of emitted dust particles and expanded the possibilities of his own theoretical method. After some work, the Principal Investigator derived a purely theoretical approach for the emission of minerals that was successfully tested within the model. However, given the acceptable results obtained with the empirical method, the Principal Investigator decided to postpone the publication of the theoretical approach in order to avoid a conflict with the research scientist in charge of the first activity.

But then again, after a few months, a serious problem emerged when the research scientist in charge of the activity finished the writing of the paper describing the new empirical method. The Principal Investigator and the other member of the team realized that even when the results were satisfactory, some of the assumptions of the empirical method were incorrect and contradicted fundamental physics of the emission of minerals.

At this moment, the logical way to proceed would have been to disregard the empirical approach and move ahead with the theoretical approach. However, this option would involve a human problem and would have created significant tensions in the group. The research scientist in charge of the activity had been working for two years on the development of the empirical approach and the group had already agreed that he would be the lead author of the paper derived from this activity. Therefore, the team decided to help him and corrected the empirical approach using aspects of the theoretical approach developed by the Principal Investigator. This solution was preferred as it recognized the work of the research scientist in charge of the first activity, maintained his lead authorship, and reduced the tension within the project. The Principal Investigator deferred his publication on the theoretical method to a later date in order to shelter his colleague while minimizing delays on content and schedule of the project.

Nevertheless, all these events strongly delayed the implementation of the second phase of the project. The Principal Investigator should have requested a one-year extension at no cost to the program manager in order to proceed with the second phase of the project. However, they were satisfied because the project had already provided innovative approaches to simulate the emission of mineral types in climate models, a development not initially foreseen by the researchers and important for their field of research.

***Interpretation of the case:*** The time and budget constraints lead to the development of a good strategy for reformulating the project, even this strategy was not the best from a scientific-development point of view. This fact constitutes a good example of the influence of the tension between the creativity of research work and the productivity constraints, in scientific research.

This case underscores the fact that there are risks in research and how the researchers overcame them. This case emphasizes the functions of judgment on evaluating and rejecting methods that are taken for granted due to previous publications, on developing strategy and making decisions about how to continue the research and on choosing among many possibilities previously not foreseen that can involve severe or minor changes in the development of the projects and in its results.

An important subject presented in this case is the moral problem concerning the decisions that will affect the recognition of the work of a researcher and the moral and solidary solution of postponing the publication of the theoretical model, which represented a cost for the research group in favor of the researcher.

# CHAPTER 7

## CONTRIBUTIONS AND FURTHER RESEARCH

### 7.1. Contributions at the theoretical level

This doctoral dissertation introduces some basic contributions to the subject of the tension between creativity and productivity in managing research with the methods of Project Management, and, more generally, the subject of the function of creative judgment in the execution of precisely specified projects in any kind of activity, which seem to determine all the operations involved in the development of a project.

With the purpose of approaching these subjects, the first contribution situates the technical concept of project management in relation to the phenomenological notion of mental project, introduced by Alfred Schutz (1953) as one of the three aspects that comprises an intentional action. His theory considers that an intentional action involves a purpose, a mental project and an act. The mental project is a mental rehearsal of the future act. This notion of project widens their spectrum, thus a project can be either very precise or ambiguous, very rigid or very flexible. The act is the actual performance of the mental project. Schutz's theory also introduces the notion of subactions and the critical view that a repeated action is a new action similar to an already performed action, such as the differences between them are not considered relevant for the actor.

The second contribution of this doctoral thesis is to introduce the following properties, which were not developed by Schutz, as important aspects of project management: first, the mental project of a new action can be created combining many subactions that are similar to previous actions already performed. This operation requires judgment in order to align the purpose of the action to the organization of subactions. Second, the recognition of an action as similar to another action; distinguishing their similarities and differences requires judgment. Third, the mental project can be considered as a hypothesis about what will happen in the execution of the act; but what occurs is more complex than the mental plan and requires paying careful attention on the possible discrepancies between these two levels. Judgment deals with these differences and it makes the actor aware of other possible subjects and developments.

The third contribution relates judgment to creativity and imagination. It grounds this relationship on the concept of judgment introduced by Immanuel Kant on the *Critique of Judgment* (1790) in which he distinguishes two kinds of judgments: "Determining judgment" subsumes particulars under universals (or concepts) already given. This is related to imagination and creativity. "Reflexive judgment" finds the universal for the given particular, it is related to empirical sciences, and specifically applied to aesthetic and teleological judgment.

The fourth contribution uncovers the rhetorical aspects of judgment and justifies them comparing the concept of judgment given by Immanuel Kant and the justification given by Aristotle of the use of rhetoric in applying the law to specific cases. In the juridical context as in project management the difficulty lays with the simplicity of the universal laws and rules and the complexity of particular actions. Isocrates was also aware that rhetoric is used both for public speeches and mental judgment or self-persuasion.

The fifth contribution emphasizes some similarities between Schutz's notion of repeated action and the concept of routine, protocols and recipes that regulate many kinds of works and common actions. This remark introduces a new perspective of looking at the routines and the role of routines in scientific research, in which the judgment involved in the execution of an action, and therefore in the execution of a routine, makes clear the creative potentiality of using routines, which is a property not stated in the study of the subject.

## **7.2. Contributions at the empirical level**

The case study on the creation of the Barcelona Supercomputing Center (BSC) presents the following empirical contributions. The fact that the mentality and vision of the Director of the BSC differentiates between scientific research and technological applications is represented in the organizational structure. The causes of his vision were that researchers coming from the Center of Parallelization, that work on technological applications felt discriminated against and refused to act according to the rules derived of the organizational division of work. The consequence was their rejection to work in support of the projects developed by the BSC scientific division research groups. The success of their scientific activity, based on attracting important projects on technological applications involving both external academic and industrial partners, led the recognition of their work, renaming of their department with a scientific name, from "Computer Applications" to "Computer Applications in Science and Engineering".

This case study constitutes a good example of the theory of structuration according to which the activities of the agents and the social or organizational structures influence one another. The case, which could not be possible in certain industries, is relevant in knowledge intensive organizations. The full context of the story explains how its conclusion was possible.

The contributions from the seven case studies that deal with managing research projects will be recognized in a thematic form that will develop the following subjects: how researchers think through the tension between creativity and productivity; what is the degree of specification of projects; how they interpret the concepts of project, Project Management and routines; how researchers create a project creatively combining subprojects and how they identified repeated actions or research routines; how researchers follow and manage the execution of their projects as a source of creative judgment. These subjects are closely related.

On the subject of the tension between creativity and productivity in executing research projects, the Director of the BSC already expressed that he did not think about it and that, at

any case, managing the tension was a matter of the professional skills of the researchers. This answer closes the subject and points out that the research activity involves many tacit aspects, thus it is reliant on the creativity and imagination of researchers. Most of the researchers also express their surprise at the subject even when it was explained to them. The researchers associate the management of the tension with the division of the projects in different categories and reveal important differences in their management. These facts are closely related to soft conceptions of project and Project Management.

On the concept of project, researchers expressed vague ideas and did not relate it with the formal methods and the strict requirements of Project Management. For them a project has to include its purpose, its main stages and budget, and the kind of findings expected. So they focus and distillate the conditions established by the sponsors and measure against the possibility of fulfilling them. In this way, projects seem to follow, in an abstract form, the specific conditions of Project Management. But the use of the term “project” is more ambiguous than that and it can refer also to a vague idea. In the case of the social agent simulations the notion of project is reduced to a mere political purpose. This situation is closely related to the concept of managing research projects and to the degrees of specification of the projects.

On the subject of the specification of research projects, the case study on the Grid Computing group manager distinguishes among two kinds of projects. Projects on which they have experience from previous research works, and can make quite precise descriptions, are submitted to compete to obtain research funding from European and National research institutions. Projects that involve creative ideas, unexpected developments, uncertain findings and are submitted to unpredictable risks are initially assigned to doctoral students, whose project proposal do not need to be very specified, therefore they have more flexibility and freedom in the development of their projects. These projects when they will be more specified they will be submitted to competitive grants. Similarly, the case of the Computer Applications department distinguishes between their projects considering the degrees of specification of their goals and the possibilities to fulfill the requirements of the funding agencies.

On the subject of managing research projects, a basic misunderstanding comes out from the professional position of research project manager, introduced by the European Research Council and assimilated by the research centers, which divide the control and final evaluation of the project into two different parts: the scientific and the administrative. The responsibilities of project managers are to take care of the budget and expenses, justify their deviations, as well as to present the scientific deliverables on time. In this context researchers do not realize that managing research projects involves managing its full execution and focusing on the scientific judgment, creativity and any type of decision that intervenes in the development of a project.

In the case study on archeological simulations, the project seems to be precisely specified, and it includes the subjects of the futures publications and the order of authorship. Nevertheless, researchers had to spend a year getting acquainted to the concepts, methods and

views comprised in the multiple disciplines of the project consortium. These findings are relevant for multidisciplinary research.

On the subject of the creative judgment involved in the elaboration of the project, the interviewees describe how they combine activities or operations similar to those already performed. This activity is analogous to identifying the research routines relevant for the composition of the project. The case study on archeological simulations emphasizes that to situate archeology in a higher scientific level, three current lines of scientific research need to be organized in a project. The case on social agent simulations show that only when the researcher, after a long period of search, got a previous example on computer parallelization in demography, could she then formulate and develop the project. Some researchers, even after an explanation of the concept of scientific routines which include activities such as applying common statistical tests, solving mathematical equations, or building mathematical models, did not identify routines in their work. These kinds of routines sometimes are easy to apply but generally involve deep judgment and can require creativity.

On the subject of creative judgment along the execution of a project, the case on the group of modelling atmospheric transport of particles emphasizes that reading an academic paper can open new possibilities for improving the aims of the research project and the field of research. The possibility to enlarge the scope of the project involved to extend it one more year at no costs for the funding agency. This case exemplifies the tension between delivering the project on time and not adding extra costs, being productive, and delivering better scientific results, regardless the time and cost constraints, being creative. In this case the researcher decided to extend the project one year and deliver the new scientific results. The researchers' creative judgment determines all the operations involved in the development of a project.

