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PhD. in Business Administration & Accounting

Employing Actor Network Theory to Explore the Role of Management Control Systems in New Product Development Projects

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CHAPTER I

INTRODUCTION

1.   Setting the scene and stating the research problem

In the current highly competitive environment, firms are under increasing pressure to develop new products and services that are both timely and responsive to customer needs. Innovative new products play an important role in building and defending competitive advantage and can contribute significantly to the firm's growth and profitability. Although product innovation is widely recognised as a potentially vital source of competitive advantage, firms still struggle to find efficient and effective new product development (NPD) processes and management.

The management literature has long considered innovation to be one of the major determinants of long-term organisational performance in contemporary environments (e.g. Clark and Fujimoto, 1987). In addition, global competition and technological development have shortened product life cycles substantially (Cooper, 2005), placing greater emphasis on the development and successful introduction of new products. Although technical and market changes can never be fully controlled, proactive NPD can influence the competitive success, adaptation, and renewal of organisations. Therefore it is a critical key source of competitive advantage for many firms (Brown and Eisenhardt, 1995).

Managers and scholars generally agree that investments in NPD activities are positively related to firm performance (Henard and Szymansky, 2001; Montoya-Weiss

and Calantone, 1994; Cooper, 1980). For these reasons, academics as well as practitioners argue about the importance to understand how management control systems (MCS) affect innovation processes and the ways through which they could support and promote innovation. (Davila, 2000; Bisbe and Otley, 2004). Both systematized processes and structures on one hand (e.g., Cooper, 1992), and creativity on the other are central aspects of innovation. Achieving both requires balance, as expressed by Clark and Fujimoto: (1991: 161) "The challenge in product development is not so much unilateral pursuit of organic structure and permissive management style as a subtle balance of control and freedom, precision and flexibility, individualism and teamwork." In such contexts, MCS have two complementary and interdependent roles: they are used to support a balance between taking actions congruent with the organization's goals and at the same time to give employees sufficient autonomy to make decisions (Roberts, 1990; Sprinkle, 2003; Ahrens and Chapman, 2004; Chenhall and Morris, 1995; Simons, 1995). Control systems, thus, may create dynamic tensions that foster the production of distinctive organizational capabilities and competitive advantages (Henri, 2006; Widener, 2007). Accordingly, a greater understanding of how organizations balance these different uses in order to support innovation activities represents an important area of management control research. In particular, the ways in which management control is enacted in a product development setting, to provide new insights into the different roles that control can play in this context, have become an open debate.

2. Research motivations

Although management control research on R&D activities has recognised the importance of investigating about the influence of control in innovation settings (Hayes, 1977; Brownell, 1985; Rockness and Shields, 1988; Davila, 2000; Ditillo,2004; Bisbe and Otley, 2004; Davila, Foster, and Li, 2009; Adler and Chen, 2011), the role of MCS on product development performance remains unclear and ambiguous.

Much of management accounting literature has focused on the use of MCS in product innovation within the subunits of an organisation, addressing the role of control at R&D departments (Abernethy and Brownell, 1997; Hertenstein and Platt, 2000; Davila, 2000; Davila and Foster 2009), product development teams (Akroyd and Maguire, 2011; Ditillo, 2004) or product development project (Jorgenssen and Messner, 2009; Brown and Eisenhardt, 1995; Bisbe and Otley, 2004; Bisbe and Malagueño, 2009) as units of analysis.

As such, in order to capture the impact of control to innovative settings, NPD projects constitute an adequate unit of analysis to examine how MCS interact with innovation initiatives and to appreciate how creative and productive processes can combine (Amabile et al., 1996; Bonner at al., 2002; Heinze et al., 2009; Brattström et. al., 2012), and the role that control has in fostering such processes.

In addition, limited attention has been placed on how MCS can influence innovation processes at corporate level. A number of recent empirical studies, in investigating how MCS affect innovation, has focused on the corporate level (e.g. Mundy, 2010; Bisbe and Otley, 2004; Mouritsen, 2009) or the business-unit level (e.g. Davila, 2000; Ditillo, 2004; Jorgensen and Messner, 2009, 2010), paying less attention to the interplay between the two levels. However, the mechanism and control tools used and their applicability may differ, depending on the different organizational levels. For

instance, it is common that the corporate level or top management control level aims to align the resources involved in the different projects, to communicate the project objectives and finally analyse and compare the outcomes of the portfolio'projects (Chiesa et al. 2009; Godner and Söderquist, 2004; Bisbe and Sivabalan, 2012). However, even if several studies have examined separately the project management control level, the business-unit control level and the top management control level, there are interferences and implications between them. Moreover, the corporate level has a relevant influence in setting the context of management control at the project level (Cooper and Kleinschmidt, 1995; Cooper et al., 2001; Bisbe and Sivabalan, 2012; Akroyd and Maguire, 2011; Bonner et al., 2002; Jorgensen and Messner, 2009, 2010). A lack of knowledge still remains on how MCS can enable the balance and coordination between the NPD projects executed in different business-units to achieve the company's overall business strategy.

For these reasons, it seems particularly fruitful for both scholars and practitioners to understand how control affects NPD process at corporate level and the ways in which it can foster, at that level, NPD portfolio management. The choice to extend the analysis to the business and corporate levels will allow us to develop a deeper appreciation about the different roles of MCS in NPD projects according to such levels.

The starting point of this research is the belief that we can perceive the role of MCS in NPD activities as depending on both social factors and technical artefacts. Besides much of management accounting literature has focused on the use of MCS in product innovation emphasizing the centrality of human agency. That means they merely focused on the human and social aspects of such processes. As such, in order to capture the impact of control in innovative settings we call for going further a "human

centred" approach where organisational practices are viewed as the outcome of human and social interaction. Thereby we believe that managerial practices enact and are enacted by the interaction of human and non human actors.

In accordance with the above-mentioned assumptions, studying the role of MCS in NPD projects requires an exploration of the way in which individuals, as well as non human actors i.e. costing systems, reports, documents, project management software, etc., interact. This implies paying attention both to human and non human agent, bypassing the distinctions between "technical" (e.g. documents, reports, software, performance measurement devices, etc.) and "social" accounting factors. (Latour 1987; Callon and Latour, 1992; Law 1992; Ahrens and Chapman, 2004; Chua and Mahama, 2007). Therefore, the work is theoretically grounded on Actor Network Theory (ANT) (Callon, 1986; Latour, 1987), which is effective in the explication of the socio-technical creation and modification of the phenomena under investigation. ANT belongs to a constructivist Science and Technology research perspective, where accounting and organisational practices can be seen as an outcome of a process tying together its technical characteristics with the social context in which it is implemented (e.g. Lowe, 2001; Ahrens and Chapman, 2004; Chua and Mahama, 2007; Quattrone and Hopper, 2006). Since innovation activities deal with creativity and productive logics, this theoretical lens allow us to shed light on the interplay between the calls for creativity and discipline emerging in NPD contexts. (e.g. Bisbe and Otley, 2004; Davila,Foster, and Li, 2009; Adler and Chen, 2011). To this purpose we seek to show the value of using ANT to examine how control affects NPD projects at business units level and NPD portfolio management at corporate level. Moreover, by using ANT's concepts as a framework for the empirical study, we aim at providing a richer understanding of the applying ANT in accounting and management accounting research. Indeed, the

exploration of the socio-technical aspects of control in NPD projects which sustain and are sustained by inscribing processes, allows us to make a theoretical contribution. Thereby we rely that the ANT interpretation of the role of MCS in NPD settings has implications that provide insights into a deeper appreciation of key elements of ANT, i.e. inscriptions, as well as semiotic and power issues.

3.   Objectives of the dissertation

This thesis is a theoretically-led conceptual investigation about the socio-technical factors that influence the role and use of control systems in NPD settings. The purpose of the dissertation is to explore the socio-technical micro-foundations underpinning the influence of management accounting and control systems in NPD contexts. In addition, this dissertation offers insights to some critical issues related to the theoretical lenses applied for the empirical analysis. Particularly, an exploration of semiotic and power issues related to non human actors is provided.

Drawing on ANT's framework, we focus on how actors interact with heterogeneous tools, e.g. texts, calculations, accounting devices and IT systems, to control accrual accounting's implementation path in accordance with their own goals and interests. The thesis focuses on two elements that could highlight how control systems affect NPD projects. The first element is about the importance of the role played by the non human elements in the exercise of control on NPD projects instead of merely focusing on human agency. According to Miller, ANT helps to study the "constitutive role of calculative practices" (Miller, 2001: 393). Therefore, this theoretical lens is useful in exploring how accounting devices help to interact with and transform human actors and by that help to manage and control NPD initiatives and

their outcomes. The second element concerns the relationships between the different actors involved in NPD activities, especially the power balance between these actors and the exploration of semiotic issues related to the ontology of non human agencies.

In line with the above arguments, to clarify the role of MCS in NPD projects and finally add a contribution to accounting and management control literature and to ANT studies, the structure of the work reflects a threefold purpose:

I.   to investigate the influence of MCS on NPD activities at business level;

II.   to investigate the influence of MCS on NPD portfolio managing at corporate level;

III.   to explain how ANT might contribute to research in accounting by placing particular emphasis on accounting systems as technological objects within networks of socio-technical relations.

4.   Structure of the dissertation

Based on ANT theory, this research is organised in a compendium of four essays. The thesis consists of two empirical chapters, a theoretical essay and a final chapter that summarises the main findings, the empirical and theoretical contributions and finally the future lines and the limitations of the research.

The two empirical research studies deal with (a) the role of control systems in NPD projects at business level (Chapter II) and (b) the role of control systems in NPD portfolio at corporate level (Chapter III). Finally, the theoretical paper (Chapter IV), using insights from the ANT-supported explanation of the role of control in NPD settings, seeks to put forward a conceptual contribution to this theoretical perspective. In particular, it suggests ways in which ANT, in addressing actor-network ontology,

semiotic issues and power relations, can stimulate the research in accounting and control studies.

The contribution that this dissertation aspires to offer to the literature is threefold in line with the three investigation chapters it contains. Consequently the dissertation is organized as follows:

I.   The role of management control systems in new product development projects.

II.   The role of corporate control systems in new product development portfolio

III.   The challenge of applying Actor Network Theory in accounting research. Semiotic and power issues.

Nonetheless, each chapter represents a complete essay in its own right that attempts to extend accounting and management accounting theory and contribute to managerial practice. The following sections present the theoretical perspective, as well as the ontological, epistemological and methodological stances underpinning the investigations.

5.   Actor Network Theory. An overview

Actor Network Theory (ANT) is an analytical framework, drawing from studies within Science Technology and Society used to study the roles played by humans and non-humans in the structuring of relationships that come together to form an apparently coherent whole: the network (Callon, 1986; Latour, 1986; Law, 1986).

In ANT terms, society is constituted by heterogeneous collectivities of people, technology, machines and objects. It is the intricate inter-relations among these heterogeneous elements that make up our society and organisations (Knorr-Cetina, 1997). The principle of symmetry underlines the important role of nonhuman elements.

This principle means that one does: "not make any assumption about the social or natural origin of entities" (Callon and Latour, 1992: 348). By contrast to social constructivism that denies the obduracy of objects and assumes that only people can have the status of actors, ANT recognizes the importance of human relations with objects in the explication of social practice. The theorizing of the role of knowledge-objects within society has developed in the Sociology of Scientific Knowledge literature (Bloor, 1982, 1991; Jasanoff, 1990,1992; Wynne, 1992, Collins, 1985; Fuller, 1993; Cambrosio et al., 1990; Travis and Collins 1991; Latour, 1987, 1993). As Orlikowski (2007: 1437) claims about socio-materiality: "the social and the material are considered to be inextricably related — there is no social that is not also material, and no material that is not also social."

From the ANT perspective, it is not only that material objects acquire their power and significance from their status within human social and cultural interpretations, but that material objects are actants in the construction of social ordering, in the same way as humans. Reality is not constructed simply through human negotiations, but is constructed by material objects and technologies. Then, it seems impossible to place Latour' s ideas in the paradigms outlined by Burrell and Morgan because Latour rejects the distinction between the subjective and the objective underpinning the Burrell and Morgan's framework. Latour's (2005a) approach is in contrast to such perspectives and his idea of "keeping the social flat" is a criticism of such reductionist explanations. He attempts to analyze every setting as a "flat space" where empirical observations help identify the boundaries of the setting (Latour, 2005). There is no "backstage" reality behind the appearances and therefore the dichotomy of appearance/reality is rejected. ANT is anti-dualist and anti-reductionist in the sense that observations are not reduced to a set of general explanatory factors "behind" the scene

or "underneath" the surface. (Justesen and Mouritsen, 2011). ANT is referred to as both a methodology (Mac Namara, Baxter and Chua, 2004; Scott and Wagner, 2003) and a theory (Lee and Sangjo, 2006; Robbestad, 2011). As a methodology, ANT is a tool to structure, describe, and frame events involving human and nonhuman elements contributing to the construction of new knowledge (Scott et al., 2003, Callon, 1986). As a theory ANT is "… a linguistic device used to organize a complex empirical world " (Bacharach, 1989: 496). The key components of the ANT framework are:

a)   inscriptions;

b)   the process of translation;

c)   the network.

Inscriptions are texts, charts, templates, diagrammes, reports, which convert ideas into visualizations. They are devices by which networks formalize their association and interests and engage in trials of strength. Inscriptions have specific facilitative qualities: mobility and combinability, which allow them to act at distance.

For instances Preston et al. (1992) explore the construction of new budgetary systems as translations of distant economic logics into fragile and changing network of technologies and responsibilities. Capital budgeting practices (Miller, 1991) have been conceived as translations of governmental programmes and policies into investment calculations. By connecting such programmes to appraisals of enterprise investment, Miller (1991) shows how Capital budgeting practices are the result of long-distance controls between state agencies and corporations. Dambrin and Robson (2011) explore how inscriptions allow performance management to exert control at a distance.

Translation is a displacement where human and non human elements act together, influencing each other in temporary alliances and by that becoming transformed (Latour, 1991, Latour, 1986). The term translation is used to label the formation of alliances as a network involving human and non human actants. The process of "translation " involves the interactions among agents through which human actors reinterpret both other human and non human interests in order to achieve an interest alignment within the actor network (Monteiro and Hanseth, 1996; Walsham and Sahay, 1999). The translation process can be divided into four phases: problematization, interessement, enrolment and mobilization. During these phases, human identity, characterized by Callon as variable and changing, is continuously shaped and transformed into interaction with other actors (Callon, 1998, 1986). Translations are not stable across individuals, time and space. They are not linear and are multiple. A lost in translation occurs when actors fail as senders and receivers of messages. Finally, deviation from origin occurs, because of reinterpretation, repackaging and simplification or poor communication during the process. The first phase of translation, problematization, is a dynamic phase, where an actor or group of actors, fights to impose his (their) respective view(s) about a problem to solve, i.e the Obligatory Passage Point, the technical issues to focus on, as well as defining the environment to take into account. The second phase, interessement, is featured by developing and cementing links with target agencies. The enrolment phase is about the construction of alliances and coalitions to agree on the same ends. Finally, during the mobilization phase, the enrolled agencies are controlled and representations of interest are ensured remaining fixed.

