

# Limitations of Project Management when Managing Research: An Empirical Study at the Barcelona Supercomputing Center

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## Abstract

The impressive development of science and technology, after World War II, drove research to massively be organized as projects and managed with the methods of project management. The application of project management methods requires the precise formulation of the project in propositions including the goals, constraints and operations. In contrast, the goal of scientific propositions is sometimes ambiguous. This article disentangles the limitations project management methods when managing research since they are unable neither to face the wide spectrum of projects research organizations deal with which might require different sort of management forms nor to face the tension between creativity and productivity research organizations coexist with. The research reveals researchers' views on research management's problems, and show a common position on the difficulty to understanding the paradox. This work is important to clarify how research is said to be managed and how it is really managed and leaves the possibility to implement a new research management approach.

❖ *Keywords:* research management, project management, creativity, knowledge production, narratives, case study

## 1. *Introduction*

The subject of managing research organization, institutions, centers, laboratories, groups and projects is becoming crucial for both theoretical and practical reasons. The wide spectrum of forms in which research is organized, the systematic efforts to strengthen the production of new knowledge -since it is considered to increasing the welfare of the estates, organizations and society (Gibbons et al., 1994) and “the growing complexity of the knowledge system” (Jensen, 2011) places the study of research management as a central topic.

Our study highlights the importance of researchers to improving, understanding and considering both, productivity and creativity, when managing research to both ensure the urgency of the commercial use of new scientific discovery and maintain the quality and nature of scientific research.

Current studies in the field of science studies focus on several topics, such as, the creation process of radical inventions and innovations (Schumpeter, 1934), the tension between scientific and commercial strategies (Latour, 1987), the balance between exploration and exploitation (March, 1991), the significance of new knowledge generation across networks (Liyanage, Greenfield, & Don, 1999; Powell, 1990), the interactions between public research institutions and private companies in the pursuit of commercialized research findings (Greenberg, 2007), and, the importance of creativity in the research activity (Jensen, 2011).

Little research has been encountered about the effects that the form of management used in research produces on the creation of new or radical knowledge. In fact, empirical studies on this area are sparse and almost non-existing. Max Boisot in his book “Collisions and Collaborations: The Organization of Learning in the Atlas Experiment at the LHC” unfolds the managerial aspects of building and exploiting a giant scientific infrastructure such as Atlas (Boisot, 2011).

This article aims to contribute to enlarge both the theoretical framework and empirical research on the field of research management. The conceptual framework of the article deals with the problem of the tension between productivity and creativity research organizations deal with. It starts introducing the "classical" approach of managing research based on the methods of project management whose main aim is to foster productivity and it is linked with the most applied oriented public research and which main requirement is the specification of the research goal.

It continues emphasizing the limitations of the use of project management methods in projects whose goal or stage of development is ambiguous; therefore, could not easily neither accurately be divided into simple tasks. Those types of research projects require an important creativity contribution.

The conceptual framework ends introducing the tension research organizations are facing when managing research between productivity and creativity. It stretches some emerging ideas from Liyanage et al. (1999), Wilts (2000) and Jensen (2011) to finally approach the science studies differently, highlighting the need of more flexible and dialogical forms of management to not marginalize new or radical discovery.

The empirical research presents a case study carried at the Barcelona Supercomputing Center which contributes on the understanding of the following questions: how do researchers manage research, what are the main problems that they identify and, how do they deal with the tension between productivity and creativity, in different types of research. Through the narratives about the creation of the research center and the researchers' experience, we unravel their views on managing research and the difficulty to understand the paradox between productivity and creativity.

This paper is not an exhaustive evaluation of managerial patterns but rather a preliminary conclusion to better capture researchers' understanding of research management, researchers' understanding about the tension between production and creativity and how this is connected to the type of research they carry out. It is a starting point for more in-depth comparisons and a wider study which will include other Spanish Singular Research and Technology Infrastructures for its study and comparison.

## *2. Conceptual Research*

### **2.1.0. Research Organized with the Methods of Project Management**

For the first time, during the World War II, research started to massively be organized as projects, partly driven by the need of control and accountability of productivity. The effective application of project management, in some important, large and complex research and development projects favored the use of project management methods in scientific organizations. In 1942, "The Manhattan project", whose name was a cover up for the construction of the atomic bomb, is an example of those research projects managed under the thriving project management methodologies (Carayannis, Kwak, & Anbari, 2005).