The logic of the research contract allows to control the project and aims to ensure productivity, this could inhibit creativity, but research projects are very flexible and often do not follow this logic. Frequently, changes in the scope of the project or in its schedule do not involve a change in the costs constraint.

The empirical research included some subjects that were not considered in the conceptual framework. The last case points out moral aspects involved in the development of research projects in relation to the prestige and career of the members of the research group.

### **7.3. Limitations and Further Research**

The ways of developing research projects share many basic characteristics in all kinds of institutions, but they also present relevant differences between them, associated to the different institutional contexts. For instance, European projects are managed by project leaders and academic doctoral research is organized with advisors. For evaluating the extent in which the previous empirical findings can be generalized and for introducing some prototypes, it is necessary to extend the research in different context. We plan, to undertake

new empirical research and longitudinal study of a project based on a big research project, on a small scientific group and on a doctoral research.

It is important to explore the present and future findings in order to make some proposals on the ways of presenting research projects and evaluating them. It is important also to make some proposal on a firm and strict form of managing research projects.

The present findings and conceptual contributions can be applied to Project Management in any kinds of activities and contributed to further studies of stimulating, recognizing and evaluating creativity.





## References

- Adler, P. S., & Chen, C. X. (2011). *Combining creativity and control: Understanding Individual Motivation in Large-Scale Collaborative Creativity*. *Accounting, Organizations and Society*, 36(2), 63–85. doi:10.1016/j.aos.2011.02.002
- Aguilar, O. (2008). *La teoría del habitus y la crítica realista al confluencionismo central*. *Persona Y Sociedad*. Universidad Alberto Hurtado, XXII(1), 9–26.
- Alvesson, M. (1993). *Organizations as rhetoric: Knowledge-intensive firms and the struggle with ambiguity*. *Journal of Management Studies*, 30(6), 997–1015.
- Amabile, T. M. (1983). *Social Psychology of Creativity a Componential Conceptualization*. *Journal of Personality and Social Psychology*, 45(2), 357–376.
- Amabile, T. M. (1988). *A model of creativity and innovation in organizations*. In B. Sutton & R. Staw (Eds.), *Research in Organizational Behavior (Vol. 10, pp. 123–167)*. Elsevier Science.
- Amabile, T. M. (1996a). *Creativity and innovation in organizations*. *Harvard Business Review*, 1–15.
- Amabile, T. M. (1996b). *Creativity in Context: Update to the Social Psychology of Creativity (pp. 1–336)*. Boulder, CO: Westview Press.
- Amabile, T. M. (1997). *Motivating Creativity in Organizations: On doing what you love and loving what you do*. *California Management Review*, 40(1), 39–58.
- Amabile, T. M. (2008). *How to Kill Creativity*. *Harvard Business Review*, (September), 1–8.
- Amabile, T. M., & Conti, R. (1999). *Changes in the work environment for creativity during downsizing*. *Academy of Management Journal*, 42(6), 630–640. doi:10.2307/256984
- Amabile, T. M., Conti, R., Coon, H., Lazenby, J., & Herron, M. (1996). *Assessing the Work environment for creativity*. *The Academy of Management Journal*, 39(5), 1154–1184.
- Amabile, T. M., & Gryskiewicz, N. D. (1989). *The creative environment scales: Work environment inventory*. *Creativity Research Journal*, 2(4), 231–253.
- Amabile, T. M., Schatzel, E. A., Moneta, G. B., & Kramer, S. J. (2004). *Leader behaviors and the work environment for creativity: Perceived leader support*. *The Leadership Quarterly*, 15(1), 5–32.
- Anderson, N., Potocnik, K., & Zhou, J. (2014). *Innovation and creativity in organizations: a state-of-the-science review, perspective commentary, and guiding framework*. *Journal of Management*, 40(5), 1297–1333.
- Archer, M. S. (1995). *Realist Social Theory: The Morphogenetic Approach*. Cambridge, UK: Cambridge University Press.

- Archer, M. S. (2003). *Structure, Agency and the Internal Conversation* (p. 370). Cambridge University Press.
- Argyris, C. (1990). *The Dilema of Implementing Controls: The Case of Managerial Accounting*. *Accounting, Organizations and Society*, 15(6), 503–511.
- Ashforth, B. E., & Fried, Y. (1988). *The mindlessness of organizational behaviors*. *Human Relations*, 41(4), 305–329.
- Bailey, D. E., & Barley, S. R. (2005). *Return to work: Toward post-industrial engineering*. *IIE Transactions*, 37, 737–752.
- Bailin, S. (1988). *Achieving extraordinary ends: An essay on creativity* (p. 156). *The Netherlands: Springer Netherlands*.
- Barley, S. R. (1996). *Technicians in the Workplace: Ethnographic Evidence for Bringing Work into Organizational Studies*. *Administrative Science Quarterly*, 41(3), 404–441.
- Barley, S. R., & Tolbert, P. S. (1997). *Institutionalization and Structuration: Studying the links between action and Institution*. *Organization Studies*, 18(1), 93–117.
- Barnard, C. I. (1938). *The functions of the executive* (p. 334). Cambridge, MA: Harvard University Press.
- Barron, F. (1988). *Putting Creativity to Work*. In R. J. Sternberg (Ed.), *The Nature of Creativity: Contemporary Psychological Perspectives* (p. 455). Cambridge, UK: Cambridge University Press.
- Becker, M. C. (2004). *Organizational Routines: a review of the literature*. *Industrial and Corporate Change*, 13(4), 643–677.
- Birkinshaw, J., Hamel, G., & Mol, M. J. (2008). *Management Innovation*. *Academy of Management Review*, 33(4), 825–845. doi:10.5465/AMR.2008.34421969
- Blumer, H. (2004). *George Herbert Mead and human conduct*. Oxford: Alta Mira Press.
- Boisot, M., Nordberg, M., Yami, S., & Nicquevert, B. (2011). *Collisions and Collaborations: The Organization of Learning in the Atlas Experiment at the LHC*. (M. Boisot, M. Nordberg, S. Yami, & B. Nicquevert, Eds.) (p. 315). Oxford, UK: Oxford University Press.
- Bonet, E. (2014). *Exploring the boundaries of rhetoric*. *Journal of Organizational Change Management*, 27(5), 703-806 doi:10.1108/JOCM-09-2014-0175
- Bonet, E., Jensen, H. S., & Sauquet, A. (2007). *Experiential Knowledge: Alfred Schutz should be there*. Barcelona, Spain: ESADE, Ramon Llull University.
- Bonet, E., & Sauquet, A. (2010). *Rhetoric in Management and in Management Research*. *Journal of Organizational Change Management*, 23(2), 120–133.
- Borgatti, S. P., & Halgin, D. S. (2011). *On Network Theory*. *Organization Science*, 22(5), 1168–1181.

- Brante, T. (1988). *Sociological approaches to professions*. *Acta Sociologica*, 31(2), 119–142.
- Briskman, L. (2008). *Creative product and creative process in science and art*. *Inquiry: An Interdisciplinary Journal of Philosophy*, 23, 83–106.
- BSC. (2010a). *History*. Barcelona Supercomputing Center. Retrieved January 1, 2011, from [http://www.bsc.es/plantillaA.php?cat\\_id=9](http://www.bsc.es/plantillaA.php?cat_id=9)
- BSC. (2010b). *Mision*. Barcelona Supercomputing Center. Retrieved January 1, 2011, from <http://www.bsc.es/about-bsc>
- Burt, R. S. (1992). *Structural Holes: The Social Structure of Competition*. Cambridge, Massachusetts: Harvard University Press.
- Burt, R. S. (2004). *Structural holes and good ideas*. *American Journal of Sociology*, 110(2), 349–399.
- Busse, T. V., & Mansfield, R. S. (1980). *Theories of the creative process: A review and a perspective*. *Journal of Creative Behavior*, 14, 91–103.
- Byrne, C. L., Mumford, M. D., Barrett, J. D., & Vessey, W. B. (2009). *Examining the Leaders of Creative Efforts: What Do They Do, and What Do They Think About?* *Creativity and Innovation Management*, 18(4), 256–268.
- Carayannis, E. G., Kwak, Y.-H., & Anbari, F. T. (2005). *The Story of Managing Projects: An Interdisciplinary Approach* (p. 373). Westport, CT: Greenwood Publishing Group.
- Cardinal, L. B. (2001). *Technological innovation in the pharmaceutical industry: The use of organizational control in managing research and development*. *Organization Science*, 12(1), 19–36.
- Cleland, D. I., & King, W. R. (1988). *Project Management Handbook (2nd ed., Vol. Second)*. NY, USA: Van Nostrand Reinhold.
- Cook, D. L. (1966). *Program evaluation and review technique. Applications in education*. U.S Department of Health, Education and Welfare. Office of Education.
- Cooren, F., Kuhn, T., Cornelissen, J. P., & Clark, T. (2011). *Communication, Organizing and Organization: An Overview and Introduction to the Special Issue*. *Organization Studies*, 32(9), 1149–1170. doi:10.1177/0170840611410836
- Crémer, J. (1993). *Language and Shared Knowledge*. *Industrial and Corporate Change*, 2, 351–386.
- Crémer, J., Garicano, L., & Pratt, A. (2007). *Language and the Theory of the Firm*. *Quarterly Journal of Economics*, 122, 373–407.
- Creswell, J. W. (2013). *Qualitative Inquiry and Research Design: Choosing Among Five Approaches (Third., p. 472)*. Thousand Oaks, CA: Sage Publications, Inc.;
- Csikszentmihalyi, M. (1988). *Society, culture and person: a systems view of creativity*. In R. J. Sternberg (Ed.), *The Nature of Creativity: Contemporary Psychological Perspectives* (pp. 325–339). New York, NY: Cambridge University Press.