To the stabilization of a translation process is relevant the role played by black box. A black box can be defined as: "a closed file, an indisputable assertion" (Latour,

1987, :23). During the different phases of the translation process, a black box can be used as a device to interest, enrol and convince actors to be a part of the network. Black boxes may help stabilize a construction either by combining several of them or by putting many elements within the same black box, making them a part of an apparently strong construction (Callon and Latour, 1981). Moreover, black boxes solicit actors by preventing from further questioning and controversies.

Finally, boundary objects need to be taken into account to gain a deeper appreciation of the translation process. A boundary object is defined as: "...an analytic concept of those scientific objects which both inhabit several intersecting social worlds and satisfy the informational requirements of each of them" (Star et al., 1989: 393). They are physical objects that enable the connection among organizational members, even if these actors have diverse goals and interests (Briers and Chua, 2001). These boundaries can either be physical such as theatre props or more immaterial such as organisational devices (Ignatiadis, 2007).

In recent social research there has been a theoretical interest in the concept of boundary objects (Star and Griesemer 1989; Carlile 2002) to draw attention to their role in the development of new scientific and technological knowledge. Such objects become relevant according to humans, to the extent that they become unremarkable – part of the background to our working lives. Yet there is growing understanding that these objects and artefacts play a significant role in organisational knowledge practices, and must be understood within this context as epistemic or trans-epistemic objects (Knorr Cetina et al., 2000; Knorr-Cetina, 1982, 2001; Ewenstein and Whyte, 2007).

At last, the third key component of ANT is the *network*. A network is a concentration of resources scattered across a few places into a net (Latour, 1987: 180). A network is a "co-ordinate set of heterogeneous actors which interact more or less

successfully to develop, produce, distribute and diffuse methods for generating goods and services" (Callon, 1991: 133). The network connects human (like workers, managers, scientists) as well as not human "actors" (scientific instruments, machines, nature, printers), and this connection consists in symbolic scripts that make them (virtually) present in the place in which they are computed. The concept of network is related to the dynamic nature of translation process. As Law claims, actor network is about a movement, a displacement, a translation: "the struggle to centre and the struggle to centre and order from a centre", which involves a tension between the main actor and the "decentred network" (Law, 1999: 5). This means that this concept is also linked with power and control at a distance (Law, 1986). As such, a network can be assimilated into a structure that gathers and conveys heterogeneous elements, which enable the translation of the context to achieve a specific aim. In a more recent contribution, Latour summarizes network as "a tool to describe something, not what is being described" (Latour, 2005: 131-132) to highlight the movements, actions and successive transformations generated by actors (Latour, 2005).

According to the ANT framework and key concepts described above, the dualism between technology and society disappears. The focus is not on the network, but on the process through which it is created. These considerations move us to reconsider these intricate socio-technical interrelations, where both humans and non humans do not pre-exist the relationship, but as Law (1999) pointed out: "entities take their form and acquire their attributes as a result of their relation with other entities". This refers to relational materiality, i.e. actors achieve their form and ontology according to their relations with other actors.

The notions of subjectivity and objectivity collapse in a broader concept of inter-objectivity (Latour, 1999). This relational dimension emphasizes the relevance of

objects and inscriptions not for the results they produce according to the former network, but for their agency and the effects they produce within the network. This is why Bruno Latour refers to inscriptions more as matter of concern than a matter of fact (Latour, 2005). This is the idea of the Object-Centered *Sociality* (Law, 1986, 2009; Cooper, 1992, 1995; Latour, 1993, 1999; Knoor Cetina, 1997). In particular, drawing on Habermasian theorization, Knoor Cetina (1996) emphasizes on the existence of "instrumental action". She advances a relation between human and object not exemplified by alienation (Habermas, 1972) and commodification (e.g. Marx, 1968; Slater et al., 1997), but featured by self-fulfillment, nonalienation and identification (Lowe, 2011). Latour claims that objects including: technology devices, machines and inscriptions are central to the production and the acceptance of facts.

Finally, even if the scientific facts are constructed, they cannot be reduced to the social dimension because this dimension is populated by objects mobilized to construct it (Latour, 1993: 6).

6.   Methodological choice

Philosophers ask themselves the following three questions when trying to understand how we come to know what we know (Guba and Lincoln 1989, p. 83):

a)   The ontological question: What is there that can be known? What is the nature of reality? What is truth?

b)   The epistemological question: What is the relationship between the knower and the known (or the knowable)? What kind of knowledge can be obtained and what are the limits of knowledge?

c)   The methodological question: What are the ways of finding out knowledge? How can we commit to finding out things?

According to the above questions, this research can be seen as located at the constructivist end of the paradigm spectrum. Therefore, both social and technical issues are considered to influence the phenomenon under study. The interpretive approach is regarded as appropriate and the case-study strategy has been chosen since it fits the philosophical assumptions underlying this research. Furthermore, these choices are compatible with the goals laid down in this thesis. Finally two single case studies have been fulfilled because they offer a unique opportunity to study in detail the complexities of the role of control, both at business and at corporate level. In the next sections we motivate our choices about the ontological and epistemological stance and the research strategy underpinning this thesis. Indeed the choice of the most appropriate research methodology depends on the phenomenon being investigated (Ryan et al., 2002). As Burrell and Morgan (1979) argue, in order to choose the appropriate research methodology, one needs to indentify the ontology, epistemology and the human nature of the research problem.

6.1. Ontological stance

Ontological beliefs are then concerned with whether the world is objective and hence independent of humans, or subjective and hence existing through the action of humans in creating and recreating it (Orlikowski and Baroudi, 1991). The debate concerning the existence of the world, interested not only philosophers but also accounting scholars. The discourse of the nature and human beings, the existence of the world and the understanding towards it, the interrelationships between human and the world and developments of this fundamental issue, have never stopped.

Moving from ANT ontology and epistemology, this research is anchored in constructivist assumptions. Then, in order to explain our ontological constructivist position we need to provide some insights about the ontological underpins of ANT. Nonetheless, Latour's constructivism is not the same as social constructivism in the sense of Berger and Luckmann (1991) because the social dimension is not assumed or privileged in advance. As Justesen and Mouritsen (2011) point out Latour (2005a: 91) makes a sharp distinction between social constructivism, on the one hand, and constructivism on the other: [. . .] "constructivism should not be confused with social constructivism. When we say that a fact is constructed we simply mean that we account for the solid objective reality by mobilizing various entities whose assemblage could fail: social constructivism means, on the other hand, that we replace what this reality is made of with some other stuff, the social in which it is really built."

On account of that, we reject the adoption of any strict relativism by partially adhering to Constructivism and to a specific ontology which recognises agential capacities when attributing properties to natural and material objects.

On critiquing social shaping and social determinism, Latour (1999b: 198) argues that: "Society is constructed, but not socially constructed. Humans, for millions of years, have extended their social relations to other actants with which and with whom they have swapped many properties and formed collectives." He calls for more consideration of the influence of technical, nonhumans agencies in human action, since "humans are no longer by themselves" (ibid, p. 190). This ontological approach rejects the boundary between the technical and the social. The social construction of technology refuses giving a dominant role to either the technical (e.g. in technological determinism) or the social (e.g. in social shaping and determinism). Instead of understanding technology as black-box with innate qualities, social constructionists

seek to understand why particular technologies emerge and how they are adapted. They argue that the success or failure of technological innovations is not just a matter of technological attributes but dependent on the interpretative action from people in their social context. Moreover, technologies continue to be shaped during their use. Thus, the ontological belief underpinning this thesis is that reality is neither technologically determined nor socially constructed, but a collective of humans and non humans: a heterogeneous network of human and nonhuman actors. This is in line with Elder-Vass (2008), who claims that ANT presents a *flat ontology* in two respects: it neglects of realities beyond the empirical domain, and it ignores the existence of emergent social structures. However, according to this assumptions, someone argues that ANT is closer to the critical realist approach, where the "content" (Mutch, 2002) or "affordances" (Hutchby, 2001) of objects such as machines are allocated an explanatory role. "From a critical realist position, essentialism allows us to identify the innate properties of an object" (Whittle and Spicer, 2008: 614) that explain why objects and artefacts have certain effect. As Law and Singleton (2000: 767) pointed out: "Actor-network theory and feminism wouldn't call themselves "social constructivist", for instance, because according to those theories hybrid material-and-social performances explain change and stability, not social factor alone". In this way ANT strengthened the critical constructivism. Then, the notion of reality introduced by the ANT is a critical one because it implies to change the references that determine what is social. Latour (1999b), using resource of the semiotics, introduces the term "collective". "*Collective*" is the opposite of "society", because it emphasizes the associations between human and non-human beings: an interchange of human and non-human properties in a corporation core (Latour, 2001). That means ANT converts the dissociation between "objective"

and "subjective" into one single circulating entity. Therefore the process of collective construction is not only social. Everything is constructed in this way, including facts.

In line with the above arguments, we assume that the world of MCS use in innovative contexts is a collective construction, shaped by the actions of users, which in turn are enabled or constrained by the technological affordance, or machine agency of control system and NPD projects. Then MCS can be shaped by users according to their own practices and the organisational context where they are used, where both agencies interact with and depend on each other for the production of outcomes such as control. This thesis therefore tries to conceptualise MCS use, according to contextual factors influencing their use. Under the above arguments, we consider individuals and their world as strictly related through their lived of experience of the world (Heiddegger, 1962; Schutz, 1967). Then, the intimate role of MCS in NPD activities cannot be understood separately from individuals and their engagement with them. MCS shape reality and they are dependent upon the context in which they operate (Morgan, 1988).

We argue that MCS have a set of characteristics that are strictly dependent on the company and people using the system. Therefore reality is dependent on the subjects involved within the organisation. Consistent with this assumption, the ways through which MCS affect NPD activities are embedded in a pattern of symbolic relationships and meanings sustained through a process of socio-technical action and interaction, around which interests are negotiated.

Afterwards, when adopting an interpretivist point of view, we refer to the role of control as where the meanings or significations are constructed from social relations of objects and humans. This socio-technical relations are exploited into a specific organisation culture (Bloomfield et al., 1992). In the case of the development and use of MCS, culture refers to the meaning of control attached to it by its developers and users.

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This implies that control systems have not only a material existence, but also a social and symbolic one. Any changes in the meaning of MCS are then made possible through organisational cultures.

6.2. Epistemological stance

The epistemological stance concerns: What is the relationship between the knower and the known? What kind of knowledge can be obtained and what are the limits of knowledge?

ANT epistemological assumptions are addressed in this work, by employing an interpretive approach that stems from the constructivist ontology. ANT is considered as an approach embracing epistemological relativism (Law, 1991). Nonetheless ANT has an ontological constructivist assumption in that it assumes that the world consists of heterogeneous networks which are socially constructed and of actors who act according to their interests, inscriptions and their interpretations of their environment. Epistemologically this implies that the researcher is far from being neutral in the research but, for example, he plays an active role in choosing the boundaries of the actor network and which events or developments are deemed relevant to the understanding. Therefore ANT seeks to highlight understandings that actors have of their own lived reality (Latour, 2005) by allowing actors "to define the world in their own terms" (Latour, 1999: 20) and seeking to "struggle against producing its own vision of the world" (Lee and Hassard, 1999: 398; Whittle and Spicer, 2008).

ANT links materials with practice. It understands practice as ontologically heterogeneous, in the same way as any other aspects of organisation. (Law and Singleton, 2003). Practice enacts and is enacted by the interaction of technologies and human actants. ANT also places inscription as central to the accomplishment of

practice. The status of particular materials or practices within a "mode of organizing" has an epistemological value. Law calls this a "practical epistemology of organizing" (Law, 1994: 151). Furthermore ANT challenges many common epistemological dichotomies by rejecting opposing categories such as: subject/object, culture/nature, and society/technology distinctions (Singleton and Michael, 1993). Actors are constituted in a heterogeneous socio-technical network, partially connected by a set of relations, and partly embodied in a range of materials (Law, 1991). In other words, actors are partly social, partly technical, partly textual, partly relating to natural materials, objects and processes.

On the basis of this arguments, we refer to the role of control as epistemologically embedded in complex socio-technical interactions between humans and non-humans. Consequently the ways in which human and non human agencies interlock within networks of construction and reconstruction allow the production of accepted facts or knowledge (McNamara, Baxter and Chua, 2004).

The process of interaction between humans and non humans gives significance to MCS. This significance is epistemologically shared within the organisation. To understand this significance it is necessary to study the intimate motivations and logics under the context in which individuals operate.

The starting point is the belief that a deeper appreciation of the role of MCS in NPD activities can be developed through a micro level analysis, making reference to the particular setting in which it is embedded (Hopwood, 1983; Burchell et al ,1980; Nahapiet, 1988). Context is inseparable from localized management actions and interactions within actor-networks, and both have to be analyzed simultaneously. The study of the role of MCS in NPD projects is necessary to identify the key factors which are involved in the construction of the world by symbols, language and other material

and immaterial elements embedded, on the one hand, in management accounting procedures, and on the other hand in NPD activities. That means studying the actors' relations and paying attention to the network in which they work (Callon, Law and Rip, 1986; Czarniawska, 1997; Chua and Mahama, 2007). Therefore, in focusing on the interactions between actors, we are interested in paying attention both to human and non human agents, bypassing the distinctions between "technical" and "social" factors. (Latour 1987; Callon and Latour 1992; Law 1992; Ahrens and Chapman 2004; Chua and Mahama, 2007).

From the perspective of ANT, such micro-levels of social and material reality express, enact and sustain broader political and epistemological dimensions. Therefore, the empirical examination the role of inscriptions and material artefacts in an organisation becomes not only a technical concern, but a way of understanding and sustaining epistemic and power discourses. Inscriptions and material tools become therefore expression of power, because they are undisputed. This implies that, from an epistemic point of view, the role of control in NPD settings is 'black-boxed' into material arrangements that are taken for granted and remain invisible and unchallenged (Czarniawska and Joerges, 1998).