Project management methods were influenced by the context of the industrial revolution and inspired by Frederic Taylor scientific management theories which ensured and prioritized productivity, based on the division and specialization of labor (F. W. Taylor, 1911). Project management, as well as operational management, is based in breaking down complex projects into simple tasks, and its methods are thought to solve problems based on "a well defined objective stated in terms of scope, schedule and cost" (Gido & Clements, 2009).

The role of the project manager is to accomplish the project goal fulfilling certain requirements, then first the project manager designs and then implement the scheduled plan (Gido & Clements, 2009). During the execution phase they control, modify and reschedule the plan due to changes in the project scope.

Those characteristics made project management attractive to research organizations which with those methods were able to obtain funds from a group of diversified agents that were looking for controlling the research process. Funding agents assume that research project design, implementation, and goals are stable and unambiguous.

### 2.2.0. Limitations of Project Management when Managing Research

Both the deterministic nature of project management and the role of project managers clash with the idea of research as a creative and “intensely personal activity, strongly dependent on the ideas and imagination of individuals or groups of individuals” (J. Taylor, 2006). The classic or romantic idea of research implicitly holds the idea of ambiguity, experimentation and freedom. Those features are intertwined with research activity and its goals. In contrast, goal specificity, refinement, efficiency and productivity are the in line of an operational production, as well as project management methods are.

Karl Popper, in his book “The Poverty of Historicism”, claims that “we cannot predict, by rational or scientific methods, the future growth of our scientific knowledge” (Popper, 1957). Today’s conception of research broadly includes applied oriented science and technology developments whose findings are almost predictable. This idea is crucial in our claim since different types of research orientations require different types of management forms.

Project management methods elude the idea of the unpredictability of the scientific knowledge in the creative sense of Popper requiring the precise formulation of the project in propositions that can be observed and tested, including the goals, constraints and operations of the project.

Project management methods appear appropriate for a certain type of research projects which nature, approach and intent is in line of control, specificity and productivity, respectively. And they provoke a deleterious effect in those research projects which nature, approach and intend is diametrically opposed.

Despite the argued discrepancy between the form of management and the nature of the subject to be managed, the influence and support of project management methods by public and private research and development funding institutions, policy makers and research programs is categorical.

Therefore, we claim that today’s research organizations have difficulties to coexist with the imposed form of management that supports goal specificity and accountability of research output, holding back the nature of new or scientific knowledge whose “realm is ambiguous” (Jensen, 2011). Research organizations end up dealing with an extensively diverse type of research projects which differences are not translated to different management forms. Consequently, research organizations customize their research projects using project management methods, thus research goal, functions and resources must be specified.

### 2.3.0. Studies on Managing Research

The massification of higher education and scientific research, the effect of research and innovation on the welfare states and the importance of knowledge production as a competitive advantage affects research organization’s forms, roles and missions (Gibbons et al., 1994), increasing the amount of research in the field of research management studies and enhancing the importance of understanding the limitations of the actual research management forms.

Several management disciplines and project management methods captured the importance of dealing with uncertainty and change offering new methodologies without altering its foundations and according to the new paradigm. In this line we find several control theory based disciplines, such as, account management and, control and information systems. Control theory based disciplines affirm that their methods promote both creativity and control simultaneously, ensuring the choice, development and efficient execution of new ideas (Adler & Chen, 2011; Davila & Ditillo, 2009)

Project management developed adaptive processes and engage the matrix management and organization theories. Adaptive processes mode increased the speed of simulating best future options by constantly updating the system with the cumulate experience. And matrix theory overturned mainly large and complex organizations, from pyramid structures or “1-man, 1-boss” to grid structures or “1-man, 2-boss” (Davis & Laurence, 1977) changing the way to translate orders from top-down to a negotiated but also more complex system.

Embracing new theories project management methods did not get to the bottom of the limitations of the fundamentals of its theory.

This study encourages the importance of finding new management approaches that address creativity, freedom and ambiguity, and consider the limitations of project management methods for a certain type of research projects.

In this line Liyanage *et al.* (1999) claim that new research management forms must link “existing knowledge of an organization with new knowledge generated across organizational and network boundaries” (Liyanage *et al.*, 1999). They assert that the nature of the research projects’ selection influences the way research is managed. They distinguish between intuitive, purposeful and “market pull” project selection. Intuitive research projects are developed under scientific freedom conception and few formal management techniques are required for the selection and evaluation of the projects. Purposeful project selection is developed with the methods of strategic management which slightly shifts to a science and technology that yields economic returns. And market pull project selection is developed with the methods of project management, control and accountability being fundamental.