- Csikszentmihalyi, M. (1996). *Creativity: Flow and the Psychology of Discovery and Invention* (p. 480). New York, NY, USA: HarperCollins.
- Cummings, L. (1965). *Organizational Climates for Creativity*. *Academy of Management Journal*, 8(3), 220–227. doi:10.2307/254790
- Cyert, R. M., & March, J. G. (1963). *A behavioral theory of the firm* (p. 268). Englewood Cliffs, NJ: Prentice-Hall.
- Czarniawska, B. (2004). *Narratives in social science research: Introducing Qualitative Methods*. Sage Publications, Ltd (Vol. First). London, UK: Sage Publications, Ltd;
- Davila, A., & Ditillo, A. (2009). *Controlling Creativity: Design and Use of Management Control Systems in Creative Environments*. To Be Published. Barcelona: Seminar at ESADE.
- Deci, E. L., & Ryan, R. M. (1987). *No Title*. *Journal of Personality and Social Psychology*, 56(3), 1024–1037.
- Descartes, R. (1637). *Discourse on Method and The Meditations*. (Translated with an introduction of F. E. Sutcliffe). London, UK: Penguin Classics.
- Dezin, N. K. (1989). *The research act: a theoretical introduction to sociological methods* (3rd ed., p. 306). Englewood Cliffs, N.J.: Prentice Hall.
- Dionysiou, D. D., & Tsoukas, H. (2013). *Understanding the (Re)Creation of Routines from within: a symbolic interactionist perspective*. *Academy of Management Review*, 38(2), 181–205.
- Ditillo, A. (2004). *Dealing with uncertainty in knowledge-intensive firms: The role of management control systems as knowledge integration mechanisms*. *Accounting, Organizations and Society*, 29, 401–422.
- Dunbar, K. (1997). *How scientists think: On-line creativity and conceptual change in science*. In T. B. Ward, S. M. Smith, & J. Vaid (Eds.), *Conceptual Structures and Processes: Emergence, discovery, and change*. American Psychological Association Press.
- Dunbar, K., & Fugelsang, J. (2005). *Scientific Thinking and Reasoning*. In K. J. Holyoak & R. G. Morrison (Eds.), *The Cambridge Handbook of Thinking and Reasoning* (p. 705). Cambridge University Press.
- Duncan, W. R. (1996). *A guide to the Project Management Body of Knowledge* (p. 182). Norht Caroline, USA: Project Management Institute.
- Eisenhardt, K. M. (1989). *Building Theories from Case Study Research*. *Academy of Management Review*. doi:10.5465/AMR.1989.4308385
- Emirbayer, M., & Mishe, A. (1998). *What is agency?* *American Journal of Sociology*, 103(4), 962–1023.
- Erik Dane, & Pratt, M. G. (2007). *Exploring Intuition and its role in managerial decision-making*. *Academy of Management Review*, 32(1), 33–34.

- Etzkowitz, H., & Leydesdorff, L. (2000). *The dynamics of innovation: from National Systems and “Mode 2” to a Triple Helix of university–industry–government relations*. *Research Policy*, 29, 109–123.
- Feist, G. J. (1998). *A meta analysis of personality in creativity*. *Personality and Social Psychology Review*, 2(4), 290–309.
- Feist, G. J. (2010). *The Function of Personality in Creativity: The Nature and Nature of Creative Personality*. In J. C. Kaufman & R. J. Sternberg (Eds.), *The Cambridge Handbook of Creativity*.
- Feldman, M. S. (2000). *Organizational Routines as a Source of Continuous Change*. *Organization Science*, 11(6), 611–629.
- Feldman, M. S., & Orlikowski, W. J. (2011). *Theorizing practice and practicing theory*. *Organization Science*, 22, 1240–1253.
- Feldman, M. S., & Pentland, B. T. (2003). *Reconceptualizing Organizational Routines as a Source of Flexibility and Change*. *Administrative Science Quarterly*, 48, 94–118.
- Flexner, A. (1939). *The usefulness of useless knowledge*. *Harper’s Magazine*, June/Novem(179), 544–552.
- Floyd, S. W., & Woodridge, B. (1994). *Dinosaurs or dynamos? Recognizing middle management’s strategic role*. *Academy of Management Executive*, 8(4), 47–57.
- Floyd, S. W., & Wooldridge, B. (1997). *Middle management’s strategic influence and organizational performance*. *Journal of Management Studies*, 34(3), 465–485.
- Ford, C. M. (1996). *A theory of individual creative action in multiple social domains*. *Academy of Management Review*, 21(4), 1112–1142.
- Ford, C. M., & Gioia, D. A. (2000). *Factors influencing creativity in the domain of managerial decision making*. *Journal of Management*, 26(4), 705–732.
- Frame, J. D. (1994). *The New project management: tools for an age of rapid change, corporate reengineering, and other business realities (2nd ed., p. 328)*. *San Francisco: CA: Jossey-Bass Inc.*
- Gantt, H. L. (1919). *Organizing for Work*. *New York, NY, USA: Harcourt, Brace and Howe.*
- Gersick, C. J. G., & Hackman, J. R. (1990). *Habitual routines in Task-Performing Groups*. *Organizational Behavior and Human Decision Processes*, 47, 65–97.
- Geuna, A., Salter, A. J., & Steinmueller, W. E. (2003). *Science and Innovation: Rethinking the Rationales for Funding and Governance*. *Massachusetts, USA: Edward Elgar Publishing Inc.*
- Gibbons, M., Limoges, C., Nowotny, H., Schwartzman, S., Scott, P., & Trow, M. (1994). *The New Production of Knowledge: The Dynamics of Science and Research in Contemporary Societies (p. 192)*. *London, UK: Sage Publications, Ltd;*

- Giddens, A. (1984). *The constitution of Society. Outline of the theory of structuration*. Cambridge, UK: Polity Press in association with Basil Blackwell.
- Gido, J., & Clements, J. P. (2009). *Successful Project Management (4th ed.)*. Mason, OH: South-Western Cengage Learning.
- Gilsing, V., Nootboom, B., Vanhaverbeke, W., Duysters, G., & Van den Oord, A. (2008). *Network embeddedness and the exploration of novel technologies: Technological distance, betweenness centrality and density*. *Research Policy*, 37, 1731.
- Ginsborg, H. (2013). *Kant's Aesthetics and Teleology*. In *The Stanford Encyclopedia of Philosophy*. Retrieved from <http://plato.stanford.edu/archives/fall2014/entries/kant-aesthetics>
- Glaser, B. G., & Strauss, A. L. (1967). *The Discovery of Grounded Theory: Strategies for Qualitative Research (p. 271)*. Saint Louis, MO: Transacrtion Publishers, Inc.
- Granovetter, M. S. (1973). *The Strength of Weak Ties*. *American Journal of Sociology*, 78(6), 1360–1380.
- Greenberg, D. S. (2007). *Science for Sale: The perils, rewards, and delusions of campus capitalism*. Chicago and London: The University of Chicago Press.
- Guilford, J. P. (1950). *Creativity*. *American Psychologist*, 5(9), 444–454. doi:10.1037/h0063487
- Hamel, G., & Prahalad, C. K. (1994). *Competing for the Future (p. 327)*. Harvard Business Press.
- Hargadon, A., & Sutton, R. I. (1997). *Technology Brokering and Innovation in a product development firm*. *Administrative Science Quarterly*, 42, 718–749.
- Hill, R. C., & Levenhagen, M. (1995). *Metaphors and Mental Models: Sensemaking and Sensegiving in Innovative and Entrepreneurial Activities*. *Journal of Management*, 21(6), 1057–1074. doi:10.1177/014920639502100603
- Hodgson, D. E. (2002). *Diciplining the Professional: the Case of Project Management*. *Jornal of Management Studies*, 39(6), 803–821.
- Hodgson, D. E. (2004). *Project Work: The Legacy of Bureaucratic Control in the Post-Bureaucratic Organization*. *Organization*, 11(1), 81–100. doi:10.1177/1350508404039659
- Hofstadter, D. R. (2001). *Epilogue: Analogy as the Core of Cognition*. In D. Gentner, K. J. Holyoak, & B. N. Kokinov (Eds.), *The Analogical Mind: Perspectives from Cognitive Sciences (p. 520)*. Cambridge, MA: The MIT Press.
- Horn, D., & Salvendy, G. (2006). *Consumer-based assessment of product creativity: A review and reappraisal*. *Human Factors and Ergonomics in Manufacturing*, 16(2), 155–175. doi:10.1002/hfm.20047