6.3. Research strategy

The research design for this study reflects the ontological and epistemological perspectives of ANT. The design and conduct of the empirical research is informed by the constructivist ontology of ANT which calls for a symmetry in the way that the effects of social and technical arrangements are held in the research (Latour, 1999, 2005; Law, 1994).

An interpretive case-study approach is adopted in this thesis. An extensive investigation is carried out in one company. As such, we basically follow a single case study approach. From the case discussions the initial ANT conceptualisation about the role of control in NPD projects are developed and enriched. The interpretive approach moves from the standpoint that the positivistic methods of natural science are inadequate to the study of social reality (Chua, 1986). Conversely, interpretive methods of inquiry rejects the possibility of an objective or factual account of events and situations, seeking instead a relativistic, albeit shared, understanding of phenomena (Orlikowski and Baroudi, 1991: 5).

Orlikowski and Baroudi (1991) advance three criteria for the classification of a study as interpretive: (1) evidence of a nondeterministic perspective, where the intent of the research is to increase understanding of the phenomenon studied, within cultural and contextual situations, (2) the phenomenon of interest is examined in its natural setting and from the perspective of the participants, (3) researchers do not impose their outsiders' a priori understanding of the situation.

The current research relates to those criteria, as (1) the purpose of the research is to increase understanding of the impact of control systems on NPD projects within the context of the use of such a system in an organisation. (2) This phenomenon is examined from the perspective of the users and managers working with the MCS and the subjects involved in NPD projects. (3) We adopt a semi-structured interviewing approach, avoiding imposing the researcher's own knowledge of the situation, but letting the interviewees express their own thoughts and ideas.

As the emphasis is on quality of entities and on the processes and meanings that are not experimentally examined or measured in terms of quantity, intensity or frequency, a qualitative research approach and a case study strategy underpin the thesis.

Therefore, we seek to improve our understanding of the phenomenon through an explanatory case study approach, to support an in-depth investigation. Furthermore, we do not aim at providing general patterns, or predict, at certain level of generality, the role of control but to capture the micro world of socio-technical interactions through which MCS act with respect to NPD activities.

This approach is aimed at understanding organisational practices (management accounting and NPD processes) at a micro-level and to appreciate how the tools of inscription shape control practices. Indeed practice is constructed through the alignment of the technical and social arrangements at hand which possess political or cultural authority and the actions i.e. the *practices* which are produced by these arrangements. Approaching research from this perspective means that the nature of MCS is understood to be a product of political, social and technological processes. By examining practice, i.e. what people do and what meanings people ascribe to their actions, the socio-technical processes can be understood. Such a practice-based approach (Nicolini et al 2003) regards the observation and understanding of the status and methods of practices as having theoretical implications and practical consequences in organisations. From the perspective of ANT, practice is constructed in the ongoing practices of action in ways that are relational, mediated by artefacts and always rooted in a context of interaction. (Nicolini et al 2003).

Finally, as specified in section 4, the third essay of the dissertation is a theoretical speculation which stems from the evidence collected in the two papers concerning the investigation of the role of control at business and at corporate level. Consistent with this aim, the research approach we deal with in the theoretical paper seems to be assimilated with the Grounded Theory assumptions (Strauss and Corbin, 1994; Corbin and Strauss, 2008) which, in line with Myers (2009), can be defined as an

inductive methodology that assists the researcher in developing a theoretical account of the common features of a topic, and at the same time grounding the explanation in empirical observation or data. The main emphasis in this methodology is on the generation of theory which is grounded in the data. Consequently, we aim to move from the empirical investigation about the role of control in NPD projects to throw light on some critical key concepts of ANT, i.e. semiotic and power issues.

7.   References

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CHAPTER II

THE ROLE OF MANAGEMENT CONTROL SYSTEMS

IN NEW PRODUCT DEVELOPMENT PROJECTS

1.   Introduction

Because of increased competition, fast product introduction and shorter product life cycles, new product development (NPD) processes have become a central dimension in the strategies of many companies (Brown and Eisenhardt, 1995; Clark and Fujimoto, 1991; Grant, 1996; Davila, 2000), as they are a considerable source of competitive advantage. Although management control research on NPD activities has recognised the importance of investigating about the influence of control in innovation settings (Hayes, 1977; Brownell, 1985; Rockness and Shields, 1988; Davila, 2000; Ditillo,2004; Bisbe and Otley, 2004; Davila,Foster, and Li, 2009), the role of management control systems (MCS) on product development performance remains unclear and ambiguous.

The objective of this study is to track how MCS intrude on NPD projects balancing the tension between creativity and discipline featuring innovative contexts. Even if recent management accounting literature has shown MCS' important role in highly uncertain contexts and has documented the positive impact of management control systems on creative exploration and innovation activities in settings such as NPD processes (e.g., Abernethy and Brownell, 1999; Ahrens and Chapman, 2004; Bisbe and Otley, 2004; Brown and Eisenhardt, 1997; Cardinal, 2001; Chapman, 1998;

Davila, 2000; Davila, Foster, and Li, 2009; Ditillo, 2004; Adler and Chen, 2011), further investigations are required to understand how control systems may support NPD projects.

This paper discusses how companies can enact MCS during the development of new products and highlights how control can be supportive in these settings. We argue that this call can be answered by adopting the perspective of Actor-Network Theory (ANT). Therefore we rely on ANT's conceptualization (Callon, 1980; Latour, 1987) which seems particularly effective for the study of the interactions between human and non human agents involved in the construction of the role of MCS in NPD activities. To this end, we seek to shed light on the socio-technical construction of the role of control in NPD process, in order to understand the realm of meanings, symbols and artefacts through which it is created and modified within the organisation.

Moving from ANT main assumptions this work attempts to explain how a focal actor, i.e. the control system, succeeds in enrolling and mobilising other actors to achieve the purpose of balancing creativity and discipline in NPD initiatives and how the NPD project as a network reaches its stability. We advance a conceptualization of a NPD project as a network featured by creative and productive logics, which oscillates between convergence and divergence. Therefore, we refer to NPD project success as the result of a translation process which aims at achieving the network convergence. In such context, the role of control is to "harmonize" these two forces in order to achieve network stability, i.e. network convergence.

The framework developed in the theoretical section of the paper is mobilised to explain the evidence carried out at a multinational company division operating in the semiconductor industry. Then, through an in depth interpretation of the empirical

evidence collected, we analyse the fabrication process and the translation mechanisms underpinning NPD network convergence.

By providing an Actor-Network Theory account of the data gathered through this methodology, we try to advance a conceptualization of the influence of MCS in NPD projects as a symmetrical relationship of co-construction of humans with technology. Aside from finding an answer to these questions, the aim of the present work is also to make a humble contribution to a better understanding of the aforementioned aspects so far neglected or overlooked in the management accounting literature. However we aim at suggesting a possible way to deal with those challenges that scholars are very likely to face when approaching a study of MCS in innovation settings.

The work is organized as follows: the next section (2) presents an overview of the main NPD models in literature. In section 3, we describe the literature relating to management control in product development. In section 4, within ANT framework, we provide a theoretical conceptualization of the role of control in NPD projects. In section 5, we illustrate the research methodology which guided the case-study. In section 6, we then analyse the case data offering an explanation of them based on the theoretical framework developed previously. In section 7, we conclude with a summary of the findings, limitations and future research directions.

2. Theoretical framework

2.1. Featuring traits in new product development processes

Academics as well as practitioners recognise that organizations need both to explore new knowledge and to exploit existing knowledge in order to create radical and incremental innovation (e.g., Benner and Tushman, 2003; March, 1991). Incremental innovations are exploitative and radical innovations are explorative. In most organizations product development initiative includes elements of both exploration and exploitation, yet the reciprocal detection of these two forms of innovation is a main challenge for innovative companies.

The *US Product Development and Management Association* defines new product development as "A disciplined and defined set of tasks and steps that describe the normal means by which a company repetitively converts embryonic ideas into saleable products or services." (Belliveau et al., 2002).

NPD is a matter of converting an abstract idea into a tangible product, delivering it to potential customers when and where they want it, providing it at a price they are willing to pay, and earning at least a reasonable margin of profit (Olson et al., 1995).

Research over the past decades has shown that the NPD process is based on a series of development stages that are interpolated by a series of evaluative stages. These evaluation stages can be better understood as ''gates'' (Cooper, 1990) or ''convergent points'' (Hart and Baker, 1994) in that they can navigate managers to avoid go and non-go errors during the development process. Within each evaluation gate, management uses pre-specified criteria to assess if different tasks have been performed efficiently and effectively.

NPD processes are guided by the new product strategy that aims to align the NPD efforts of the firm with its strategic imperatives. This alignment warrants that the

new products planned will support the strategic objectives of the firm and make the best use of its strategic competencies. The development stages of the NPD process include the generation of new product ideas, the development of an initial product concept, an assessment of its business attractiveness, the actual development of the product, testing it within the market, and finally the launch of the product in the marketplace. Alongside each of these stages, an evaluation takes place, essentially to establishes whether the new product should advance further or be terminated.

Drawing on the literature of NPD processes (Brown and Eisenhardt,1995; Wind and Mahajan, 1997; Schilling and Hill, 1998; Meyer and Utterback, 1993; Clark and Wheelwright, 1993; Kamoche and Cunha, 2001) it is possible to gain out five NPD models: the sequential model, the compression model, the flexible model, the integrative model and the improvisational model.

The Sequential Model

The sequential approach to product innovation constitutes the dominant perspective in the management of product innovation (Cooper, 1993). Step-by-step models are presented as enabling safe and efficient new product development projects. These models are based on mechanical tools intended to guide product managers along the entire product innovation process. They are expected to reduce the uncertainty inherent to innovation (Dosi, 1988) by suggesting a number of steps to be made in sequence.

The main goals are to achieve efficiency and predictability. Moreover, product innovation processes are featured by discipline and control in each phase. Sequential models rely heavily on planning, anticipation and control. According to the above assumption the organisation seeks to address equilibrium, stability and predictability.

As such, sequential model are not learning or creativity- oriented tools, but means of control through standardisation (Perrow, 1986). One of the dangers inherent to these models is the creation of habits of mind (Louis and Sutton, 1991) or automatic ways of dealing with problems that may instead require learning and flexibility.

The Compression Model

The Compression Model implements Cooper's (1994) and Clark and Wheelwright's (1993) frameworks for parallel processing of the activities involved in product development. As in the previous model, a sequence of steps forms the basis for developing new products under a compression model. However, as a result of market pressures, collapsing product life cycles, and the competitive importance of time (Kessler and Chakrabarti, 1996), these steps sometimes need to be accelerated or compressed.

The compression model assumes that: development activities can be known in advance, and that product innovation models are expected to reduce uncertainty as much as possible. This means compressing some activities, overlapping others and obliterating those that are not strictly necessary. Thus, the logic is that some development tasks can start simultaneously, instead of following a rigid sequence of developmental steps. This perspective intends to keep the uncertainty reduction philosophy of sequential models, while recognizing the need to save time. Therefore, it implies that tasks should be reduced to the minimum and sometimes delegated, namely to suppliers. The compression model can be adequate for developing products that demand the use of familiar technology and are directed towards well understood but fast-changing markets (Eisenhardt and Tabrizi, 1995).

The Flexible Model

The high-speed and uncertainty of the environment in which operate a growing number of industries led to the appearance of another model for developing new products: the flexible model. Moving from the idea that sequencing, featured the previous models, is not the appropriate way of managing new product development, in the flexible model, a more dynamic perspective is adopted, based on learning-while-doing and on the emergent nature of the innovation processes under turbulent conditions. The flexible model introduces an organic approach to the development of new products (Iansiti, 1995). Flexibility, or the capacity to introduce adjustments in design according to a changing environment with little or no penalty (Sobek, Ward and Liker, 1999), becomes an important feature of product innovation models when turbulence increases. When flexibility is low, the economic cost of modifying the product is high. Flexibility is influenced by the product development's expense, unit cost, performance, and development schedule, and can be increased via the adoption of flexible technologies, the modification of management processes or of design architectures (e.g. using modular product structures and reducing the coupling between modules). According to these characteristics this model is well-matched to business environments that are unpredictable, rapid and populated by aggressive competitors (e.g. computers and software, multimedia and the fashion industry).

The Integrative Model

The Integrative Model acknowledges that NPD is a complex activity that requires the capability to obtain, transform and interpret large amounts of market, technical, financial and other internal and external information, in order to develop product ideas and evaluate their technical soundness, manufacturability and economic

feasibility (Ancona and Caldwell, 1990). This usually requires the efforts of various individuals from a number of functional areas. Hence, NPD process needs to be managed according to a highly-complex collective achievement. Then, NPD as a collective task, requires a certain degree of reciprocal interdependency among teams involved in the project. (Ancona and Caldwell, 1990).

In this model, control involves delegation to project teams such that they have enough autonomy to be motivated and creative. Top level management should communicate a clear vision of objectives to their teams while simultaneously giving team members the freedom to work autonomously.

According to the above arguments, the organisation should be structured around a processual view instead that a structural view. Managing and describing organizations in terms of processes instead of structures, thus, helps to go beyond a static view of innovation and NPD processes.

The Improvisational Model

The improvisational approach to NPD best suites to turbulent environments. It combines elements of the flexible model with elements of traditional approaches including the need to use developmental models as control devices. As the environment turbulence increases, the synthesis of freedom and control constitutes a major challenge for product innovation (Clark and Fujimoto,1991). Afterward, the improvisational model introduces the concept of minimal structures. Minimal structures, basically, consist of a simple and well-defined set of rules, where some features are formalized while others are not (Kamoche and Cunha, 2001). Control is executed through the use of minimal structures.

In the case of product innovation, minimal structures may consist of clear roles and responsibilities for product definition and financial performance, project schedules, portfolio priorities and time intervals between projects, etc. (Brown and Eisenhardt, 1997).

Minimal social structures should coexist with minimal technical structures. In an improvisational mode, NPD may proceed through gradual convergence or the progressive narrowing of an initially larger range of acceptable solutions. Gradual convergence means that each group involved in the development of a new product works autonomously, but has to meet regularly with the other groups to coordinate efforts and eliminate flawed solutions.

The improvisational model's search for flexibility and efficiency (Adler, Goldoftas and Levine, 1999), and it seems to be especially suitable for organizations competing in industries where high levels of efficiency can be considered critical, and for which the purely organic functioning of the flexible model is not suitable (e.g. the automobile and computing industries).