The categorization emphasizes the need of finding appropriate forms of management considering the nature of research projects.

Special attention has been given to the empirical study carried by Arnold Wilts (2000), in the context of university and non-university publicly funded research, who claims that the differences between research organization forms of work rest in the organization’s research orientation. In this study, two groups of economists were asked concerning the organization’s strategy, financial organization and intellectual research orientation. His results suggest that the institutional structures in which research is embedded explain the

differences among research projects, distinguishing between theoretically oriented research which are freely chosen and applied research, which are defined with very specific goals.

He also reinforces the idea of the change of the nature of research by subtly assuming that research is “constantly integrated into existing schemes of recognized problems and accepted problems solutions” that at the same “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).

#### **2.4.0. Emerging Theories on Managing Research**

The paradox of research organizations is that, on the one hand, they need to support freedom and creativity, to nurture discovery; and on the other hand, their activity has to be controlled from the organizational and productivity side, to account its return to the society and ensure funding. To balance the double side nature of contemporary research shall be considered to appropriately approach new forms of management.

March (1991) pointed at the importance and the difficulty of “understanding the choices and improving the balance between exploration and exploitation” (March, 1991) due to the unpredictability of the environment. Those concepts are important to move research management field forward. This paper joins recent conceptually-based perspectives on the paradox research organization coexist with such us, the management of ambiguity and unpredictability of research (Jensen, 2011).

Hans S. Jensen, (2011) in his article “The Role of Ambiguity in Innovation”, asserts that the objectives, constraints and operations of many research programs are formulated in very ambiguous terms and in order to make room for the new we need to keep situations open and ambiguous and resist early closure (Jensen, 2011).

Programs that involve few scientific innovations and many technical developments can be managed with classical methods of project management. Programs that involve intensive creativity, ambiguity and uncertainty have to be managed in more sophisticated ways along two periods; the first fosters rhetorical openness and the second works with precise aims. (Pinch & Bijker, 1984)

New management theories shall consider at least two stages in the research process, the discovery and closure stages. The discovery stage where ideas are open, ambiguous and divergent, using flexible and dialogical management forms fosters rhetorical openness. The closure stage, where managers can plan over explicit constrains, such as some research problems, research policies, legal frameworks and resources allocation, ensuring concrete outputs and continuous resources, using classical approaches to management will foster action. Notably, Jensen also includes the need of looking towards gaining recognition for the research work (Jensen, 2011).

Considering those precedents our claim is that there is a correlation between stages of development and the ambiguity of the research goal that gives awareness of the appropriate management form. It is the nature of the problem that should determine how we are going to deal with no the other way around.

Based on this conceptual framework our empirical study shows the significance of the problem of the paradox between productivity and creativity, through some stories on how researchers managed research.

### ***3. Empirical Research***

The main objective of our exploratory research is to obtain and enlarge empirical evidence on the following questions: how do researchers manage research, what are the main problems that they identify and, how do they deal with and understand the tension between creativity and productivity in different types of research.

The first part of this study is undertaken in one of the most renowned research and technology infrastructures of Spain, the Barcelona Supercomputing Center (BSC) which is the Spanish supercomputing facility. Further research will be done in other research infrastructures and organizations to compare the results obtained from the present study.

The empirical research is intensively developed in gathering information methods such as participant observation, analysis of documents and several in-depth interviews. The close insight into the researchers' practices and motivations brought the experience of the researcher as a project manager of the institution, the events and context of the creation of the research organization and the stories of three of the interviewees. The first story, with the director of the BSC, focuses on the scientific development that made possible the creation of this research organization. The second, with the director of the management department, emphasizes the scientific policy undertaken by the Spanish Ministry of Education and Science and the administrative steps that led to the creation of this research organization. And the third, with a group manager, contributes, more specifically, on how she manages research.

The two first interviewees played essential roles in the creation process and their narratives reflect their personal character and the ways they were living that experience. The stories they told are important for the understanding their ideas on managing research and on the paradox of creativity and productivity.

### 3.1.0. The Role of the Researcher

The researcher has been working at BSC for more than 3 years as a project manager. For this reason she has a deep knowledge of the institution and has access to many documents for triangulating the information. However, for the purpose of this paper is important to clarify that the name given to her position is misleading because her work does not follow the functions advocated by the theory 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.