- Howard-Grenville, J. A. (2005). *The Persistence of Flexible Organizational Routines: The Role of Agency and Organizational Context*. *Organization Science*, 16(6), 618–636.
- Howells, J. (2006). *Intermediation and the role of intermediaries in innovation*. *Research Policy*, 35, 715–728.
- Jacob, M. (1997). *The Life in Triple Helix: the Contract Researcher, the University, and the Knowledge Society*. *Science Studies*, 10(2), 35–49.
- Jensen, H. S. (2008). *Management and Learning in the Knowledge Society*. *The Journal of Regional Analysis and Policy*, 38(2), 130–137.
- Jensen, H. S. (2011). *The role of ambiguity in innovation*. In E. Bonet, B. Czarniawska, D. McCloskey, & H. S. Jensen (Eds.), *2nd Conference on Rhetoric and Narratives in Management Research: Management and Persuasion* (pp. 49–58). *Barcelona, Spain: ESADE*.
- Jensen, M. C., & Meckling, W. H. (1976). *Theory of the Firm: Managerial Behavior, Agency Costs and Ownership Structure*. *Journal of Financial Economics*, 3(4), 305–360.
- Kennedy, G. A. (1991). *Aristotle, On Rhetoric: A Theory of Civic Discourse* (Translated by George A Kennedy). *Oxford, UK: Oxford University Press*.
- Kerzner, H. R. (2013). *Project Management: A System Approach for Planning, Scheduling, and Controlling* (11th ed., Vol. Copyright, p. 1296). *Hoboken, New Jersey, USA: John Wiley & Sons, Inc.*
- Kim, K. H. (2006). *Can we trust Creativity test*. *Creativity Research Journal*, 18(1), 3–14.
- Klimoski, R. J., & Karol, B. L. (1976). *The impact of trust in creative problem solving groups*. *Journal of Applied Science*, 61, 630–633.
- Knights, D., Murray, F., & Willmott, H. (1993). *Networking as knowledge work: a study of strategic interorganizational development in the financial service industry*. *Journal of Management Studies*, 30(6), 975–995.
- Koberg, D., & Bagnall, J. (1981). *The All New Universal Traveler: A Soft-Systems Guide To Creativity, Problem-Solving, And The Process Of Reaching Goals*. *Los Altos, CA: William Kaufmann, Inc.*
- Korsgaard, M. A., Schweiger, D. M., & Sapienza, H. J. (1995). *Building commitment, attachment, and trust in strategic decision-making teams: the role of procedural justice*. *Academy of Management Journal*, 38(1), 60–84.
- Kozbelt, A., Beghetto, R. A., & Runco, M. A. (2010). *Theories of creativity*. In J. C. Kaufman & R. J. Sternberg (Eds.), *The Cambridge Handbook of Creativity* (p. 489). *Cambridge, UK: Cambridge University Press*.
- Kuhn, T. (2008). *A Communicative Theory of the Firm: Developing an Alternative Perspective on Intra-organizational Power and Stakeholder Relationships*. *Organization Studies*, 29(8-9), 1227–1254.

- Latour, B. (1986). *The Powers of Association*. In J. Law (Ed.), *Power, Action and Belief. A New Sociology of Knowledge* (Vol. 32) (pp. 261–277). London, UK: Routledge and Kegan Paul.
- Latour, B. (1987). *Science In Action: How to follow scientists and engineers through society* (p. 271). Cambridge, Massachusetts: Harvard University Press.
- Lawrence, P. R., & Lorsch, J. W. (1967). *Differentiation and Integration in Complex Organizations*. *Administrative Science Quarterly*, 12, 1–30.
- Levitt, B., & March, J. G. (1988). *Organization learning*. *Annual Review of Sociology*, 14, 319–340.
- Liyanage, S., Greenfield, P. F., & Don, R. (1999). *Towards a fourth generation R&D management model-research networks in knowledge management*. *International Journal of Technology Management*, 18, 372–394.
- Ludwig, A. M. (1998). *Method and Madness in the Arts and Sciences*. *Creativity Research Journal*, 11(2), 93–101.
- MacKinnon, D. W. (1962). *The nature and nurture of creative talent*. *The American Psychologist*, 17(7), 484–495.
- Manz, C. C., & Sims, H. P. (1987). *Leading Workers to Lead Themselves: The External Leadership of Self-Managing Work Teams*. *Administrative Science Quarterly*, 32(1), 106–129.
- March, J. G. (1991). *Exploration and Exploitation in Organizational Learning*. *Organization Science*, 2(1), 71–87.
- March, J. G. (1994). *Primer on Decision Making: How Decisions Happen* (p. 289). New York, NY, USA: Simon and Schuster Inc.
- McCloskey, D. N. (1983). *The Rhetoric of Economics*. *Journal of Economic Literature*, 21, 481–517.
- Mead, G. H. (1934). *Mind, self, and society from the standpoint of social behaviorist*. Chicago, IL: University of Chicago Press.
- Mednick, S. A. (1962). *The associative basis of the creative process*. *Psychological Review*, 69(3), 220–232.
- MICIN. (2010). *Instalaciones Científico-Técnicas Singulares*. Ministry of Science and Innovation. Retrieved in January, 1, 2011, from [http://www.idi.mineco.gob.es/portal/site/MICINN/menuitem.6f2062042f6a5bc43b3f6810d14041a0/?vgnnextoid=d27fce5451f44410VgnVCM1000001d04140aRCRD&lang\\_choosen=en](http://www.idi.mineco.gob.es/portal/site/MICINN/menuitem.6f2062042f6a5bc43b3f6810d14041a0/?vgnnextoid=d27fce5451f44410VgnVCM1000001d04140aRCRD&lang_choosen=en)
- Mumford, M. D. (2003). *Where Have We Been, Where Are We Going? Taking Stock in Creativity Research*. *Creativity Research Journal*, 15(2-3), 107–120. doi:10.1080/10400419.2003.9651403



- Mumford, M., & Gustafson, S. B. (1988). *Creativity Syndrome: Integration, Application, and Innovation*. *Psychological Bulletin*, 103, 27–43.
- Nadal-Burgues, N. (2014). *Project specification: Creativity and Rhetoric in Scientific Research*. *Journal of Organizational Change Management*, 27(5), 807 – 818.
- Nadal-Burgues, N., & Bonet, E. (2012). *Limitations of Project Management when Managing Research: An Empirical Study at the Barcelona Supercomputing Center*. *The International Journal of Management*, 1(2), 1–20.
- Nelson, R. R., & Winter, W. G. (1982). *An evolutionary Theory of Economic Change* (p. 454). Cambridge, MA: Harvard University Press.
- O'Brien, J. J., & Plotnick, F. L. (1999). *CPM in Construction Management (Vol. 5th)*. USA: McGraw Hill Companies, Inc.
- Obstfeld, D. (2005). *Social Networks, the Tertius Iungens Orientation, and Involvement in Innovation*, 50, 100–130.
- Obstfeld, D. (2012). *Creative Projects: A Less Routine Approach Toward Getting New Things Done*. *Organization Science*, 23(6), 1571–1592.
- OECD. (2002). *Frascati Manual: Proposed Standard Practice for Surveys on Research and Experimental Development* (p. 254). Paris, France: OECD PUBLICATIONS.
- OECD. (2011). *Public Research Institutions: Mapping Sector Trends*. OECD Publishing.
- Oldham, G. R., & Cummings, A. (1996). *Employee Creativity: Personal and Contextual Factors at Work*. *The Academy of Management Journal*, 39(3), 607–634.
- Orlikowski, W. J. (1993). *CASE Tools as Organizational Change: Investigating Incremental and Radical Changes in Systems Development*. *Management Information Systems Quarterly*, 17(3), 309–340.
- Patton, M. Q. (1990). *Qualitative evaluation and research methods* (2nd ed., p. 532). Thousand Oaks, CA, USA: Sage Publications, Inc.;
- Patton, M. Q. (1999). *Enhancing quality and Credibility of Qualitative Analysis*. *Health Services Research*, 35(5), 1189-1208.
- Paul, E. S., & Kaufman, S. B. (2014). *Introducing the Philosophy of Creativity*. In E. S. Paul & S. B. Kaufman (Eds.), *The Philosophy of Creativity: New Essays* (p. 336). New York, NY: Oxford University Press.
- Pentland, B. T., & Rueter, H. H. (1994). *Organizational Routines as Grammars of Action*. *Administrative Science Quarterly*, 39, 484–510.
- Pich, M. T., Loch, C. H., & Meyer, A. De. (2002). *On Uncertainty, Ambiguity, and Complexity in Project Management*. *Management Science*, 48(8), 1008–1023.
- Pinch, T. J., & Bijker, W. E. (1984). *The Social Construction of Facts and Artefacts: or How the Sociology of Science and the Sociology of Technology might Benefit Each Other*. *Social Studies of Science*, 14(3), 399–441.

- Pons, C., Bonet, E., & Iglesias, O. (2003). *A Study of Hitchcock's Film "The Rear Window": On How We Interpret Social Actions*. In 19th EGOS Conference. Copenhagen, Denmark: Copenhagen Business School.
- Popper, K. (1957). The Poverty of historicism (March 2002., p. 176). London, UK: Routledge.
- Powell, W. W. (1990). *Neither market nor hierarchy: network forms of organization*. *Research in Organizational Behavior*, 12, 295–336.
- Puccio, G. J., & Cabra, J. F. (2010). *Organizational Creativity*. In J. C. Kaufman & R. J. Sternberg (Eds.), *The Cambridge Handbook of Creativity (First., p. 489)*. New York, NY: Cambridge University Press.
- Puig Rovira, F. X. (2002). *Cronología*. Facultad De Informática de Barcelona. Barcelona, España. Retrieved January, 1, 2011, from <http://www.fib.upc.edu/25e/Llibres/Cronologia.pdf>
- Runco, M. A., & Robert S. Albert. (2010). *Creativity Research: A Historical view*. In J. C. Kaufman & R. J. Sternberg (Eds.), *The Cambridge Book of Creativity (p. 489)*. Cambridge, UK: Cambridge University Press.
- Salaman, G., & Storey, J. (2002). *Managers' theories about the process of innovation*. *Journal of Management Studies*, 39(2), 147–165.
- Sarasvathy, S. D. (2001). *Causation and effectuation: towards a theoretical shift from economic inevitability to entrepreneurial contingency*. *Academy of Management Review*, 26(2), 243–263.
- Schumpeter, J. A. (1934). *The Theory of Economic Development: An Inquiry Into Profits, Capital, Credit, Interest, and the Business Cycle*. (Transaction, Ed.) (10th (1983 ed., p. 255). New Brunswick, NJ: Transaction Publishers.
- Schutz, A. (1953). *Common-Sense and Scientific Interpretation of Human Action*. *Philosophy and Phenomenological Research*, 14(1), 1–38.
- Schutz, A. (1967). *The Phenomenology of the Social World*. Evanston, Illinois: Northwestern University Press.
- Scott, R. K. (1995). *Creative Employees: A Challenge to Managers*. *The Journal of Creative Behavior*, 29(1), 64–71. doi:10.1002/j.2162-6057.1995.tb01424.x
- Seegerberg, K. (1985). *Routines*. *Synthese*, 65(2), 185–210.
- Shalley, C. E., & Gilson, L. L. (2004). *What leaders need to know: A review of social and contextual factors taht can foster or hinder creativity*. *The Leadership Quarterly*, 15, 33–53.
- Sillince, J. A. A. (1999). *The Organizational Setting, Use and Institutionalization of Argumentation Repertoires*. *Journal of Management Studies*, 36(6), 795–830. doi:10.1111/1467-6486.00159