2.2. Management control systems in new product development

The management literature has long considered innovation to be one of the main determinants of long-term organizational performance in contemporary environments (e.g. Clark and Fujimoto, 1991). There are different views in literature about the strategic value of investing in research and development activities (Henard and Mc Fadyen, 2005). Some contributions (Mansfield, 1980; Cassiman et al, 2002) claim that firms should invest in applied research initiatives. This is due to their short-term horizons and profit potential, instead of basic research investments, generally portrayed as long-term investments and having more uncertain and practical output. Conversely,

other scholars (Grilches, 1986; Mansfiled, 1980) argue that basic research activities facilitate product development processes. However, a growing stream of research focus on control in NPD context (e.g. Rockness and Shields 1984, 1988; Abernethy and Brownell, 1997; Davila, 2000; Bonner et al., 2002; Ditillo, 2004; Sivabalan and Bisbe, 2012). Nevertheless, in regard to new product development, where innovation-oriented projects are a prevalent form of organizing activities (Davila et al., 2006; 2000; Schmidt et al., 2009), project level has been selected as unit of analysis. On acknowledging this fact, the MCS literature on innovation has emphasized that the consideration of the project level is important to understand how MCS actually contribute to the generation of creative ideas and their eventual conversion into marketable products. A growing number of studies has increased the current understanding of management control in the NPD context. Some of these articles include qualitative case studies (Abernethy and Brownell, 1997; Nixon, 1998; Adler and Chen; Leotta, 2011) focusing on detailed descriptions of management control in a few cases and others are quantitative survey studies (Rockness and Shields, 1984, 1988; Davila, 2000; Hertenstein and Platt, 2000; Bonner et al., 2002) that have taken larger samples and tried to test different hypotheses. While some of these studies have only explored the suitability of different control mechanisms in different tasks, organizations or environmental contexts, some others have tried to find a more profound correlation between the use of certain control mechanisms and their performance.

Traditionally, the rational plan approach to NPD (Brown and Eisenhardt, 1995) presumes that development activities are relatively predictable and are best managed as a top-down process whereby monitoring, evaluation, and control activities appear strongly related to a systematic cycle.

The studies reported above mainly refer to management control in a product development setting through three-core control concepts – input control, process control and output control (Merchant, 1985; Simons, 2000).

How an organisation can use its control systems to support both innovation and performance has also emerged as an important research question (Shields, 1997). A relevant stream of research mainly suggests that MCS has a positive impact on uncertain settings and innovation processes. Khandwalla (1972) examined MCS as supportive tools in environment characterized by high levels of uncertainty. Simons (1990,1991,1995) argues that the interactive use of formal MCS, i.e. feedback and measurement systems, may stimulate innovation and implementation of new product development ideas. The author advances two different styles of use of MCS (e.g. budget systems, balanced scorecards, project management systems): a diagnostic and an interactive style of use. When implemented diagnostically, MCS are used for setting pre-established standards, monitoring and correcting deviations. They attract the managers' attention only on an exception basis. When used interactively, MCS rely on formal feedback and measurement systems used by senior managers to focus organisational attention on strategic uncertainties and to provoke the emergence of new initiatives and strategies (Sivabalan and Bisbe, 2012). Lundberg (1995) suggests the relevance of procedure for helping innovation by coding learning from past experiences (Levitt and March, 1998). Amabile (1998) argues that MCS facilitate goals achievement by increasing their stability for a sufficiently long period of time. Chapman (1998) uses four case studies to argue that accounting does have a beneficial role in highly uncertain conditions. Ditillo (2004) has argued that the role of MCS depends on the type of knowledge complexity of the project. Akroyd and Maguire (2011) have emphasized that formal MCS may reduce uncertainty and enable goal congruency primarily at the

decision gates. Davila (2000) recognises the reduction of uncertainty and the achievement of goal congruence as the main roles of management control during product development processes. Jorgensen and Messner (2009, 2010) basing upon a filed study and following a narrative approach, highlight how the interactive use of accounting information and strategic imperatives may be helpful in high complex and uncertain settings such as new product development processes.

Nonetheless, other contributions (Hayes, 1977; Brownell, 1985; Rockness and Shields, 1988) suggest that MCS are irrelevant in NPD activities. For example, Rockness and Shields (1988) basing on Ouchi's framework (Ouchi, 1979) suggest a limited relationship between types of control and project characteristics. Abernethy and Brownell (1997) following Perrow's model of technology and structure which relates form of control with task analyzability and the number of exceptions (Perrow , 1970), explains that "*reliance on accounting controls has significant positive effects on performance only where task uncertainty is lowest*" Moreover behaviour controls "appear to contribute positively to performance in no situation" (Abernethy and Brownell 1997: 245).

Another stream of research argues that MCS constrain research activities and stifle innovation (Tushman et al, 1997, Amabile, 1998; Amabile and Gryskiewiecz, 1987; Abernethy and Brownell,1997; Ouchi, 1979). In the studies reported above, the overall conclusion was that innovation processes are managed through informal mechanisms and that formal systems can only damage their performance (Davila,Foster and Li, 2009).

Finally, recent works, shifting away from a mechanistic model of control, advance a new approach to the question. These contributions propose a dynamic and flexible frame of MCS, which better fits with the needs for creativity and flexibility

characterizing NPD activities (Davila, Foster and Li, 2009, Adler and Chen, 2011). In particular, Adler and Chen (2011), on emphasizing the requirement for both creativity and control in R&D activities, advance the concept of large scale collaborative creativity. Specifically, they argue a motivational effect of MCS, a positive relationship between control system and collective creativity. Finally Leotta (2011) drawing on Structuration Theory (Giddens, 1984) and on the framework of Kamoche and Cunha (2001) advocates for an enabling and stifling role of control..

2.3. New product development initiatives and control issues from the perspective of Actor Network Theory

Several studies have shown that a certain degree of freedom and flexibility are essential to the success of product development initiatives (Burns and Stalker, 1961; Moorman and Miner, 1998) and traditional formal controls at the project level continue to be one of management's main tools for keeping NPD projects on schedule, within budget, and aligned with strategic goals (Cooper and Kleinschmidt, 1995). Then, it is acknowledged that an appropriate balance between creativity and constraints, empowerment and accountability, intended and emergent strategy is the key to management control in organizations that need space for innovations and flexibility involved in NPD projects.

According to Simons (1995) an adequate balance between freedom and constrain in applying MCS is necessary to promote innovation. Recent works, shifting away from a mechanistic model of control, have advanced a new approach to the question. These contributions propose a dynamic and flexible frame of MCS, which better fits with the needs for creativity and flexibility characterizing NPD activities (Davila, Foster and Li, 2009, Adler and Chen, 2011).

Drawing on these evidence from the former studies on the topic we try to advance a conceptual framework underpinning some elements of ANT to explore the effective role of control in NPD contexts featured by two opposite exigencies: creativity and freedom on one hand and control and discipline on the other. We assume that ANT (Callon, 1986; Latour, 1988) would be particularly useful for our study for three reasons. Firstly, it provides a framework to conceptualise a project as an emerging socio-technical network that extends and transforms over time. This network includes a series of heterogeneous animate and inanimate elements also called "actants". Secondly, ANT proponents refuse to pre-empt the identity of actors independent of the relations or effects they have within a network (Latour, 1988). In addition, according to general symmetry principle actants are assumed to be equal to human actors. This ontological symmetry is fruitful to conceptualise the role of control in NPD activities as a socio-technical creation. Thirdly, from this perspective, the success of a project is considered to be dependent on the active participation of actor-networks who are determined to advance and who thus prompt a convergent network. (Callon, 1991). Indeed, according to Callon, a network can be developed in two directions, towards convergence or divergence of its components. The success or failure of a project can be explained from its degree of convergence and, inversely, divergence. Thus, as Latour pointed out "projects are also chains of translations, but this time in a different key, of the ability to maintain a highly complex socio-technical assemblage of heterogeneous constraints" (Latour, 2010: 602).

We propose to conceptualise a NPD project as a network "swinging" between convergence and divergence. In such contexts MCS operate to foster NPD network convergence. Convergence measures the extent to which the process of translation and its circulation of intermediaries lead to agreement (Callon, 1991). Network convergence

means that actors' activities and interests fit together despite their heterogeneity (Meier and Missonier, 2012). This implies that the network as a whole should be capable of concentrating its efforts towards a single point. Conversely, in a divergent project actors find both that their status is constantly in question and that it is difficult to mobilise other parts of the network. Actors resist the role the network assigns to them and will respond to instruction unpredictably. Thus, if the degree of tension between call for freedom and call for control is high, the NPD project collapses in a divergent network; on the contrary, if the degree of tension is moderate, a convergent network will ensure the project success. The concepts of convergence and divergence are related to the alignment of interests goals and resources in the translation process. The alignment of interests and goals implies that individuals' motivations and goals are aligned to the objectives of the network. This happens during the translation process in the interessement phase. Therefore, in line with Callon (1991), a network is aligned when respective interests of each actors or groups of actors are aligned on a more global interest, which results from the convergence of different instances. Convergent project networks typically have clear and agreed "obligatory points of passage" (Law and Callon, 1992: 31) through which all other actors, translations, and intermediaries have to pass. In weak and divergent network projects, actors do not all share a common understanding of the intermediaries circulating the network and many of them will fail to recognize the legitimacy of an organization or institution regarded by others as an obligatory point of passage or centre of control. To really appreciate the dynamics of convergence/divergence in NPD projects one needs to mobilise the concept of *Obligatory Passage Point* (OPP). The notion of OPP is closely related with the problematization phase (Callon, 1986) and it can take various shapes. Lowe (2000)

defined an OPP as specific practices (such as centres of calculation) used by the main actor to frame the behaviour of other entities according to the main actor's goals.

Over the course of problematization, the focal actor defines all the actants which are needed in the innovation process (Callon 1986b). In addition, it is important that the focal actor makes his own role indispensable. In order to make himself/herself indispensable, the focal actant needs to "establish" an Obligatory Passage Point for the other actants of the network. Furthermore, when they attempt to achieve their individual goals, they have to pass the Obligatory Passage Point.

Having said that, in NPD projects the aim is to make the balance between creativity and control an Obligatory Passage Point. In such perspective MCS act as the focal actor which translates the wills of other actors into a single, larger will: the successful implementation of the NPD project. Therefore, according to the theoretical assumptions of ANT, a NPD project is a network including human and non human agents. Therefore the NPD project is not the action or the result of one actor, but the project itself is a network of people and technology which acts as a single block. Thus, networks are built by enrolling heterogeneous actors inside the net. Consequently, recruiting a new member for the network implies "translating" his/her own interests so that he/she will naturally accept to be part of this net.

Consistent with these assumptions, ANT concepts are useful to understand how in NPD projects a focal actor, i.e. the MCS, succeeds in enrolling and mobilising others actors to achieve the purpose of balancing creativity and control and how the project reaches its stability. The four major stages of translation, problematisation, interassessment, enrollment, and mobilization are useful to explain the negotiation process played by MCS in NPD projects. It is through this negotiation that the project network achieves convergence and stability.

As several studies have shown, MCS may have a supportive role in fostering innovation process, but there is a lack of knowledge on how this happens. Influenced by ANT, we propose to throw light on the role of MCS in NPD projects. To this end, (to this purpose) we need to clarify the notion of control we will being using in the research.

Far from a cybernetic and functionalist conception of control, the present framework is more consistent with the notion of system of social control advanced by van der Meer-koistra and Scapens (2008) which perfectly fits with the role of control to manage creative and productive processes in NPD projects. This implies to take into account a broader definition of management control systems which go beyond financial measures and also include non-financial measures. Then management control systems in new product development cannot be restricted to traditional accounting measures (Bisbe and Otley, 2004; Davila, 2000). It should foster dialogue and interaction during the different product development phases. .

In line with ANT theorization MCS can be considered complex black boxes that depend on techniques, materials, processes and behaviour. A black box is a technical artefact that appears self evident and obvious to the observer. According to this view, the ability of control to encourage innovation activities is related to its aptitude to attract and enrol different interests. To explain MCS influence on innovation activities, and NPD projects in particular, ANT principles suggest re-opening these black boxes. Opening the black box of MCS technology leads to an investigation of the ways in which a variety of social aspects and technical elements are associated and come together as a durable whole. Then, it is possible to explain how MCS enrol heterogeneous interests and actors and establish ways to prevent instability, ambiguity, and tension within the NPD project. Furthermore, this research proposes a

conceptualisation of accounting and management accounting as proud of inscriptions which have a constitutive power in organisations and really "act" rather than monitoring and measuring NPD project performance.

We advance a conceptualization of MCS as "heterogenous" objects (Quattrone and Hopper, 2006) which are able to attract a heterogeneity of actors in order to provide homogeneity to the network project. Therefore, MCS inscriptions act as forces and influence the stability of a NPD *network* project. For a deeper understanding of the way in which MCS are able to enrol different NPD actors in a convergent network, balancing between freedom and constrain we need to recall the concept of "*punctualization*". In fact, the actants of actor-network must be considered as a composition of numerous heterogeneous elements. Moreover, the actants of the actor-network are consisted of networks as well. Callon (1986) admitted that a researcher has to make some simplifications for the study because it would be impossible to keep the study under control if all the potential actants were treated as heterogeneous networks. Callon and Latour (1981) used the notion of *punctualization* for this simplification. *Punctualization* refers to the concept of treating a heterogeneous network as an individual actor in order to reduce network complexity. Consequently, control system is itself a network consisting both of human and non-human elements or, more consistent with ANT, simply actants. Grounding in ANT concepts, MCS should be treated as networks themselves and actants in relation to the NPD network. This means that control should be able to build the NPD project network through a process of translation. This involves the mobilisation of different actants, the alignment of their interests, and the representation of wider communities to speak as a single will.

This framework moves from previous contributions which related ANT concepts to innovation activities. There are two main ANT elements, which we identify as the key to develop an understanding of the phenomena discussed.

The first returns us to the idea of the process of 'translation' (Callon, 1986). This concerns how one actor translates other actors' will into a single, larger will. The translation of phenomena through inscribing, and their translation into other objects which then stand for them, constitutes one of the most important ways in which social ordering is enacted, and phenomena such as knowledge and practice are constructed.

Understanding the dynamics of the *translation* process will support our examination of the degree of *mobilisation* actions taken according to the rules set in translation) and *convergence* of interests (level of agreement) of the wide range of socio-technical actor-networks underlying the NPD network convergence. This will immediately help detect the dynamic role of MCS in fostering such processes.