### 3.2.0. Introducing the Barcelona Supercomputing Center

The concurrence of three circumstances unleashed the creation of BSC: the success of the Polytechnic University Department of Computer Architecture initiatives, the governmental investment on research facilities through the program on singular scientific and technological infrastructures (ICTS) (Ministerio de Ciencia e Innovación, 2010) and IBM looking for the appropriate locations to build four supercomputers.

The BSC is a public consortium officially constituted in March 2005 by 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 (Barcelona Supercomputing Center, 2010). In 2003 they started the negotiations with IBM which, at that time, had constructed four of the faster supercomputers and was looking for appropriate public partners interested in hosting one of them to investigating and developing supercomputer technologies.

Thus, the history of the creation of the BSC is the product of several events already highlighted in Jacob's (1997) article: first, the importance for governments of fostering the merger between industry and science to accelerate and promote economic growth through the creation of new knowledge and technologies, and second, the will of some corporations to externalize some of its in house research and development (R&D) and find new clients (Jacob, 1997).

The institutions that formed the public consortium agreed to fund the hundred per cent of the resources needed to buy, implement and later exploit the supercomputer. They provide the structural funds needed to run the supercomputer. Extra funds are acquired from the cooperating with industrial partners and from successfully participating in other European and Spanish research programs.

Diverse BSC resources acquisition channels are in line with the double nature of its mission which on the one hand aims to investigate, develop and manage technology to facilitate the scientific progress. And on the other hand, it aims to take advantage of the infrastructure to develop its own research in fields that are use information technologies for the development of their research, such as, Computational Sciences, Life Sciences and Earth Sciences.

Some of the features that make BSC a good sample choice to carry out our research are: first, the fact that it is an important scientific and technological infrastructure hosting one of the most powerful supercomputers in Europe; second, that it holds institutional autonomy to independently decide and choose its research goals and orient its priorities; and third, its will to meet both academic success and support industry demand.

The circumstances of BSC development and the double nature aim of its mission develop the understanding of the paradox between creativity and productivity and the problems researchers face when managing research.

### **3.3.0. Three Stories on Managing Research at the Barcelona Supercomputing Center (BSC)**

#### *3.3.1. The story told by the Director of the BSC*

This story explains the main conditions, events and developments of the creation process of this research organization. It is an epical narrative told with both rigor and passion, in which the story teller is the hero. He finds himself in a very challenging situation that he takes up with an exceptional effort, willingness and with the appropriate decisions on the fields of basic science and 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 Parallelization Center of Barcelona, 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. From the long interview we will transcribe the story in the following way:

The story we were told started in 1980. At that time, the Barcelona Faculty of Informatics, together with the Faculty of Informatics of Madrid and San Sebastian, was recently created, in 1976. In this context, the teller of the story was a young researcher, who soon got a full professorship and became the chairman of the Computers' Architecture Department. It did not take him so long, around his thirties; to be 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 to working on the way to overcome these awkward circumstances. To get over this situation, he decided to potentiate the cooperation with private companies, working with them as sponsors of the 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 of 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 department, and he could pay them with the money he got from the industrial partners, and, he consolidated a research group. In that line, a little bit later, the Computers' Architecture Department was a success and his group was playing in the international league, participating in important conferences and seminars, and attracting important researchers.

In 1991, he strove to create the European Center of Parallelization 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' parallelization techniques which extraordinarily improve computers capacity and speed, as well as, bring those techniques closer to SMEs by offering them, not just access, but training.

The CEPBA collaborated on research projects of the Polytechnic University of Catalonia and collaborated with key private partners. In this period, Compaq Computer Corporation, an American company, founded in 1982, was known for producing some of the first IBM compatibles personal computers. Compaq failed and was acquired by Hewlett Packard and Intel. Intel acquired the Compaq processors design branch and decided to maintain the Lab Compaq has in Barcelona and continue the cooperation with the CEPBA.

The CEPBA success and development was also accompanied by the capacity his idea got to attract doctoral students and researchers from his university department, as well as, other university researchers.

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

IBM was looking for the appropriate locations to build four supercomputers. He convinced IBM to build one of them 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 Catalonia, with a 14%. With this agreement IBM established a laboratory at BSC and daily they improve and develop supercomputing technologies.

However, for him the reason to create the BSC was not just to investigate, develop and manage information technology in order to give supercomputing services to the scientific community. His will now is to create a bridge between technology or computer sciences and scientist from different field and backgrounds, 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 and earth sciences' departments.