- Simon, H. A. (1983). *Discovery, invention, and development: Human creative thinking*. *Psychology*, 80(4569-4571).
- Simon, H. A. (1987). *Making management decisions: The role of intuition and emotion*. *Academy of Management Executive*, 1(1), 57–64.
- Simons, R. (1995). Levers of control: How managers use innovative control systems to drive strategic renewal (p. 232). *Cambridge, MA, MA: Harvard Business Press*.
- Simonton, D. K. (1975). *Sociocultural context of individual creativity: A transhistorical time-series analysis*. *Journal of Personality and Social Psychology*, 32(6), 1119–1133.
- Simonton, D. K. (2004). *Creativity in Science: Chance, Logic, Genius, and Zeitgeist* (p. 234). *Cambridge, UK: Cambridge University Press*.
- Simonton, D. K. (2010). *Creativity in highly eminent individuals*. In J. C. Kaufman & R. J. Sternberg (Eds.), *The Cambridge Handbook of Creativity*. *Cambridge, UK*.
- Steiner, G. A. (1971). *Introduction to The Creative Organization*. In G. A. Steiner (Ed.), *The Creative Organization* (p. 267). *The University of Chicago Press*.
- Sternberg, R. J., & Lubart, T. I. (1996). *Investing in creativity*. *American Psychologist*, 51(7), 677–688. doi:10.1037/0003-066X.51.7.677
- Straus, A., & Corbin, J. (1988). *Basics of Qualitative research: Techniques and procedures for developing grounded theory (Vol. Internatio)*. *Thousand Oaks, CA: Sage publications*.
- Taylor, F. W. (1911). *The Principles of Scientific Management*. *New York and London: Harper & Brothers*.
- Taylor, J. (2006). *Managing the Unmanageable: the Management of Research in Research-intensive Universities*. *Higher Education Management and Policy*, Volume 18(No. 2), 1–25.
- Taylor, J. R., Cooren, F., Giroux, N., & Robichaud, D. (1996). *The Communicational Basis of Organization: Between the Conversation and the Text*. *Communication Theory*, 6(1), 1–39.
- Vallas, S. P. (2006). *Empowerment redux: Structure, agency and the re-thinking of managerial authority*. *American Journal of Sociology*, 111(5), 1677–1717.
- Vallas, S. P. (2012). *Work: A Critique*. *Cambridge, UK: Polity Press*.
- Wallace, D. B., & Gruber, H. E. (1989). *Creative People at Work: Twelve Cognitive Case Studies* (p. 320). *Oxford University Press*.
- Wallas, G. (1926). *The Art of Thought* (p. 162). *London, UK: Johnathan Cape*.
- Watson, T. J. (1995). *Rhetoric, Discourse and Argument in Organizational Sense Making: A Reflexive Tale*. *Organization Studies*, 16(5), 805–821. doi:10.1177/017084069501600503

- Weisberg, R. W. (1992). *Creativity: Beyond the Myth of Genius* (p. 312). New York, NY: W.H. Freeman & Co.
- Weiss, C. H. (1998). *Evaluation methods for studying programs and policies* (2nd ed., p. 372). Upper Saddle River, NJ: Prentice Hall.
- Wilts, A. (2000). *Forms of research organization and their responsiveness to external goal setting*. *Research Policy*, 29(1), 767–781.
- Woodman, R. W., Sawyer, J. E., & Griffin, R. W. (1993). *Toward a theory of organizational creativity*. *Academy of Management Review*, 18(2), 293–321.
- Woodman, R. W., & Schoenfeldt, L. F. (1990). *An interactionist model of creative behavior*. *Journal of Creative Behavior*, 24(4), 279–290.
- Wright, A. (2014). *Organizational Routines as embodied performatives: a communication as constitutive of organization perspective*. *Organization*, 1–17.
- Yahya, S., & Goh, W.-K. (2002). *Managing human resources toward achieving knowledge management*. *Journal of Knowledge Management*, 6(5), 457–468. doi:10.1108/13673270210450414

### **Annex 1: Brief biographical notes of the interviewees**

#### **Dr. MATEO VALERO CORTES**

Professor Valero obtained his Telecommunication Engineering Degree from the Polytechnic University of Madrid (UPM) in 1974, his Ph.D. in Telecommunications from the Polytechnic University of Catalonia (UPC) in 1980, and he has been Chair of the Computer Architecture Department (1983-84; 1986-87; 1989-90 and 2001-2005), and the Dean of the Computer Engineering School (1984-85).

From 1990 to 1995 Professor Valero created and directed the European Center for Parallelism of Barcelona (CEPBA) and successfully contribute to develop basic and applied research in parallel computing. He was also the director of C4, the Catalan Center for Computation and Communications, during 1995-2000. Since October 2000 to 2004, he has been the director of CIRI, the CEPBA-IBM Research Institute, created to conduct research on parallel computers. Since May 2004, he has been the director of the Barcelona Supercomputing Center (BSC), the National Center of Supercomputing in Spain. His extraordinary leadership and vision of bringing closer to science and industry the research and development on parallel computing has gained recognitions worldwide.

#### **ERNEST QUINGLES SOTERAS**

Mr. Quingles obtained his Degree on physics from the University of Barcelona in 1964. He holds a large experience as civil servant in the Spanish National Research Council (CSIC). He was appointed, in 2000 as deputy director the Spanish Ministry of science and technology (MICYT), assessing the policy of the Spanish scientific activities, programs and projects. Afterward, in 2004, he was named deputy director for the advancement of technological infrastructures and big installations of the Spanish Ministry of Science and Education (MEC). With this experience, in 2007, he was designated as managing director of the Barcelona Supercomputing Center, the National Center of Supercomputing in Spain. His connection and large experience with the public administration has been essential to successfully administrate the Barcelona Supercomputing Center.

#### **FRANCES SUBIRADA**

Mr. Subirada holds an Engineering degree in Chemistry from the Institut Químic de Sarrià (IQS, Spain) and a Master degree in Business Administration (MBA) from the Open University Business School (OUBS / United Kingdom). Since its creation in 2005 he has

been the Associate Director of the Barcelona Supercomputing Center. From 2000 to 2004 he was Associate Director of the joint IBM-UPC Research Institute at the Technical University of Catalonia. He was also Director of the IBM Center for Advanced Studies (CAS) in Barcelona, Spain. From 1989 to 1999, IBM employee, responsible for different technical and business strategy positions, including Business Intelligence, University Relations and Research and Development. He was member of several IBM technical advisory boards.

His main professional interests are Research Strategy & Management, Deep Computing and Emerging Technologies. Along his professional career, he has continuously collaborated with Research & Development centres and managed University-Industry collaborations.

#### **Dr. JOSE MARIA CELA ESPIN**

Dr. Cela graduated as a Telecommunication Engineer and holds a Ph.D. on Computer Sciences from the Polytechnic University of Catalonia, since 1996. He is full professor in the Computer Architecture Department (DAC) of the Polytechnic University of Catalonia and develops his research at the Barcelona Supercomputing Center where he is the director of the Computer Applications in Science and Engineering (CASE) department. His group develops new computational strategies to simulate complex problems capable of running efficiently on modern supercomputers.

#### **Dr. CARLOS PEREZ GARCIA-PANDO**

Dr. Pérez Garcia-Pando graduated in 2001 at the Polytechnic University of Catalonia, as Industrial Engineer, and obtained a double degree in engineering in collaboration with the École Centrale de Paris, France. In 2005, he gained his Ph.D. in Environmental Engineering in the Polytechnic University of Catalonia. In 2006, and for three years, he was group leader at the Earth Sciences Department of the Barcelona Supercomputing Center. He worked as a postdoc at the International Research Institute for Climate and Society in New York, and currently, he is an Associate Research Scientist and Project PI at the NASA Goddard Institute for Space Studies and the Department of Applied Physics and Applied Math at Columbia University, New York. His research is mainly related to the understanding of aerosol processes and interactions within the Earth System, he contributes to the development of climate and atmospheric aerosol models, and he is involved in multidisciplinary research involving climate and health.

#### **Dr. ROSA MARIA BADIA SALA**

Dr. Badia graduated, in 1989, on Computer Science at the Facultat d'Informàtica de Barcelona (FIB), and since 1994, she holds a Ph.D. from the Polytechnic University of Catalonia. She has been lecturing and doing research at the Computer Architecture Department (DAC) at the Polytechnic University of Catalonia from 1989 to 2008, where she held an Associate Professor position from 1997 to 2008. Currently, she is a Research Scientist at the Spanish National Research Council (CSIC) and the manager of the Grid Computing and Clusters group at the Barcelona Supercomputing Center.

### **CRISTINA MONTAÑOLA-SALES**

Cristina Montañaola holds an MSc in Computer Science from Polytechnic University of Catalonia, and she is currently a Ph.D. candidate at the Statistics and Operations Research Department in Polytechnic University of Catalonia (now, UPC-BarcelonaTech) and develops her research at the Barcelona Supercomputing Center (BSC). Her research interests include agent-based modeling, computer simulation, high-performance computing, and computational social science.

### **Dr. MARIANO VAZQUEZ**

Dr. Vázquez holds a MSc. in physics from the Buenos Aires University, Argentina, and in 1999, obtained his Ph.D. in physics in the Polytechnic University of Catalonia. He is the group leader of the High Performance Computational Mechanics group at the Computer Applications in Science and Engineering Department of the Barcelona Supercomputing Center (BSC). His team develops algorithms and their derived computer codes for computational mechanics to run in high performance facilities.