The second element concerns the involvement of material objects (Callon and Latour, 1981). ANT insists that actor networks are built not just on human associations, but also on the involvement of non human allies. Objects, machines, symbols, signs, technology, etc. are all enrolled into a strong actor-network, and form a crucial part of its strength. In fact, it can be argued that these non human allies actually give actor-networks their most durable form. This is in line with the socio-material stream that has recently emerged in organization studies and Information System research as well as in the writings of Orlikowski and Scott (2008). It can be used as a way to make a move away from focusing on "how technologies influence humans, to examining how materiality is intrinsic to everyday activities and relations" (ibidem: 455). Thus, successful development projects involve non human allies, which give the project a durable and material form. Development projects often do this by mobilizing material

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objects and inscriptions. In addition, development projects rely on images and designs to announce their presence. Therefore, reports, manuals, managerial software, control tools, etc. become key material manifestations of any project. All these material objects are crucial to development projects, as they outlive the purely personal relationships involved, they help mobilise allies, and they give the network a more tangible form.

Finally, according to the above assumptions, if we assume the existence of some functional quality of MCS in relation to NPD projects, we argue that control systems and practices are placed at the centre of the NPD network where human actors interplay with other non-human managerial techniques and technologies (McFayden et al. 2009; Quattrone and Hopper, 2006). Then, MCS is itself a network where all the actors and agents play a role in relationally defining the nature and multiple tasks of these practices to enhance the balance between creativity and discipline in NPD initiatives. It is this multiple nature which allows MCS to act.

3.   Research methodology

As Quattrone (2004) points out, the research methodology is not a neutral tool: it reinforces the idea that there is a dichotomy between the research object and its analysis. In this section and in the next, we provide details about the selection of the "case studies" and about the empirical evidence collected. According to assumptions advanced in the theoretical framework, we aim at understanding the ways through which management accounting and control system become the focal actants which prompt the NPD network convergence. Then to gain out a deeper understanding of the role of control in NPD settings it is necessary to take into account the interactions between the various actants (human and non human) involved in. That means studying

the actors' relations paying attention to the network in which they work (Callon, Law and Rip, 1986; Czarniawska, 1997; Chua and Mahama; 2007). In focusing on the interactions between actors, we are interested in concentrating both on individuals as well as objects and inscriptions (costing systems, reports, material documents, machines) and bypassing the distinctions between "technical" and "social" accounting factors. (Latour, 1987; Callon and Latour, 1992; Law, 1992; Ahrens and Chapman, 2004; Chua and Mahama, 2007).

An interpretive scheme based on the socio-technological assumptions of the Sociology of Translation (Callon, 1990; Latour, 2005; Lowe, 2001) underpins the research method. A central point of this approach is that accounting cannot be understood simply with reference to its supposed functional properties because it is implicated in the shaping of its own context (Ahrens and Chapman, 2007: 100). In this sense, we mobilise ANT as a methodological lens to look into the organizational life and possibly to find significant management accounting practices consistent with the assumption that they are the output of different actors' actions.

We seek to improve our understanding of the phenomenon through an explanatory case study approach, to support an in-depth investigation, and validate the ability of the theoretical lens adopted. Case study is suited to this research topic because of its exploratory aims and because of the complex and embedded nature of the phenomenon under study (Briers and Chua, 2001; Ryan et al., 2002; Chua and Mahama, 2007; Alcouffe et al; 2008). The use of a case study approach is suited to exploring the use of inscription to manage the complex, situated, embodied aspects of MCS in NPD projects. Our analysis is based on an explorative case study conducted in *AB Micro-conductor*, a multinational company which allowed us to develop an understanding of the translation process through which MCS allows the balancing between the need for

creativity and flexibility on one hand and the need for rules and control the other hand. In ANT terms, that means increasing network stability and convergence dealing with actor-networks controversies.

We see the choice of case research as consistent with our research question, directed to understand how MCS are relevant in enacting the enrolling process and in supporting coordination needs among actants involved in NPD activities. This requires to go beyond the theoretical propositions advanced in the theoretical framework and enrich them with a deeper and more concrete description of the phenomena. In this sense, field research can provide data that can be examined through the conceptual lenses of the framework presented in the previous section. In line with this role, the theory presented above is used to explain the specifics of influence of control in NPD activities, rather than to provide generalizations (Scapens, 2004). Consequently, a case study approach seems to provide a potentially fruitful method for studying the influence of control on NPD projects.

In line with Robert E. Stake, (1995) we choose an instrumental case studies, i.e. the study of a particular case to "provide insight into an issue or refinement of theory." as a consistent approach to study the phenomena of this research. This is in line with the aim of this work "to optimize understanding of the case rather than generalization beyond."(Stake,1995). We thus aim to emphasize the features of this particular case to show how the influence of control on innovation activities is part of a *translation* dynamic (Callon, 1986).

3.1. Case study design

Our investigation focuses on the NPD processes within a multinational company division operating in the semiconductor industry: the *AB Micro-conductor*[1]. The company has various divisions around the world. The product portfolio is quite multifaceted and requires a complex organizational structure articulated in different product segments: *Industrial and Multisegment Sector*, *Home entertainment*, *Automotive product group* and *Computer and Communication Infrastructure*. We have selected this company for the following reasons:

- the semiconductor industry seemed a suitable focus for this research because it is extremely competitive and technological innovations are critical and relevant to gain and preserve the competitive advantage;

- the company is highly focused on product innovation;

- the company's NPD processes are highly structured and their protocol certified;

- the observations within the division allowed us to analyse how both social and technical aspects underpinning the role of control in innovation activities.

Furthermore, these points justify the use of a single-case design. The research site was selected for the personal relations between the researcher and *AB Micro-conductor*'s managers, facilitating data gathering and direct observations.

We focused our empirical analysis on a division operating in the *Automotive Product Group* segment. The products portfolio of this division generates significant sales and profits. Therefore this division offers a financial support to the less profitable products of other divisions. The product returns have a target of 25%. The semiconductor technology is applied in the production of integrated circuits which are the main output of the productive processes within *AB Micro-conductor.*.

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[1] Pseudonym.

The NPD process is coordinated by a Program Manager. The other managers involved in a NPD project are: the Marketing Manager, the Designer, the Product Engineer, the Applications and Market Development Manager, the Division Financial Controller and the Corporate Financial Controller.

The typical *AB Micro-conductor*'s product development process has three main phases: the *Concept-design phase*, the *Design-Engineering phase* and finally the *Testing phase*.

According to the unnecessary separation between description and explanation claimed by the theoretical perspective adopted (Briers and Chua, 2001; Latour, 1991), we will analyse the product development stages in the next section, constructing the story as a theorized account (Alcouffe et al., 2008).

Our analysis concerns the NPD projects within the division's projects portfolio. We observed the projects according to three different levels of maturity, i.e., *Concept phase*, *Design and Engineering phase*, *Testing phase*. This selection criteria are consistent with the need to map the ability of MCS to enrol different network-actors through a process of translation and to achieve the network convergence in each phase of the NPD process.

3.2. Data sources

We collected the field material reported in this study over a ten-month period from September 2012 to July 2013. During these visits, we made field notes of the observations of project selection meetings, product development meetings, functional and executive manager meetings, interviews and other discussions related to product development activities. The period of observation was defined so as to gather the main traits of control influence on product development practices we were interested to

describe and explain. Thus, we spent about 20-30 days in direct observations within the firm. Data were collected from various sources. These documents came from various sources: company archives, interviews, reviews, manuals with key actors of the NPD process. In line with the ANT ontology calling for the 'symmetrical' approach of humans and non-humans, we do not rely on humans as the main information source, but we recognise people, texts, symbols, and technologies play an equally essential part in the construction of actor-networks (Cressman, 2009).

In order to facilitate the analysis of the material gathered, we tried to maintain as much as we could the same broad questionnaire structure for each of the categories of actors identified and involved. For example, whereas the first question was usually an open and a general one concerning the way in which control influence NPD projects, the next gradually tended to regard into more specific network-related issues.

In total we carried out 15 interviews: 10 one-to-one interviews and 5 group interviews. Most of the interviews were recorded, so we were able to compare the notes we collected during the meetings with the transcribed information extrapolated from the interviews. In doing so, this way of collecting data helped us to confirm or reject the knowledge about the field, avoiding risks of influencing our informants. Of course the results, collected from multiple sources, will be juxtaposed and interpreted via a triangulation of the facts (observation within the organization, in-depth interviews, archival data), in order to overcome the limits of this approach.

Finally, since we acknowledged most of the empirical material in the aftermath of events, in order to avoid the risk of dealing with possible mistakes in their recall from our informants, we used data triangulation throughout the whole fieldwork and afterward so as to be more confident with our conclusions. This process of cross-verification not only included the use of different sources, spaces, methods and

categories of actors, but also implied the feedback on some of the same interviewees at different time intervals between 2012 and 2013, especially when contradictions occurred. This practice led to a continuous search for further data aimed at cross-examination of results, aimd at a meticulous documentation of our steps and, perhaps a higher reliability of this study.

4.   Case study account

In reporting the case from the point of view of ANT, the emphasis is placed on the MCS efforts to create a sufficiently powerful consortium of actors and to support and push forward the NPD project. Therefore, understanding of the escalation of the NPD project from an ANT perspective is based, to a large extent, on the particular way in which a durable actor-network is created.

We expand this argument by looking at MCS as a pool of agencies which utilise balancing methods to facilitate a continuous work of convergence within the product development network and mediating between creativity and efficiency.

The NPD process in *AB Micro-conductor* is structured around well defined phases: the concept phase, the design phase, the engineering phase, and finally, the production phase. As reported in the internal Manuals of *AB Micro-conductor*, the NPD is defined as "*(...) the set of interrelated sub-processes dedicated to transform customer specification and market or industry domain requirements into a semiconductor device and all its associated elements, qualified respecting AB Micro-conductor internal procedures and able to be manufactured using AB Micro-conductor internal or subcontracted technologies (...). Particular general customer requirements have to be taken into account in overall product development and product qualification activities*".

Fig. 1 The NPD process
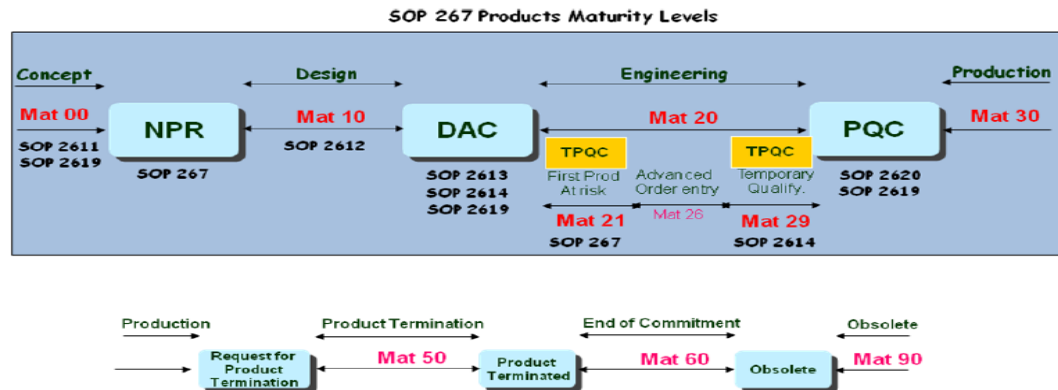
According to the Program Manager: "*The development process is divided into a series of steps, whose conduct is strictly governed by cost and time objectives. The three main steps contemplated in the PDP (Concept, Design and Engineering stages) represent the set of guide-lines that have to orientate the work of each member in different ways and with different level of responsibilities involved in projects.*" In ANT terms the influence of MCS on NPD projects can be traced through the translation process in terms of problematisation, interessement, enrolment and mobilisation. However, this is a fragile process and the network itself is constantly "re-perfomed".

Detecting the problematisation stage in this case study means searching for the first series of acts of persuasion concerning the way in which MCS act with respect to NPD actor-network. The role of MCS is to problematise and scope the NPD project in their own terms. That means balancing between needs for creativity and control feature innovation activities. Control system is the initiator of the problematisation stage by responding itself to the problem that it had risen before.

This means that the balance between these two opposite exigencies fostered by MCS, configures as a scope definition. The scope definition is an important aspect of the ANT as well. As the first step of translation, the focal actant must identify all actants that are needed for a project. (Callon, 1986). This once again emphasizes the collective nature of a NPD project where the MCS, as focal actant, must take into consideration different views. Then, control systems should face the challenge of stimulating creativity and embracing the formal controls that coordinate such creative activities with other ones.

However, how control inscriptions are mobilised in NPD processes? How do they foster NPD network convergence?

To this end, we need to explore how control inscription provide visibility to the entire NPD process, and consequently, how they are able to foster NPD network convergence.

4.1. Management control systems as visibility providers

According to ANT assumptions, the shift from the interessement to the enrolment of actors in a translation process is characterized by the use of various inscriptions. To clarify the role that control inscriptions play in NPD contexts, we explore their attitude to make NPD process visible. Thus, in line with Mouritsen (2009), the primary quality of management accounting calculations in relation to innovation activities is their ability to describe innovation activities and make them increasingly transparent. Afterward MCS are implemented and translated through a continuous process of "de-fining", information needs to mobilise and engage NPD convergence through accounting and visibility (Quattrone and Hopper, 2006).

The following episodes reflect on how management accounting practices create visibility throughout the organization. In *AB Micro-conductor*, detailed procedures are laid down by the NPD team, leading to a heavy well structured process for NPD projects.

The first phase of NPD process in *AB Micro-conductor* is the *Concept phase*. In this phase one needs to verify the economical and technical aspects of the project. This phase starts with the launch of the *New Product Proposal* (NPP). If the project achieves a maturity level of 10, the *New Product Request* (NPR) is approved and the NPD project can start. Going further the concept phase, the second step is the *Design-Engineering phase* during which the electric and geometric qualities of silicon are tested. If the project achieves a maturity level of 20 the *Design Approval Certificate* (DAC) is approved. Finally during the Testing phase a series of testing procedures take place to verify the reliability and resistance of the prototype. Then, if the NPD project achieves a maturity level of 30 the *Production Qualification Certificate* (PQC) is approved.

Nonetheless the NPD process in *AB Micro-conductor* is made up by different phases, featured by strictly procedures, a requirement for providing visibility to NPD process appeared. This need for making things visible emerged during our visits, since NPD managers, from Designers to Production Managers, perceived the earlier NPD phases as highly uncertain and less concrete than other development phases. And the Financial Manager added: "*Controlling NPD process is different from controlling the overhead of a product. You see a product or the service you provide, but it is more difficult seeing a NPD process, especially before testing phases. We run a lot with ideas, schemes, figures, and finally, but only if the process is still going on , with*

prototypes. Before prototypes testing, we evaluate and face with ideas, we know how of course, but nothing really concrete".