The will, the hard work and the right decisions placed him again in the successful path. Now, he 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.

### *3.3.2. The story told by the Director of the Management Department at BSC*

This story explains the important role of the Spanish Ministry of Education and Science and the decisions that lead to the creation of the BSC.

This narrative is close to a technical or administrative report, in which the main characters, if there is any, are the Ministry, its departments, its experts, and the story teller, who, at that time was the Deputy of the Ministry. They were in charge of designing and implementing a new scientific policy. The story teller 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 to manage the research and technology transfer of the university. 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), 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 the story ends. From the long interview we will transcribe the story in the following way:

He became Deputy Director of the Spanish Ministry of Education and Science and he has been involved in the design and implementation of the research policies and programs of the Spanish research infrastructures.

His story tells the important role the Ministry played for the creation of the BSC. He explains how the Ministry introduced changes in the scientific policies to prioritize the construction of several scientific

infrastructures to ensure enhancement of the Spanish research. The type of infrastructures included in this program should accomplish several requirements: first, to be singular, referring to the need of being unique; second, to be too expensive to be build by the current research organizations and; third, to be placed where the knowledge is, to ensure the success of the scientific infrastructure. The Ministry also aimed to achieve certain rationality and uniformity in the management model of the infrastructures and ensured 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 story teller 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 knowledge on the ICTS research program and, gathered support from key decision makers, who where 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.

Was in 2007 when he took the control of the management department. 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 to each unit concrete tasks. He supports project management methodologies and processes to ensure the success of the administration of the research projects and to lead with the equilibrium between basic research and the fact that the BSC gives supercomputing services to a broad community of scientists.

Nowadays, and after the extraordinary growth of the BSC in the number of people and projects, he is focusing in the implementation of new policies related with career and educational plans, thus, a strategic plan is being developed to move away from the vices acquired from the university and to build a research center with its own culture.

### *3.3.3. The story told by the Grid Group Manager of the Computer Sciences Department*

This story explains the role, experience and developments of a young researcher who is now leading one of the research groups of the computer science department at the BSC.

The story is a short narrative about the career development of the researcher who was a doctoral student in a university department since 1994. The scarcity of resources and the ambiguity and openness of the research topics proposed by her advisor on circuit design, took her to set a course for change through new fields and groups on computational sciences. She, then, joined the CEPBA to take care of an emerging topic on parallel

computing, called Grid computing. At CEPBA, she increased her expertise in this area and soon started promoting and lobbying around Europe. Her success took her to be selected as Grid group manager when BSC was created.

The story starts around 1999, when, due to an invariable and uncomfortable situation, as a young researcher of a department of the faculty of informatics of the Technical University of Catalonia, she decided to join another group on computational sciences; this circumstance led her to CEPBA a growing and well-known research organization belonging to the university. When she got there, she started to work as a researcher and was assigned to take care of a special and promising type of parallel computing, called Grid computing. She took this situation bravely and she was contented with the new challenges. Her research development was accompanied by a strong determination to promote and also to increase her network among different industrial and academic partners. This strategy ensures the necessary resources for the continuity of her research.

Some years after, the BSC was created and she was offered to be the Grid Group Manager. Her work is important, she attracts doctoral students and researchers, and she holds several types of basic and applied research projects. She is aware that every project type has to be managed differently as the specificity of the goal is lower when she deals with basic research compared to applied research projects. Therefore, she controls her group very closely to ensure the success of the research project and to obtain additional funding for research; her team must work under deadlines and controlled pressure.

The concreteness of her research subject and the fact that she knows national and European research instruments to get funding for her projects made her a very efficient researcher in getting resources and obtained a lot of freedom to manage her group and research.

The success of her strategy made her consider that a good manager has to be rigorous and chaotic however, she also thinks that empathy and communication are important and can not be learned; those are traits that are innate.

#### **3.4.0. Managing Research: Creativity and Productivity from the Researchers' Point of View**

The empirical research demonstrates the theoretical considerations previously made on the problems that researchers face when managing research.

Their answers on our research question: how do researchers manage research, what are the main problems that they identify, and, how do they deal with the tension between creativity and productivity in different types of research, are closely related to their personality and experience. The interview with the directors focused on the story of the creation of the research organization and on our main question about the paradox between creativity and productivity, freedom and control. The third interview contributes to specific information on managing research and also the interviewee's point of view about the paradox.