### **Dr. GUILLAUME HOUZEAUX**

Dr. Houzeaux holds a Ph.D. in physics. He is leads the physical and numerical modelling group at the Computer Applications in Science and Engineering Department of the Barcelona Supercomputing Center (BSC). His team develops high performance computational mechanics.

### **Dr. XAVIER RUBIO CAMPILLO**

Dr. Rubio holds a degree on Computer Science at the Facultat d'Informàtica de Barcelona (FIB) and obtained his Ph.D. in Didactics of Social Sciences in the University of Barcelona. Currently, he is a Research scientist at the Barcelona Supercomputing Center (BSC). He develops novel quantitative methods to explore human behavior using an evolutionary framework, such as Agent-Based Models and spatiotemporal analysis to explore the emergence of social interaction. He has applied these techniques to a diverse set of contexts, from the dynamics of innovation during military conflict to ecological resilience of hunter-gatherer populations.

### **Dr. MARCO MADELLA**

Dr. Madella graduated at the University of Milan, Italy in Natural Sciences (major in Botany) and obtained a PhD in Archaeology at the University of Cambridge, Darwin College. He holds an ICREA Research Professor position in Environmental Archaeology and is the Director of the Laboratory for Palaeoecology and Plant Palaeoeconomy, Department of Archaeology and Anthropology, Institució Milà i Fontanals, at the Spanish Council for Scientific Research (CSIC). Among others projects, he coordinates a big, innovative, and interdisciplinary project SimulPast of the CONSOLIDER program. This framework is

appropriate to model and simulate ancient societies and their relationship with environmental transformations.

#### **Dr. VICTOR GUALLARD TASIES**

Professor Guallar performed his Ph.D. in theoretical Chemistry in 1999 in collaboration between Universitat Autònoma de Barcelona (UAB) and University of California Berkeley. From there he moved to Columbia University for a postdoctoral research stay and was then appointed, in 2003, assistant professor in the Biochemistry and Molecular Biophysics department at the Washington University School of Medicine. In 2006, Dr. Guallar was awarded an ICREA Professor position and the group moved to the Barcelona Supercomputer Center (BSC). He is a recipient of the Advanced ERC IDEAS grant and an advisor editorial board member of Biophysical Chemistry. His research focuses on the theoretical modeling the different times scales in biochemical processes in order to achieve atomic (and electronic) detailed information of protein biochemistry and biophysics, and it also involves software development and applications in enzymatic reactivity and engineering.

#### **Dr. ORIOL JORBA CASELLAS**

Dr. Oriol Jorba graduated as Industrial Engineer in 1999, and afterwards obtained his Ph.D. in 2005 in Environmental Engineering, in the Polytechnic University of Catalonia. His research interest includes high resolution mesoscale meteorology and air quality, development of online meteorology-chemistry models, boundary layer studies, chemical mechanisms and environmental impact assessment. In 2005, he was enrolled as researcher at the Earth Sciences Department of the Barcelona Supercomputing Center, and since to 2008 leads the Meteorological Modelling Group.

#### **Dr. MARIA GONÇALVES AGEITOS**

Dr. Gonçalves is interim professor at the Engineering Projects Department of the Technical University of Catalonia. She currently teaches project management and environmental technology courses to under-grad and master students. She also works as an associate researcher at the Earth Sciences Department of the Barcelona Supercomputing Center, where she conducts her research in the atmospheric modelling field. Her research interests go from the study of air quality and the analysis of strategies for the abatement of air pollution, to the study of climate and climate change at regional scales and high resolution.

#### **Dr. FERMIN SNACHEZ CARRACEDO**

Dr. Sánchez, graduate, in 1987, on Computer Science at the Facultat d'Informàtica de Barcelona (FIB), and in 1996 he received his Ph.D. in computer science from the Polytechnic University of Catalonia. However, he is involved in the Computer Architecture Department since 1985, and has been an associate professor of the Polytechnic University of Catalonia, since 1987. In 1997, he became full professor, and since May 2007, is vice dean of innovation



at the FIB. He currently coordinates the European mobility program of High Performance Computers at the Barcelona Supercomputer Center (BSC) and he develops his research at the VLSI CAD group. His research interest is in software pipelining and register optimization.

**Dr. VANJA SISIRAK**

Dr. Sisirak obtained his Bachelor of Science and Master of Science in cellular and molecular biology in the Ecole Normale Supérieure de Paris, France. In 2010, he obtained his Ph.D. on immunology at the Claude Bernard Lyon 1 University. He is a postdoctoral research fellow at Columbia University, in NY. His research is on the mechanisms involved in the initiation of Lupus pathogenesis.

## **Annex 2: Interview procedure used in the study**

### **SECTION A: THE CREATION PROCESS: PERSONAL AND CONTEXTUAL CHARACTERISTICS OF A SUCCESSFUL CASE.**

1. Usted durante la creación de esta organización jugó un papel clave, ¿me podría explicar la experiencia vivida antes, durante y después de la creación del BSC, indicando los roles que jugó en las distintas etapas?
2. La misión del BSC es colaborar en las áreas científicas donde la supercomputación pueda ayudar a obtener nuevos resultados científicos, contribuyendo así con el progreso científico.
  - ¿Cómo considera usted que el centro realiza su misión? Cuáles han sido y son los procesos que se han establecido para su realización?

*(Puede enfocarse a nivel de personal, las relaciones que ha establecido con otros centros, puede identificar si son líderes en este campo y porque...)*

- ¿Cuáles eran/son sus expectativas para el centro? ¿Qué cosas cambiaría y cuáles mejoraría?
- ¿Cómo obtiene el centro los recursos para llevar a cabo su misión?
- ¿Cuál es la política del centro a la hora de escoger las diferentes líneas de investigación?
- ¿Cuál es la política del centro a la hora de escoger los proyectos que se llevaran a cabo?

### **SECTION B: THE CASE OF THE TENSION BETWEEN STRUCTURE AND AGENCY**

1. Contexto. Vida y experiencia como científico. ¿Cuál es su formación? ¿En qué te licenciaste, dónde, cuándo y en qué hizo la tesis?
2. ¿Cómo llegó al BSC?
3. ¿Cómo se formó el departamento de CASE? ¿Y cuál es su evolución hasta día de hoy, ha habido cambios destacables? Tenían algo proyectado, qué?
  - ¿Qué te atrajo de la idea inicial de su grupo de investigación y te hizo venir a este Centro y departamento en vez de ir a otro sitio?
  - Cuando entró en CASE, ¿cuál era su trabajo, qué se esperaba de ti? Y ahora cuál es tu trabajo y qué se espera de ti?
  - ¿Qué hacéis en el departamento de CASE? ¿Y qué le diferencia de otros departamentos? Un departamento de soporte no puede ser un departamento científico? ¿Si fuera un departamento de soporte que cosas no podría hacer? Y viceversa.

4. Una de las misiones del BSC es colaborar en las áreas científicas donde la supercomputación pueda ayudar a obtener nuevos resultados científicos, contribuyendo así con el progreso científico.

- ¿Cómo contribuye el departamento de CASE a alcanzar la misión del BSC?
- ¿Cuál es la misión de su departamento?
- ¿Cómo afecta esto a tu carrera científica? ¿Cómo ves el futuro de tu carrera científica?
- ¿Qué tipo de formación recibís en el departamento o en el Centro?
- ¿Cómo se hace la selección de las distintas personas que trabajan en CASE?
- ¿Cuál es el grado de libertad para llevar a cabo los temas que te interesan? ¿Cuál es el grado de libertad para llevar a cabo los temas que interesan al grupo?

5. ¿Cómo convives con esta tensión? ¿Cómo gestiona la tensión entre el interés científico propio y los intereses del centro, o con los programas de investigación?

### **SECCION C: CREATIVITY AND PRODUCTIVITY PARADOX IN SCIENTIFIC WORK**

Como ya sabe, hay un debate en la comunidad científica. Actualmente se dice que los centros de investigación tienen que lidiar con una paradoja. Por un lado, estas instituciones tienen la necesidad de promover la creatividad y así asegurar la creación de nuevo conocimiento. Y por otro lado, la gestión de la investigación requiere control, calidad, contabilidad, garantía en la obtención de los recursos y diseminación,... En su opinión:

- ¿Cuáles son las repercusiones que esta paradoja tiene a nivel de la comunidad científica? ¿Cómo convive esta organización con este tema?
- ¿Cómo cree que los directores de cada una de las áreas del centro viven esta paradoja?
- ¿Cómo cree usted que los distintos investigadores gestionan la tensión entre el interés científico propio y los intereses del centro, o con los programas de investigación?

*(Son independientes dirección y las áreas de investigación, quién coordina y qué coordina?)*

### **SECTION C': SCIENCE ORGANIZED IN PROJECT AND ITS MANAGEMENT**

Aquest treball de recerca intenta aprofundir en temes que tenen a veure amb la gestió de la recerca. Aquesta entrevista és per parlar de direcció i gestió de la recerca que dur a terme. Per altra banda, voldria introduir-te un tema prou conegut per la comunitat científica que és la paradoxa amb la que el centres de recerca coexisteixen. Per un costat, aquestes institucions tenen la necessitat de promoure la creativitat per poder assegurar la creació de nou coneixement. I per un altra banda, la gestió de la recerca requereix productivitat, control, comptabilitat, i obtenció de recursos, etc.

1. Dit això. Experiència en gestió científica. Podries explicar, quina és la teva experiència en la gestió de projectes? Quin és la teva experiència en dirigir, escollir, preparar, desenvolupar, i controlar projectes de recerca?