As a consequence, NPD managers perceived MCS more effective if the object of control is more visible and structured. Then, they recognise MCS played a role in providing visibility to a process that is not always immediately tangible. In this respect, the Program Manager told us: "*NPD projects in the front-end phases, i.e., the activities that take place before the launch of the formal development project phase, are not something really concrete. Our challenge is to render the entire NPD process "tangible" during all its phases. Production Managers, Engineers, Financial Manager and his staff want to appreciate material and concrete things, not merely abstract concepts or ideas. To this end we need to deal with the NPD protocol, procedures and targets, as they provide formalization and "concreteness" to NPD processes.*" Thus, NPD projects management can be faced more effectively by employing control tools and procedures which attempt to render process well structured and defined.

NPD visibility is allowed by the production of certificates, reports and other schemes. They act to provide robustness and a certain degree of materialization to a process which is not completely tangible. Afterwards, the entire process is perceived more concrete. Therefore, the constructive influence of control on innovation project is to "mediate" between project costs and revenues and embrace creativity logics on one hand, and need for efficiency and profitability, on the other. Indeed, control inscriptions enable the progression of translation and network convergence and they foster processes visibility. As a consequence, MCS enroll different agencies and prompts the NPD network convergence because they enable translate, get translated and engage a conglomerate of humans (users) and non-humans (e.g. accounting, excel spreadsheets,

software package) (Quattrone and Hopper, 2005), providing visibility and "simplicity" to complex processes sustained by divergent logics, i.e., productive and creative logics.

As the above episodes highlight, the various certificates, i.e. NPR, the DAC the PQC, etc. are not simply documents which allow the NPD project to go further each step. These certificates play a central role in the NPD process. They are enrolling agents within a strong actor-network and they form a crucial part of its strength. Indeed, it can be argued that these non human allies actually give actor-networks their most durable form and provide visibility to the entire NPD process.

These arguments are confirmed by empirical data collected during several meetings and interviews in *AB Micro-conductor* which reinforce the ability of control inscriptions to increase the visibility to NPD processes.

AB Micro-conductor has several tools and systems for bid review, cost, and risk management, internal design, and specification change management in NPD projects. Formal systems for project recording, controlling, and reporting are employed. Projects, from the abstract concepts to the production phase, are constantly monitored through control devices such as budgets, reports, protocols and certificates. This is reinforced by the Financial Manager who stated: "*Of course, managing processes needs to implement control for several important reasons: to ensure strategy implementation, to prevent the dysfunctional behaviour of NPD staff, to enable coordination and reporting. Then, we recognise that without these control tools and practices we could not monitor our NPD processes and ensure that the organisation implements its strategies effectively and achieves its long-term objectives*".

Within *AB Micro-conductor'* business units the NPD process is monitored and controlled using dedicated software :

- *MPT-TS – Master Project Table – Table System*, it is a table in which all the projects are updated and identified through a code: the MPT Project Number

- *PCS*, it is a software package to manage NPD projects

- *Microsoft Project*, it is a divisional software which offers a more detailed management of projects;

- *Layout Management*, it allows the communication between Design and Layout teams;

- *ELISIR*, it is used to transmit orders of silicon masks direct to Testing;

- *SAP*, to create, it is the software which allows all the developed and manufactured tools to be modified and deleted;

- *TLS - Time Logging System*, it is used to upload the number of labour hours in each project.

Figure 2 : NPD managing and control software
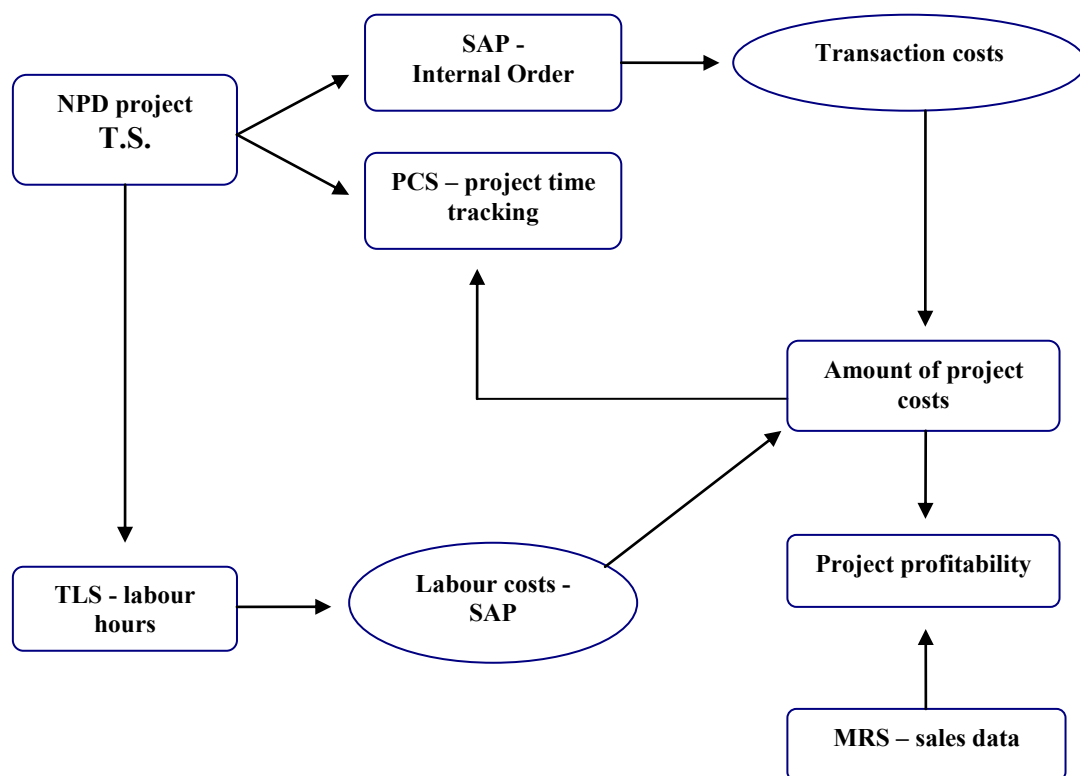
Source: Internal document

The entire NPD process is monitored through monthly regular projects review meetings during which the Program Manager meets with all NPD staff. At these meetings, activity and performance reports generated by Controllers are discussed. We were allowed to take part in some meetings. On such occasions, we noticed how meetings took place around a big table and normally a monitor was used to show reports, files and images related to each project.

Generally, the meeting started with the Business Manager who orchestrated it, selected the arguments to be discuss and moderated the debate among the different participants, i.e. Engineers, Controllers, Designers, Production managers, Marketing Managers. For each project, reports containing financial and non financial data, e.g., time schedule or technical matters, were shown.

During one of these meetings, the Business Manager introduced us to the other managers, and he was really pleased to explain how NPD projects reviews were organised. He stated: "*You see that we work on several projects and each product development process consists of roles, functions and responsibility of each member. Moreover, we make a prior identification and a constant monitoring of costs, time and performance targets, useful to decide whether to continue or break off projects. Furthermore, we organise regular meetings and reviews to control that each project phase is on time.*" The Financial Manager concurred with these views added: "*Thanks to this report systems we are able to draw together the financial and non financial measures and they appear surprisingly persuasive and appealing to other guys who generally do not deal with accounting stuffs.*"

As we detected during our empirical observations, a need to balance accuracy and simplicity of cost calculation emerges in such contexts.

This need for making things visible and intelligible was highlighted by the Program Manager who claimed: "*Even if these reports contain so many numbers, they are organised in such a way to be intelligible to all the participants.*" However, Business Manager's main arguments in favour of this way of managing NPD meetings was that it allows NPD managers to stay in the same room, to debate, to discuss and, finally, to find solutions to the problems. In this respect, we noticed how meetings were not merely "guided" by managers, but on the contrary, accounting and control tools, as well as technical data shown in the monitor, influenced the interaction among people. For instance, the main report, containing all NPD projects managed in the business unit, is like a "guide" around which the entire discussion is organised. Of course, this report is prepared by the Program Manager staff; however in that context, we were interested in highlighting how this material objects act as inscriptions and influence human actions and interactions. In this sense, reports are so powerful not because once projected they appeared more visible, but because their content was shared and immediately intelligible to all participants. This implies that they affected organisational practices since they interacted with managerial logics. In other non managerial contexts, they could not have this ability to act and enrol people.

Therefore, we can safely say that the table all participants were sitting around, the monitor and, of course, all the technical and financial reports shown are typical examples of material objects which exert an influence over human actions.

In addition, in providing visibility, control inscriptions foster a critical information flow among NPD projects staff. Besides, information circulating and communication are key elements to foster actor network convergence. Thus, the result of the actor-network co-operation is negotiated through conversational interplays between the actants (Baxter and Chua, 2003). The innovation process is a collective

process where all the necessary participants must be convinced of an innovation in order to succeed (Latour, 1987). For that reason, convincing communication is an essential tool for the project management.

As confirmed by the empirical data, in *AB Micro-conductor* several formal and informal meetings are planned with the purpose to encourage the exchange of ideas and economic, technical and professional knowledge and skills among the project participants. Even if *Product Development Protocol* contemplates a clear distinction of rules and functions for each member, it enables, at the same time, the process of exchange and interaction run across the company. Moreover, this is reinforced by Program Manager's argument: "*Of course, we foster dialogue and communication during all the NPD phases as communication is important, so that everyone knows which stage we are in. If an issue doesn't go the way it is meant to, it may be due to the fact that communication has failed. I talk to the Product engineers, technicians and controllers almost every day, because working relations are vital. It is a matter of mutual trust and continuous information flow.*"

According to stated above, control inscriptions to become visibility providers should be accepted and recognized as powerful tools which represent something absent, i.e. (the NPD process), involving different logics (creativity and managerial) and languages (financial and non financial data). Their ability is to transfer complex information in a simple way, providing simplicity and accuracy to what is "inscribed" and to give visibility to various and frequently divergent interests.

Following ANT theorization, we can refer to these documents as black boxes which act as inscriptions. They are widely accepted because they are the result of compromise and negotiation (Robson, 1992, 1994; Lowe, 2001) which is the balance between two opposite logics: creativity and efficiency. They are the materialization of

these dualistic feature of the NPD process. Furthermore, MCS entice different interest and diversity, becomes an attractor that inducing action taken from other things. Thus, material relations and managerial practices (e.g. calculating costs) that make and sustain control system as an object, give it a unity. That means these heterogeneous collaborations make MCS appear homogeneous and NPD processes visible. This unity and homogeneity concerns therefore the ability of MCS to act more as a facilitator of innovation and organization processes, rather than as a constrainer of them. The above mentioned statement highlights how reciprocal relations between control systems and NPD activities relate to visibility, i.e., the inscriptions ability to accumulate information in a centre of calculation to exert control (Latour, 1987; Quattrone and Hopper, 2005, 2006; Robson, 1991, 1992). As Latour (1987: 255) argues: "It is going from paperwork to still more paperwork, from one center of calculation to another which gathers and handles more calculations of still more heterogeneous origins...in the very process of their construction they disappear from sight because each part hides the other as they become darker and darker black boxes".

4.2. Management control system as convergence makers

As we highlighted during our empirical observations, the Program Manager has to perform a highly complex task of balancing various NPD managers' interests, and meeting the different demands in terms of reporting and control of the entire NPD process. He is responsible for coordinating resources allocation, monitoring processes and reporting to Business Manager on projects performance.

NPD projects run according to a codified formal communication with NPD managers who report to Program Manager. In addition, NPD projects face complexities and difficulties in external coordination. As a Production Engineer told us: "*To satisfy*

costumer requests we often have gain information and commitments from engineering, purchasing, and production departments…the main challenge is to comply with costumers' requests for changes quickly and efficiently."

During our visits we were allowed to attend various meetings between various NPD managers, related to specific problems with the tension emerging between financial controller and engineers. These problems were described by the Program Manager as follows: *"My problem is: how do we can get people from financial and control staff and people from R&D work together? How do we set a NPD project that they feel will be acceptable to them? How do we deal with need for rules and procedures (as required by Financial Manager) one hand and need for creativity and flexibility (as Concept Managers calls) on the other?"*

In particular, during a periodic meeting for the evaluation of NPD projects status, some designers advanced their calls for more flexibility, emphasizing the rigid NPD protocol and some financial targets as a paralyzing mechanism for the entire NPD process, especially in its earlier phases. Specifically, we report an episode concerning the evaluation of a critical NPD project.

On that occasion we noticed tension between the Divisional Financial Controller and the Concept Designers: the former wished to impose the respect for financial targets, while the latter tried to bypass the financial and technical requirements and to call for creative thinking and freedom in NPD processes.

Tools and reporting were seen by Designers as an added bureaucratic burden, unhelpful in the managing of projects. This is in line with a Concept Designer's argument who claimed: *"I use my imagination to work out the best way of developing a new product concept. Unfortunately, this does not get on very well with strictly control tools, procedures and formal reporting."* Such problems were perceived by the program

manager as the challenge of striking a balance between, on one hand, dealing with rules and procedure through the existence of systematic processes and, on the other, stimulating creativity and flexibility through permissible variation in NPD protocol.

As the Concept Designer claimed: *"Our prototypes require adjustments and modifications and we need more time and a less stressful schedule time."* Then, the Division Financial Controller added that each modification meant increasing costs and losing efficiency in resource allocation. Finally the Program Manager replied that respect for procedures was an imperative but the success of the NPD project required the challenge of combining rules and discipline. In that occasion, the matter concerned the evaluation of the cost variances of a critical NPD projects. The report highlighted an increasing level of overheads in the last three months and there was the concrete possibility that the project should be stopped. The Financial Controller claimed this solution arguing: *"Although NPD project teams are largely on their own, they cannot go completely uncontrolled…the definition of financial targets is necessary to be sure that each NPD project is running in line with the financial resources assigned to it…we deal with a transparent and agreed budgeting and reporting system and we can not tolerate such a huge variation in the level of costs caused by your continuous modifications of prototypes."*

As one Product Engineer, in order to mediate the tension between the Financial Manager and the Designers added *"…guys, we know that rules and practices as well as the level of costs we have to observe for the development of silicon are well defined. Nonetheless we operate in a highly turbulent environment, therefore, in applying our product development procedures, we try to deal with uncertainty".*

While the traditional report (see figure 1) employed during projects meeting was a report organised to show the project code, the cost centres, the cost centre manager

and the overheads, the Program Manager invited other managers to appreciate NPD performance according to critical data, i.e., the project status. To this end, in addition to the former report, he employed another table (see figure 2), imported from the *Project Control System Software* (PCS) which showed the project status.

The Program Manager explained to the other participants it was not the first time that a project was technically and financially problematic, especially over the design phase. He argued that other projects with initial inadequate performances had performed well in the last phases. The report was so clear, so appreciable, that the Program Manager was able to solve that conflict between Designers and Financial Manager, and the project carried on.