The interpretation of these stories reveals many aspects related to the way interviewees understand the paradox research organizations face between creativity and productivity. Further works assert how different organizations and researchers approach the paradox differently.

#### *3.4.1. The Director's Point of View*

The Director of the BSC has been successful on developing theoretical and applied research, and also on creating thriving research groups and organizations. He did not 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 compensated by several requirements, such as, producing important results and get 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.

#### *3.4.2. The Director of the Management Department's Point of View*

The Management Department Director did not make any direct comment on the subject of creativity and productivity. He focused on 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 institutions.

The problems the Director of the Management Department 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 the following general problems and situated some of them in the context of BSC.

The first problem is related to research policy makers. Traditionally, the research policy is made 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 resources allocation and acquirement from a variety of research projects, both theoretical and practical oriented.

The second and third problems are already mentioned by Wilts (200) where he states that the goal setting strategy of an organization requires different forms of management and different organization's structure. He also approached the paradox based on the distinction between theoretically oriented research which is freely chosen and applied research, defined with very specific goals.

The fourth problem explains that many research organizations, as well as, BSC inherit the traditional research and management vices of the university. This is a common topic; they refer to it without giving any indication about those vices; they are just taking them for granted.

Finally, the Management Department Director adopts a very constructive position for the future of the BSC and, makes references to general instruments, commented in some meetings, which could improve the ways of managing research, the creativity and the 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 they perform and improve in their activities. All those plans will be contained in an overarching Strategic Plan. The idea of the Training Plan on how to do and manage research could be very positive, but the form in which he described it corresponds to classical concepts of human resources management and it would be important to extend and complement them with specific subjects on research management.

#### *3.4.3. The Group Manager Group's Point of View*

The Grid Manager group is successful on applying to theoretical and applied research projects, which allowed her to reach a comfortable position at BSC. She takes advantage of the traditional rewards for successful scientific research -professional reputation and research funding. She emphasizes that she has enough freedom and she is successful in getting resources from different public funders, by orientating her research towards their practical demand. Her research group, as well, 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 researcher's research towards personal goals and objectives.

When speaking about creativity and productivity, she recognized 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.

Moreover, she reinforced this idea when she explains how the cooperation with the administrative department helps her to develop projects. 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.

This fact gives evidence that managing research has been restricted to be successful when applying for resources rather than be entirely focused on the creation of new knowledge. She also added that the necessary traits researchers should have, to manage research, are innate; they cannot be learned.

#### ***4. Concluding Summary and Further Research***

The narratives obtained from the interviews to the researchers of the Barcelona Supercomputing Center allow to study and understand the institutional development that goes from the creation of a new professorship in a faculty with out academic tradition to the creation of the BSC an important Spanish research and technological infrastructure. They give details about the scientific, economic and politic strategies involved in the process. The researchers' experiences strongly contribute to embed a particular mentality regarding the management of research as an activity that does not require special training but is part of the research work. Scientists claim to use Project Management methods to manage research but in practice they are partially used and fairly unknown.

The empirical findings show that the diverse spectrum of projects developed at BSC -from theoretical to applied oriented research projects, are uniformly managed with methods close to project management. Considering Wilts' (2000) empirical study these findings were unexpected. He emphasizes that the problem of "external imperatives" –governmental policy and market demand conditioning the scientific orientation or research goals of a research organization are absorbed by the form of the research organization. Our study illustrates that the type of research or research goal determines the research management form. And further research is pointing at how different areas of knowledge also must determine different management forms. Thus is the nature of the research subject a better predictor of the research management form and organization.

Further development needs the idea extracted from both the empirical results and the conceptual research. A relational model that explain the appropriate research management form taking into consideration the ambiguity of the research goal and the stage of development.

Finally, the difficulties of researchers to understand the tension between productivity and creativity, can represent an obstacle for undertaking and managing more creative projects which are important to ensure new radical knowledge production. The explanation of this fact is that most projects correspond to technological developments whose processes are fairly predictable until the point that they can be organized almost with the methods of project management. Besides, most theoretical research on parallel computing systems does not include highly creative ideas or new approaches but well known principles.

In general those features could be common among public research organizations in Europe. But it is almost possible that our results are influenced by the area of research –an institution whose research is devoted to technological developments, and the mentality of computational sciences researchers. For this reason, this

paper is part of a wider empirical research carried out on other research organizations and with other type of researchers which will approach the influence of their disciplines when managing research.

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