- Com gestiones els teus projectes? Com els dirigeixes, els prepares, els gestiones i els controles?
  - Com esculls el grup de treball, com assignes responsabilitats?
2. Criteris de selecció de projectes. Quins criteris tens per decidir una línia o una altra d'investigació. O com tries quins són els projectes que t'interessa dur a terme?
  3. Problemes de les polítiques científiques. Quins són per a tu els principals problemes que hi ha a nivell de política científica a l'hora de dur a terme la teva recerca?
    - Com t'afecten les polítiques científiques? (tan les de nivell europeu, com les de nivell nacional)
  4. Problemes entre l'investigador i la política científica i els objectius de l'organització. Els objectius del BSC com influencien en la teva recerca? Quins són per tu els principals problemes amb els que et trobes a l'hora de decidir i de dur a terme la preparació, desenvolupament i control dels teus projectes?
  5. Tipologia de projectes. Quin tipus de projectes dus a terme o dirigeixes? Projectes de recerca bàsica, projectes de recerca aplicada, i/o contractes comercials?
    - Diferències en la gestió de cada tipus. La gestió d'un projecte de recerca bàsica y la gestió d'un projecte de recerca aplicada o contracte comercial, és molt diferent?
    - Quines diferències a nivell de direcció trobes entre uns i altres?
  6. Efectes del grau d'indefinió de cada tipus de projecte. Com t'afecta la diferència del grau d'indefinió dels objectius dels tres tipus de projectes? Veus alguna diferència en la teva direcció quan es tracta de recerca bàsica, aplicada o contractes comercials, degut al grau de predicibilitat que tenen cada un d'ells?
  7. Diferències en el procés de selecció. El procés de selecció és diferent en cada un d'ells?
  8. Problemes a nivell de desenvolupament. Quins problemes destacaries a nivell de desenvolupament de cada tipus de projecte?
  9. Focalitzant sols en projectes de recerca bàsica. Quina és la teva experiència, en el procés següent: comences a pensar quin problema vols resoldre, en aquest moment segurament un ventall de diferents visions i significats sobre el problema sorgeixen, però després hi ha un moment en que aconseguixes passar a tenir un objectiu més ben definit. Et trobes sovint en aquesta situació? Com gestiones aquest procés?
  10. Llibertat com a investigador/a. Creus que tens el grau de llibertat que necessites com a investigador per dur a terme la recerca que creus convenient?
    - Per exemple tens com a manager de grup la llibertat suficient per seleccionar el projecte en el que vols participar?, i escollir com serà el seu desenvolupament?, etc...
  11. Gestió dels graus de llibertat com a director/a. Quin grau de llibertat té la gent del teu equip per escollir i desenvolupar els seus projectes? Com prens la decisió de donar/treure llibertat? Com controles la seva productivitat? És a dir, com gestiones la tensió entre el interès

científic de l'investigador, el del departament i el interès del centre? A més a més de l'interès científic dels programes de recerca?

12. Habilitats per dirigir la recerca. Des de la teva experiència, quines són les habilitats que creus que es necessiten per gestionar projectes? Quina importància te saber tractar amb el contrast que suposa gestionar la creativitat i la productivitat i/o els graus de llibertat i control?

- Al teu entendre com s'adquireixen aquestes capacitats? Les veus més una dimensió de la professió d'investigador o creus que poden millorar-se a través de la formació?

## **SECTION D: HOW IS JUDGMENT INTERFERING IN YOUR CREATIVE UNDERTAKINGS**

El estudio que llevé a cabo a partir de las entrevistas realizadas durante los años 2010 a 2013 reportan un modelo de gestión para la investigación distinto al comúnmente aceptado. Desde la IIGM y debido al éxito de una serie de proyectos científico-militares, la investigación se organiza por proyectos y es comúnmente aceptado que se gestiona usando los métodos de gestión de proyectos (PM). El éxito y la repercusión de esta forma de gestión se debe en parte a que los métodos de PM ASEGURAN una PLANIFICACIÓN, CONTABILIDAD y PRODUCTIVIDAD EXHAUSTIVA del PROYECTO.

1. Para ti que significa/supone que tu trabajo o la actividad científica este organizada por proyectos?

- ¿Qué te sugiere el concepto gestión de proyectos? ¿Qué entiendes por gestión de proyectos?
- ¿Cómo escoges los proyectos en los que participas o lideras?
- ¿Cómo los preparas y diseñas?
- ¿Qué supone preparar un proyecto? ¿Cuáles son los elementos básicos o a incluir en tus proyectos?

2. ¿Durante el diseño del proyecto puedes especificar todos los estadios, operaciones y actividades que tendrá el proyecto? ¿Puedes poner un ejemplo reciente de cuál es el proceso que sigues?

*Si puedes dame ejemplos concretos de lo que explicas*

3. ¿Podrías clasificar los proyectos en los que has participado y liderado por categorías? ¿Cuál es la diferencia fundamental que ves entre ellos?

*Si puedes dame ejemplos concretos de lo que explicas*

4. ¿Durante el desarrollo de un proyecto siempre puedes realizar las operaciones, actividades y cumplir los tiempos que has planificado?

SI/NO

- ¿Describe qué tipo de problemas son frecuentes en tus proyectos?
- ¿Cómo resuelves los problemas que general esas desviaciones?
- ¿Quién evalúa la legitimidad de las desviaciones sobre lo planificado? ¿Has encontrado algún problema? ¿Cómo lo has resuelto?

*Si puedes dame ejemplos concretos de lo que explicas*

The interview wants to focus on the different ways of executing a project. Once the project is planned you have specified a number of operations or activities. The characteristic of the specified operations is that they are similar to some other previously known operations or activities. Therefore, planning a project involves combining similar operations or activities, the combination of the similar operation offers at least two scenarios:

- a. The combination of habitual operations or activities can result into a new result/output
- b. The combination of habitual operations or activities can result into a completely new project

If a project involves the combination of similar operations, is the same as saying that those activities are not mechanical therefore, they require judgment. The judgmental activity required to undertake any common or complex activity can be considered creative.

Based on this could you explain how do you solve the following scenarios based on your experience managing research projects? Please answer giving a concrete example.

1. While undertaking any activity of the project I have other ideas. What do you do with those ideas?

*Please answer giving a concrete example*

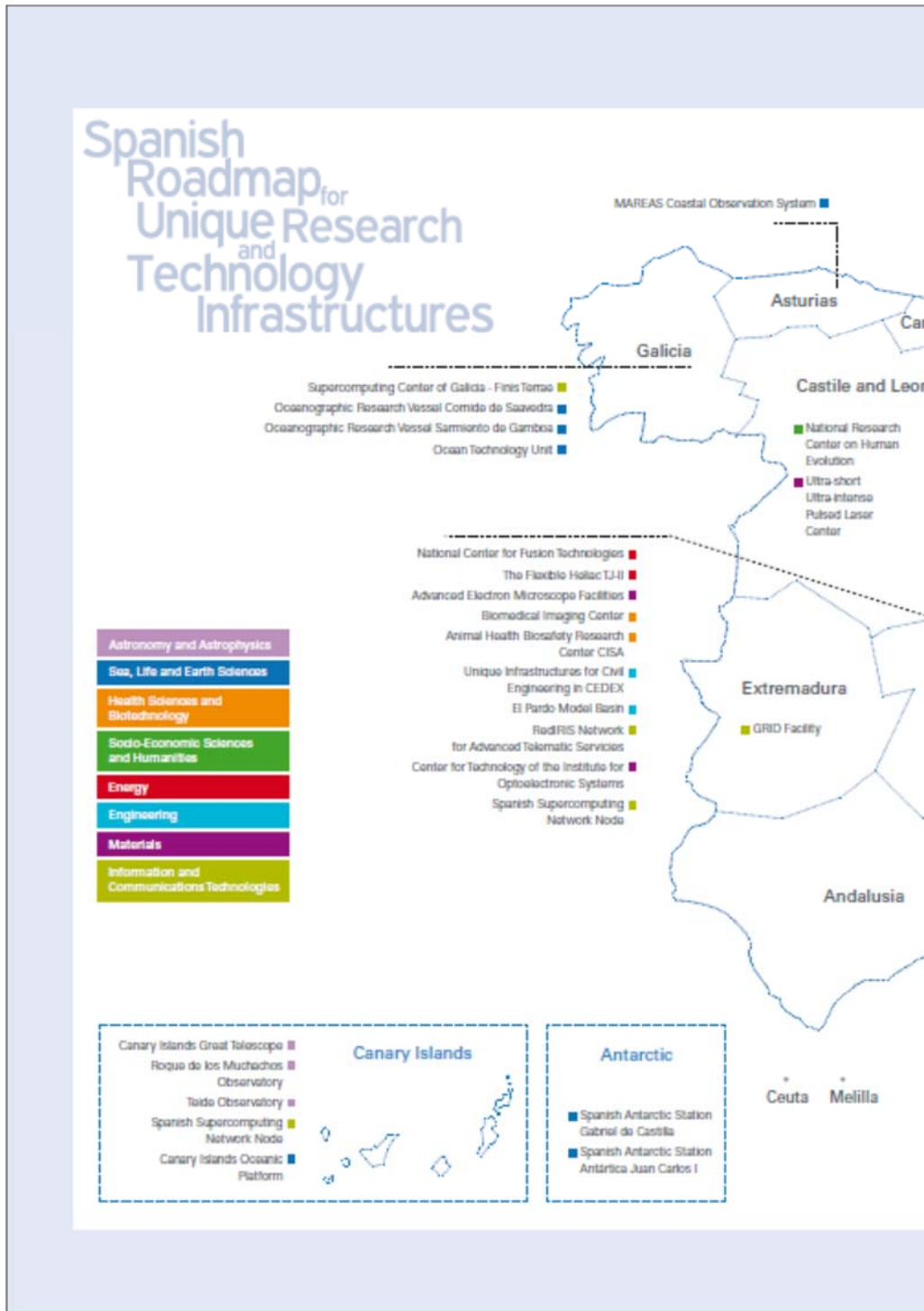
2. While undertaking any activity of the project I have to introduce changes that were not expected. How often this occurs? How do you solve this situation? What are the consequences of the changes?