Fig 3. Division Projects expenses trend - detail by Cost centre.

MPT Project Code	Project Pcs_id	Project description	Cost center N-2	Cost Center	Cost center Manager	JAN	FEB	MAR	APR	Grand Total
10009102	XXX	XXX	XXX	CL2714	XXX					
10009194	XXX	XXX	XXX	CL2442	XXX					
10009299	XXX	XXX	XXX	CL2442	XXX					
10010404	XXX	XXX	XXX	CL2442	XXX					
10011036	XXX	XXX	XXX	CL2442	XXX					
10011132	XXX	XXX	XXX	CL2442	XXX					
10011257	XXX	XXX	XXX	CT6015	XXX					
Total										

Source: Internal report

Figure 4 Project status. Detail from PCS software.

code	pr_status	title
10017016	10	Integrated Emitter switching, 1700 V, 6A

Source: Internal report

Fig. 5. Project status description.

MPT status code	MPT Status description
01	Insertion
10	Development (Rnd active)
30	Prod (RnD for maint/support)
60	Stopped
90	Closed

Source: Internal report

Indeed the Program Manager integrated that reported with the information about the project status imported from the PCS. This allowed him to show the status of the project and to better understand the reasons for a variation in the level of costs. As the Program Manager explained at the end of the meeting: "*Frequently, during the initial phases, the prototypes require more adjustments and modifications than costs increase. Thanks to the information about project status, we are able to make a more reasonable evaluation of the project costs. Then, in some cases, we can tolerate a deviation from financial targets, calling for a better performance in the next months.*"

Briefly, these management control technologies relate the divisional financial controller, the engineers and designers and finally, the program Manager since they act as flexibility and discipline providers. They were produced showing high degrees of aggregation but allowing Program Manager or others to make selected enquiries into the

data. Furthermore, empirical observations also assume that the Program Manager makes adjustments in the information emerging from the reports. Data are not necessarily accepted blindly; instead, they are interpreted and integrated with other informal information emerging during breaks or one-to-one session. We noticed that reporting system also operates through informal contacts among different managers in order to provide a more reliable analysis of variances. so that problems could be communicated, discussed and shared among project staff. This allows to complement what the technologies of performance measurement cannot address. Yet, the data gathered throughout fieldwork also highlighted cases in which inscriptions proved to have a tendency to use enrolling methods to ensure the establishment and the continuous performance of NPD projects.

As a consequence, we can refer to the different reports as inscriptions that represent the contexts of two categories of actors: the Financial Manager and Controllers dealing with financial and productive logics, on one hand, and the Concept Managers and the Designers dealing with creativity logics, on the other. A full network convergence and a divergent interests alignment occur since that report, as well as other control devices, allow the integration of financial data with other technical information. This unique report is able to represent the instances of all the actors of the network. Therefore, the value of a report depends not so much on the reliability of its content, but on its ability to represent and align interests of all actors in the network. However, the aforementioned episode reported by the Planning Manager was not the only one. A similar problem arose when some critical NPD were stopped.

The examination of the NPD protocol and our empirical observations confirmed that, after concluding the concept stage, the Designer and the Marketer prepare a project presentation for the Division Financial Controller to obtain approval for proceeding to

the design and testing stage of the product development process. At this gate, the Division Financial Controller has three possible courses of action for each project:

- approving the project to move to the design and testing phase;

- cancelling the project permanently;

- asking the Designer to continue working on the project and present the project proposal again.

Figure 5 Reasons for projects write-off
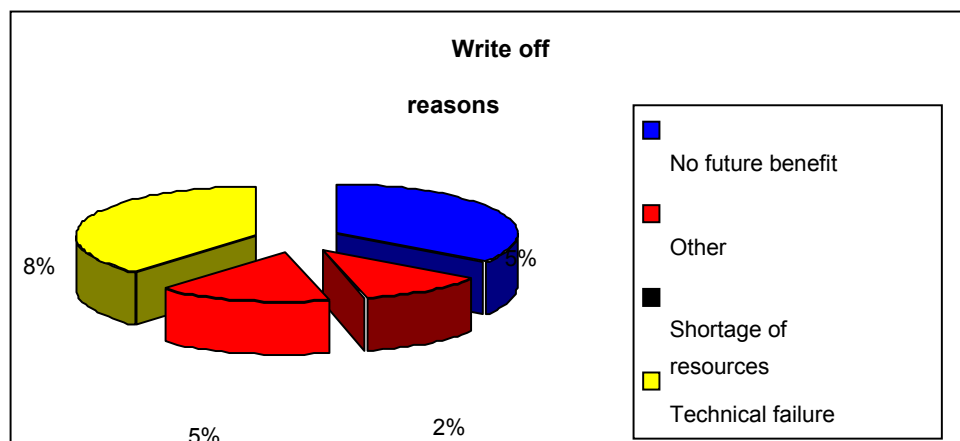
Source: Internal report

This is what occurred when a project was stopped and cancelled for technical and financial problems. In particular, project overheads had been under-estimated and the project was completed either slightly over budgeted, and with a lower level of profit than expected.

As the Program Manager explained: "*In order to have a New Product Request for a project approved , the Marketing Manager's data on future revenues must be coupled with cost estimations tentatively made by the Designer and Engineer. These data lead to the prevision of the product margin, which must be 25-30%, otherwise the*

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Division Financial Controller stops the project." In the company, the main reasons for NPD failure are:

1.   No future benefits

2.   Shortage of resources

3.   Technical failure

4.   Other

On that occasion all managers agreed on the need for stopping and writing-off the project. It was a highly technically problematic project, that was technically unmanageable and it required frequent modifications. As the Planning Manager told us: *"The required changes in the customer's order were not technically and financially manageable since the project was not relevant for the corporation. This project also implied a huge modification of the production plan managed by the plant. That involved test increasing, delay in managing other projects and ineffective allocation of resources."* Designers and engineers were the first to recognise the project failure and to rely on the content of the report which showed the worse financial performance of the project. In such occasion, the control system acted as a selecting device for critical NPD projects. As one Designer told us: "*In such situations, targets and rules are not merely constrained since they allow us to give directions and add in creativity and flexibility in more profitable projects.*"

In line with the above evidences, systematic procedures and explicit technical and financial targets are not always bureaucratic and stifling requirements; instead, they might stimulate creativity and reduce uncertainty in NPD management. Thus, in that occasion, control tools and procedures were considered helpful both in selecting and evaluating NPD projects.

As we highlighted from the aforementioned episode, formal communications, meetings, financial and technical targets, as well as reporting activities encouraged interaction among product development staff, since they are viewed as helpful tools in selecting and stopping unprofitable and problematic projects. Consequently, the write-off project might address creativity as well as resources allocation in other cost-effective projects.

The network convergence occurs since various actors recognise the need to remove certain projects as they are confident that the resources freed by the trimmed project could be invested in new projects in the future or into existing ones. This highlights a dynamic dimension of the convergence process: the ability of a control procedure to promote convergence depends from an expectation on future actions. Specifically, economic and financial data alone are not able to facilitate this convergence, but should be integrated with other tools, protocols, rules or routines showing top managers' willingness to use the resources freed up for other projects. As a consequence, we are faced with the need to evaluate the effectiveness of a control tool by putting it in relation with the whole management control system and practices, as well as with the way in which managers implement them at different levels.

Our observation of *AB Semi-conductor* projects reveals the role that translation and controversies play in achieving convergence or divergence in a project. In particular, lot of these controversies emerge during the testing activities. The NPD process involves the production that has to support testing activities. Frequently, *Testing* procedures force the plants to interrupt their industrial production, and this is perceived by the plant managers as a loss of efficiency.

As the Division Financial Controller reports: "*This is a source of conflict, because the plant is forced to stop its production , that follow a strict program, in order to start low-*

volume production of prototypes, and so with higher unit costs." Indeed, products make diverse demands for resources because of differences in volume, process steps, batch size, or complexity. Production and testing of prototypes absorb lot of time and resources. We asked the Production Manager about that issue and he stated: "*How can I keep costs down when marketing ignores our standard specifications and insists on several different versions of every prototype? Testing and prototypes production are a real headache. And as there is an increasing number of specials going on, small production runs continue to increase and I need many more set-ups per shift and that involves skilled work.*" Next we talked to the Marketing Manager: "*We are facing fierce competition from our bread and butter, high volume lines and we just can't compete with the low prices in the market. However, we have successfully increased our more sophisticated products sales.*" The Program Manager understood that costing system needs maintenance and decided thus to re-shape cost information to support NPD competitive strategy of offering keen prices in a highly competitive market dominated by a few large corporations. He faced considerable resistance to the changes he suggested with several managers who were more willing to accept the deficiencies of the old system because they "understood it" and had "learned to live with it". However, testing procedures required more complex activities, absorbed more resources, and interrupted the production flows of other products. One needed to find a solution which worked as incentive for the production department in executing prototypes tests. As the Program Manager told us, after several meetings, they finally found the solution to the problem. Testing costs were allocated to various prototypes using direct hours labour as allocation base. In addition, three levels of priority for prototypes testing were introduced: low, medium and high. As the project priority increased, more costs were assigned to it. As the Plant Manager reported: "*In doing that we respect a correct*

allocation criteria which avoid to generate distortions in the cost systems calculations."

As this episode highlights, we can refer to this modification in allocating the production costs related to the testing procedures as the result of a "mediation" between the prototypes calling for speed and the production logic callings for efficiency. Therefore this cost allocation methodology and the related report was regarded by the Plant as the solution to a problematic area of cost.

The divergence generated by the previous cost accounting systems is bypassed through a cost accounting re-designing, an *Obligatory Passage Point* (Callon, 1986) in which all human and non human agencies are enrolled. Besides, as it came out from the reported account, that process of re-designing involves the material dimension of the control system. In other words, controversies help to stress the concept of "performativity" and materiality. The relationships and boundaries between humans and technologies, thus, are never fixed, but emerge from practice (Wagner et al., 2010).

4.3.   Further reflections and theoretical implications

As we highlighted before, the NPD process, as a combination of productive and creative logics, is featured by sequential phases but, in implementing each phase a need to deal with flexibility emerges. However, these phases do not necessarily represent the time limit of the NPD translation process, since partial translations run in parallel during each product development phase. In other words, different, local, translation processes carry out during each product development phase setting rules and finally induce intermediaries to act in favour of support of project convergence. This convergence is materially translated by means of inscriptions: the certificates related to each product development step. That implies that the NPD network translation convergence we advanced in the theoretical framework cannot be explained in a linear way. The ANT

moments cannot be seen as a linear continuum when translation occurs. As Callon (1987) emphasizes, the different moments of translation overlap and ignore chronology. In line with Latour, (1999: 179) "[translation] mean[s] displacement, drift, invention, mediation, the creation of a link that did not exist before". During this feasibly, non linear ongoing translation process, MCS establish an *Obligatory Passage Point* (Callon, 1986), thus rendering themselves indispensable. In other words, it is the initiator of the problematization phase.

While a NPD project is put into practice, some dissidence amongst NPD agents emerge, since the Marketing Manager, the Designer and the Product Engineer perceive financial and lead time targets as constrained. In fact, they call for more flexibility in dealing with NPD processes. On the other hand, the financial manager calls for the respect of the financial objectives, finally the program manager requires that each project deals with rules and procedures. According to this point the Division Financial Controller claims: "*We believe that the successful implementation of the NPD projects will go a long way to minimize the tension between managerial and creativity logics. Although NPD project teams Work mostly on their own, they are not completely without control. Furthermore, the definition of financial targets is necessary to be sure that each NPD project is running in line with the financial resources assigned to it.*"

From the above empirical evidence we can refer to MCS as translators. They become indispensable, *Obligatory Passage Point*, for the NPD network constituents because without them the balancing between creativity and discipline and the consequent network convergence would not be possible. As the Program Manager refers: "*Our control system is designed to be the gatekeeper of the NPD project…It is necessary that management control is perfectly fit to the double and divergent interests featuring NPD projects: discipline and control on one hand, and creativity and*

freedom, on the other. MCS establish ways to prevent instability, ambiguity, and tension. At the same time they avoid the kind of rigid control that impairs creativity and spontaneity of the different NPD projects." Then, the control system, that we can refer to as a network becomes the focal actant and defines identities and interests of other actants, which are consistent with the main goal of combining creativity and efficiency.

Even if, as we explained before, the translation process suitable for the NPD network convergence is not linear, the movement of inscriptions (e.g. reports, tools, methods and the managing software) which attempts to achieve a stable network construction, could be assimilated with the interessement phase. Over problematization MCS, i.e., the focal actant, tried to impose his/her view(s) about the problem to solve, i.e. the NPD network convergence. Over interessement, the focal actant has to convince other actants that the interests defined by "him" are well in line with their own interests. In this translation step, various tools are used to ensure its success. These tools can be of a physical substance, such as objects or texts, or without a physical substance such as conversations or meetings. These devices act as enrolling agencies since they create the right dynamic tensions which allow NPD projects to run effectively. As the Financial Manager explains, "*written task definition, business and performance objectives, limitations for concepts and rough time, resource and cost targets generate the appropriate tensions between freedom and creativity seeking and control requirement.*" He continues: "*We set pre-established financial and technical standards, but we do not exercise a rigid control since we aim at monitoring NPD processes and correcting deviations from technical and financial targets.*"

Thereby, MCS offer the best solutions to the problems above, since they act as *enrolling* actors. They negotiate between respect for rules and procedure as required by program manager; respect for financial targets as called for by the financial manager,

and needs for flexibility and creativity required by concept managers and product engineers. In this sense, management control tools and procedures represent a mechanism to mobilise all actors' identities and interests around NPD network convergence. In fact, financial and technical actors delegated MCS as the focal actant for representing the interests of different actors involved in NPD processes.

The above mentioned arguments highlight the agency power of such control devices. They are inscriptions which both constrain (they exert control) and facilitate NPD projects flexibility. Their ambivalence facilitates the NPD process. How does this occur?

MCS act as intertwined abstract referencing systems modified by translation processes. MCS facilitate the NPD network convergence and stability thanks to their malleability, which is necessary for mediating, forging alliances, engaging diversity, and satisfying divergent and emergent needs. This malleability emerges with regards to some forms of input control, particularly rules and practices. As the Program Manager recounts: " *Even if rules and practices must be observed during the entire development process, this praxis is sometimes rejected when there's the risk of slowing down the process because of excessive bureaucracy due to the rigid observance of Product Development Protocol".*

Consistent with the evidence coming from our empirical data, the NPD network convergence is allowed by the actions that various different socio-technical control devices (e.g. reports, screens, tables, etc.) prompt. It is in these socio-technical aspects that we can retrace the role played by control inscriptions. As we reported before, we can refer to control system as the central agency which, through the use of several accounting inscriptions, manages to control organisational member behaviour according to the need for balancing between creativity and discipline. That means control tools act

and influence organisational practices, such as NPD processes since they enable control – even through at a distance. Therefore, reports and other images mobilised during those meetings are inscriptions which involve organisational members' agency, i.e. Financial Controllers, Engineers and Designers to produce information in a pre-determined manner according to the central agency's information needs and goals.