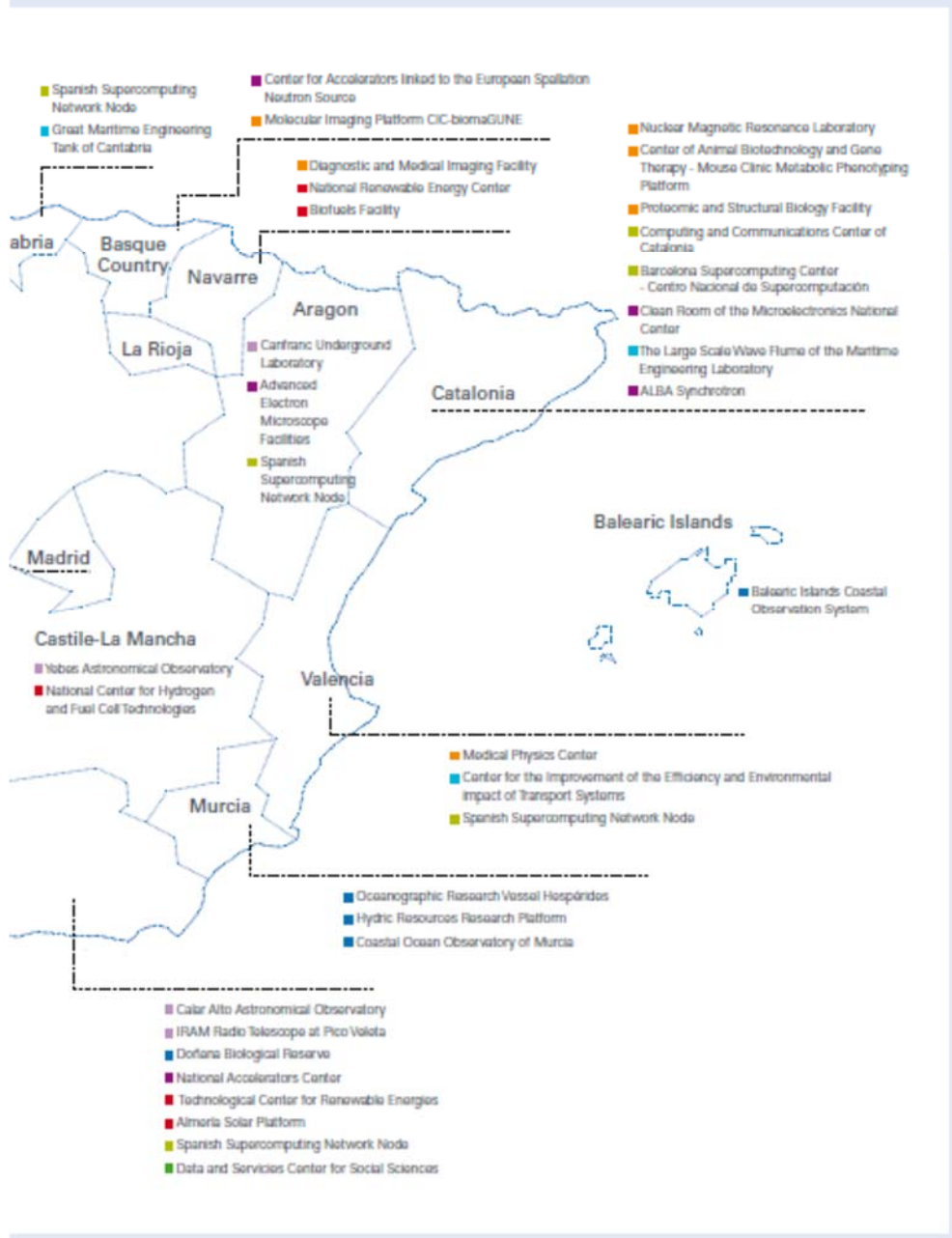
*Please answer giving a concrete example.*

3. While undertaking any activity of the project have you ever arrived to an unexpected dead end that you do not know how to solve? What do you do in this situation?

*Please answer giving a concrete example.*

## Annex 3: Spanish Roadmap for Unique Research and Technology Infrastructures





Source: Ministry of Science and innovation annual ICTS book 2010



## Annex 4: Data Source Collection: Web and Text Documents

Web and text documents have been reviewed aiming to improve, validate and give consistency to the research:

1) Documents used to assess the context of the Barcelona Supercomputing Center:

*BSC. (2010a). History.* Barcelona Supercomputing Center. Retrieved January 1, 2011, from [http://www.bsc.es/plantillaA.php?cat\\_id=9](http://www.bsc.es/plantillaA.php?cat_id=9)

*BSC. (2010b). Mision.* Barcelona Supercomputing Center. Retrieved January 1, 2011, from <http://www.bsc.es/about-bsc>

*BOE. (2005). Resolucion creación, equipamiento y explotación del Barcelona Supercomputing Centre-Centro Nacional de Supercomputación.* Boletín Oficial del Estado. Retrieved January 1, 2011 from [http://www.boe.es/diario\\_boe/txt.php?id=BOE-A-2005-19378](http://www.boe.es/diario_boe/txt.php?id=BOE-A-2005-19378)

*MICIN. (2010). Instalaciones Científico-Técnicas Singulares.* Ministry of Science and innovation. Retrieved January 1, 2011, from [http://www.idi.mineco.gob.es/portal/site/MICINN/menuitem.6f2062042f6a5bc43b3f6810d14041a0?vgnextoid=d27fce5451f44410VgnVCM1000001d04140aRCRD&lang\\_choosen=en](http://www.idi.mineco.gob.es/portal/site/MICINN/menuitem.6f2062042f6a5bc43b3f6810d14041a0?vgnextoid=d27fce5451f44410VgnVCM1000001d04140aRCRD&lang_choosen=en)

*MICIN. (2010). Spanish RoadMap for Unique Scientific and Technological Infrastructures.* Ministry of Science and innovation. Retrieved January 1, 2011 from [http://www.idi.mineco.gob.es/stfls/MICINN/Investigacion/FICHEROS/Instalaciones\\_Singulares/Libro ICTS.pdf](http://www.idi.mineco.gob.es/stfls/MICINN/Investigacion/FICHEROS/Instalaciones_Singulares/Libro ICTS.pdf)

*Puig Rovira, F. X. (2002). Cronología.* Facultad De Informática de Barcelona. Barcelona, España. Retrieved in January 1, 2011, from <http://www.fib.upc.edu/25e/Llibres/Cronologia.pdf>

*UPC. (2010). History Computer Architecture Department.* Polytechnic University of Catalonia. Retrieved January 1, 2011, from <http://www.ac.upc.edu/es/content/hist%C3%B2ria>

2) Documents used to extend the understanding on the aims of some of the projects and programs the research organizations and researchers are dealing with:

*BOE. (2009). Resolucion Programa CONSOLIDER-Ingenio 2010 y del VI Plan Nacional de Investigación Científica, Desarrollo e Innovación Tecnológica 2008-2011.* Retrieved May 20, 2012 from <http://www.boe.es/boe/dias/2009/05/30/pdfs/BOE-A-2009-9026.pdf>

*European Research Council (2012). Starting Research Grants.* Retrieved May 20, 2012 from <http://erc.europa.eu/starting-grants>

*SIMULPAST. (2012). Project.* Consejo Superior de Investigaciones Científicas. Retrieved May 20, 2012, from <http://www.dicat.csic.es/rdcsic/index.php/es/humanidades-y->

[ciencias-sociales-2/109-proyectos/91-simulacion-informatica-para-reinterpretar-la-historia](#)

3) Documents that publicly show the scientific developments of the Barcelona Supercomputing Center:

**TVI - Lab 24.** Mateo Valero, *Supercomputadores para la investigación*. Published May, 13, 2014, <http://www.rtve.es/alaharta/videos/lab24/lab24-mateo-valero-supercomputadores-para-investigacion/2559447/>

**La Vanguardia.** *El tercer supercomputador MareNostrum, potencia para la ciencia*. Published November, 25, 2013, <http://www.lavanguardia.com/tecnologia/electronica/20131125/54394492962/el-tercer-supercomputador-marenostrum-potencia-para-la-ciencia.html>

**BSC Facebook.** <https://www.facebook.com/BSCCNS>

4) Documents used to inform about the relevance of the subject of research

**Nature News.** *Germany's researchers welcome €5-billion funding boost*. April, 17, 2015, <http://www.nature.com/news/germany-s-researchers-welcome-5-billion-funding-boost-1.17353>

**Nature News.** *Peer review — Reviewed: Top medical journals filter out poor papers but often reject future citation champions*. December, 22, 2014, <http://www.nature.com/news/peer-review-reviewed-1.16629>

**El País.** *Tres problemas de la Universidad*. Published December, 16, 2014, [http://elpais.com/elpais/2014/12/15/opinion/1418646405\\_524512.html](http://elpais.com/elpais/2014/12/15/opinion/1418646405_524512.html)

**La Vanguardia.** *Como el Barça cuando busca portero*. Published January, 28, 2014, <http://www.lavanguardia.com/20140128/54399623233/como-el-barca-cuando-busca-portero-josep-corbella.html>

**The Guardian.** *Randy Schekman: How journals like Nature, Cell and Science are damaging science*. Published December, 9, 2013, <http://www.theguardian.com/commentisfree/2013/dec/09/how-journals-nature-science-cell-damage-science>

**The Guardian.** *Peter Higgs: I wouldn't be productive enough for today's academic system*. Published December, 6, 2013, <http://www.theguardian.com/science/2013/dec/06/peter-higgs-boson-academic-system>

**The Scientist.** *Don't Underestimate The Usefulness Of 'Useless' Knowledge*. Published August, 12, 1992, <http://www.the-scientist.com/?articles.view/articleNo/12443/title/Don-t-Underestimate-The-Usefulness-Of--Useless--Knowledge/>