In line with ANT, these reports and other material artefacts become interesting objects to be performed because they could be appropriate to various users, i.e., the various managers involved in the NPD project, and for various reasons thanks to the simplicity of the visual representation they offer. Afterwards, MCS, as a whole of social and technical agencies, act thanks to the enabling capacities of inscription devices to mediate the relationship between "measure" and object (Mouritesen, 2009). Then, we can refer to various inscriptions, such as NPD process certificates, software package, control tools, as devices which provide an "objectualization" (Lowe, 2001) of the entire NPD process. As Latour points out, inscriptions are "transformations through which an entity becomes materialised into a sign, an archive, a document, a piece of paper, a trace" (Latour, 1999: 306). Besides, these inscriptions do not simply refer to something other, i.e. the NPD project phases, inscriptions, ''are not the world: they only represent it in its absence" (Latour, 1987: 247), but they mobilise action in order to achieve the network convergence around a stable goal: the NPD project success. To this end, MCS do not simply "measure", they provide the adequate discipline and flexibility to the NPD process.

5.   Conclusion

This study tried to improve an understanding of the way in which MCS act with respect to NPD projects. Moreover, if previous studies have investigated the role of MCS in NPD settings, a lack of knowledge remains about how control can be mobilised to support NPD projects. Therefore, we have seen an open opportunity to dig deeper into the investigation of the role of control in innovative settings, by conducting a field study which allows us to follow interactions among human and non human actants.

Drawing on ANT framework, we represent the NPD project success as the result of a process of network convergence. During this dynamic translation process, the actor-networks face "swing" between two opposite logics: creativity and flexibility on one hand, and disciplined need for rules and control, on the other. Then, we explained this tension as an oscillation between network convergence and divergence.

The field evidences carried out at a multinational company division operated in the semiconductor industry offered specific insights into the phenomenon under investigation and allowed us to redefine and integrate the theoretical framework proposed. Thus, beyond empirical description, we develop from the case empirically grounded reflections and new theoretical insights on how MCS become the focal actants and allow NPD network convergence.

This work offers a twofold contribution to the existing literature on the phenomena. Firstly, on taking part in the topic debate, we explored the phenomenon from a non functionalist perspective in order to provide new insights that contribute to a re-interpretation of the contradictory results of previous works on the topic. Moreover, we craft a theoretical contribution. Thus, through an interpretive approach based on an explanatory case study (Scapens, 2004) we tested the power of the theoretical framework to offer an explanation of the ways in which MCS affect NPD projects. The

exploration of the translation processes underpinning NPD actor-networks convergence highlighted how the role of control in fostering innovation activities is embedded in a complex, dynamic, fragile and interconnected number of heterogeneous animate and inanimate actants. Furthermore, our discussions suggest a central role of materiality according to the aptitude of MCS to act. This means that technologies influence humans and enact the "obejectaualization" of the entire NPD process. Then, the concept of materiality is relevant in the explanation of the way in which MCS are able to manage controversies. This is in line with our empirical evidences about the ability of control to mediate the conflicts between the Plant and the Program Manager during the *Testing Phase*. We highlighted how the introduction of new cost allocation "rules" and the new report showed a clear example of the "perfomativity" ability of inscriptions to act and manage controversies, i.e., these objects and techniques produce effects on individuals and organizations.

To this end, we went further the assumption that inscriptions simply represent what is absent, i.e., an organisational process. We advanced the need for a deeper exploration not only about the content, the "fact" represented by control inscriptions, as well as on its reliability, but we recognised also their ability to provide visibility to something not immediately intelligible, sustained by divergent interests, e.g., productive and financial logics vs. creative logics. Doing so, they provide representativeness to processes, such as NPD, where various heterogeneous actors deal with financial languages and economic targets in addition to technical procedures and non financial data.

According to the theoretical lens and to our findings, management accounting and control inscriptions do not act exclusively and accordingly to a productive logic for achieving efficiency and profitability. They do not simply represent the loss and profit

"reality". Actually, inscriptions act and play an influential role in innovation settings: they can provide the adequate discipline and flexibility to the NPD processes.

In addition to a theoretical contribution, this study provides new insights into practical business management. The study advances the need for an adequate adaptation of tools and control processes in innovative settings. Therefore in NPD activities, featured by creative and productive processes, the main managerial challenge can be found in the ability of MCS to mediate between creativity and need to deal with rules and practices.

All research studies have limitations and this study is no different. This study provides a single case study, as to ensure the scope of our framework, one needs to extend the analysis to other contexts in order to validate the explanation power of our theoretical conceptualization about the role of control in NPD settings. Besides, ANT is characterized by an exclusive emphasis on case studies and empirical observation, leading to situations where researchers simply report what they see and intangible elements like values and norms are not recognized (Radder, 1992). Thus, what the social is, or how it is conceived, become impoverished when we understand what the tools of social research consist of: "surveys, interviews, opinion polls, participant observation, statistical analyses, and so on" (Callon,1987).

Future research may also mobilise other concept related to ANT, such as the notion of inscriptions power and agency as a basis for examining why a NPD project becomes a technological object made of 'signs, language and texts' which we take for granted. That means to examine how power, as a lever of control, is enacted in the NPD network. This implies that representations, images and inscriptions, ''are not the world: they only represent it in its absence'' (Latour, 1987: 247). They instead mobilised action and allowed the user to develop an associative ability. (Quattrone and Hopper, 2006).

Moreover, future contributions in this area could aim at generating a richer understanding of the way in which corporate control systems affect NPD projects managed at divisional level. A special need for further insights concerns the exploration of the way in which inscriptions travel in R&D settings, for example in basic research activities.

6.   References

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CHAPTER III

MANAGEMENT CONTROL SYSTEMS

IN NEW PRODUCT DEVELOPMENT PORTFOLIO

1.   **Introduction**

The increasing complexity of New product development projects has led to a debate about the way in which corporate control systems could support multi-projects management. Thus, there are increasing calls for research to examine the dynamic nature of control mechanisms at corporate level as they are constructed and as they perform the firm NPD portfolio, i.e., the whole of projects managed at business level.

Recent contributions in the area of management control put some emphasis on control activities of single projects (e.g. Davila, 2000). These contributions pointed out the general importance of the study of management control in project settings. Nonetheless, management control system (MCS) in innovative settings and multiple projects management, represent a fundamental challenge for many companies and in interesting research focus for academics, little attention has been given to the relationship between projects and to the control of NPD portfolio at corporate level.

A number of recent empirical studies, in investigating how MCS affect innovation, focused on the corporate level (e.g. Mundy, 2010; Bisbe and Otley, 2004; Mouritsen et al., 2009) or the business-unit level (e.g. Davila, 2000; Ditillo, 2004; Jorgensen and Messner, 2009, 2010), paying less attention to the interplay between the two levels. However, the mechanism and control tools used and their applicability may

differ, depending on the different organizational levels. Furthermore, the corporate level has implications in setting the context of management control at the project level (Cooper and Kleinschmidt, 1996; Cooper et al., 2001; Sivabalan and Bisbe, 2012; Akroyd and Maguire, 2011; Bonner et al., 2002; Jorgensen and Messner, 2009, 2010).

That is why we aim at shifting away from the traditional positivistic approach that featured most of the previous contributions (Rockness and Shield, 1984; Abernethy and Brownell, 1997; Davila, 2000) as they have drawn upon a mechanicistic and functionalistic notion of control to discuss the compatibility between control systems and NPD practices. However, a lack of knowledge still remains on how corporate control systems enable the balance and coordination between the NPD projects executed in different business-units. For these reasons, we aim at exploring how corporate control system affect NPD processes implemented at business level and the ways in which it can foster NPD portfolio management.

Our focus is, therefore, primarily on the ability of corporate control system to support the activities and relationships between projects. In doing so, we aim at exploring the social and technical traits underpinning innovation activities and control systems. Then in order to understand the role of MCS in NPD settings, it is necessary to take into account the interactions between the various factors (social and technical) involved. For this reason, in this paper we explore relations between various actors paying attention to the network in which they work (Callon, Law and Rip, 1986; Czarniawska, 1997; Chua and Mahama; 2007). In focusing on the interactions between actors, we highlight the actions prompt by both human and non human agents, overcoming the distinctions between "technical" and "social" accounting factors. (Latour 1987; Callon and Latour 1992; Law 1992; Ahrens and Chapman 2004; Chua and Mahama; 2007). According to the aim of studying the micro context of the

interactions, Actor Network Theory (Callon, 1980; Callon, 1986; Latour, 1987) is particularly fruitful for the study of the interactions between agencies (human and non human) involved in control systems on one hand, and in NPD activities, on the other. Drawing on ANT framework, we highlight the role of management accounting and control devices in constructing and exerting control at a distance, i.e., how the corporate control acts over business units' NPD. Moreover, this theoretical perspective allows us to explore the conflicts and controversies between actors (Callon, 1980; Robert and Scapens; 1985; Latour, 1987; Briers and Chua, 2001; Alcouffe et al; 2008; Chua and Mahama, 2007) and to highlight the tension between corporate control systems and business unit control system in the context of NPD portfolio management.

Finally, in this paper we explicate how corporate control system comes to acquire its existence, meaning and influence through power mobilisation. ANT main concepts are mobilised to explain the evidence drawn from a case study carried out at a multidivision company operating in the semiconductor industry. In particular, we report on the NPD portfolio management in this company.

An interpretive case-study approach is adopted in this paper. Thereby from the case discussions the initial ANT conceptualisation about the role of control in NPD projects are developed and enriched. Thereafter, we worked back and forth between the empirical data and the theory (Ahrens and Chapman, 2006) which was aimed at explaining the role of corporate control system in NPD portfolio as the result of ongoing socio-technical interactions involving social and technical entities. By doing so, we extend the exiting literature in management control, since we offered a detailed account of how control over NPD portfolio emerges as an exercise of power balancing and action at a distance. This allows managers, at corporate level, to exert control on NPD projects implemented at business level. This is possible through the presence of

inscriptions that enable corporate control system to act at distance. Therefore, we elucidate how corporate control system in NPD portfolio may be supportive in managing the tension between centralised and decentralised control, conflicts in resource allocations and interactions among various NDP projects executed in different business units.

The work is organized as follows: the following section (2) presents an overview of the concept of project development portfolio; section 3 describes the literature relating to management control at corporate level. Then, section 4 describes the research methodology which guided the explanatory case-study and introduce the case setting. Section 5, drawing on ANT framework, discusses the case data in order to provide a theoretical conceptualization of the role of control in NPD portfolio. Finally, section 6 concludes with a summary of the findings, limitations and future research directions.

2.   Theoretical framework

2.1.   The concept of product development portfolio

In studying new product development (NPD), researchers have applied different functional perspectives such as a marketing orientation (Wind and Mahajan, 1997), design engineering orientation (Suh, 1990) or manufacturing orientation (Ettlie, 1995). Furthermore, they have examined NPD initiatives at different organizational levels of analysis such as the firm or business unit (Capon et al., 1992), the product development portfolio (Meyer et al., 1997) or the individual development project (Clark, 1989; Rosenthal, 1992; Iansiti, 1995; Tatikonda, 1999).

Several academics have pointed out the need to balance between project and ongoing functional work activities (Gerwin and Susman, 1996), and balance between a

single project and a portfolio of projects (Adler et al., 1995; Meyer, 1977; Wheelwrigt and Clark, 1992; Sanchez, 1995; Muffato and Roveda, 2000). The idea of a balanced portfolio is based on modern portfolio theory by Markowitz (1952, 1991). Furthermore, they have examined NPD initiatives at different organizational levels of analysis such as the firm or business unit (Capon et al., 1992), the product development portfolio (Meyer et al., 1997) or the individual development project (Clark, 1989; Rosenthal, 1992; Iansiti, 1995; Tatikonda, 1999).

Research on multi-project management has witnessed a renewed interest shown by both researchers within the field of project management (e.g. Engwall and Jerbrant, 2003), and by researchers on product development (Cusumano and Nobeoka, 1998). The growing interest is presumably explained by the fact that the success or failure of a single project is, in many cases, explained by its relationship with other projects. Consequently, success cannot be studied and explained only by studying the single-project level (Pinto, 2002). Moreover, several authors have highlighted the importance of companies developing multiple product development projects in order to minimize development time, engineering cost and managerial complexity. Especially in electronic, automobile and software industries, featured by increased speed, variety and reliability in product development, firms need for a multi-project strategy in new product development management (Meyer, 1977; Wheelwrigt and Clark, 1992; Sanchez, 1995; Garud and Kumaraswamy, 1995; Muffato and Roveda, 2000; Nobeoka and Cusumano, 1997). In particular, sharing critical technologies across a portfolio of projects allows firms to compete effectively in a hypercompetitive environment (Ilinitch et al., 1996; D'Aveni, 2010), where new products initiatives are one of the most important key competitive success factor (Ellison et al, 1995; Nobeoka and Cusumano, 1997; Drejer and Gudmundsson; 2002). In addition, a number of researchers argues

about the value for firms of developing product development platforms where already existing and new technologies are allowed to be leveraged and transferred among different new product development projects (Meyer and Lehnerd, 1997; Muffato and Roveda, 2000; Morris and Jamieson, 2005; Shenhar et al., 2001; Meskendahl, 2010; Gudmundsson, 2001). The concept of platform is quite popular in product development and operations management settings and it affects production and logistic processes, development processes, project organisational structure, or more generic knowledge and know-how transfer among projects (Drejer and Gudmundsson, 2003). Nonetheless, in literature there are several platform concept definitions, general production oriented, as Muffato and Roveda (2000) pointed out, in the present work we assume the general Meyer's definition as a set of subsystems and interfaces intentionally planned and developed to form a common structure from which a stream of derivative products can be efficiently developed and produced (Meyer, 1997; Meyer and Lehnerd, 1997). This in return exposes the relevance of activities and practices that multiple product development may conduct in order to sustain the competitive advantage for firms (Barney, 1991).

Besides, the multi-product approach has been deeply studied related to the platform strategy concept (Meyer and Lehnerd, 1997; Morris and Jamieson, 2005; Shenhar et al., 2001; Meskendahl, 2010). Current literature highlights the importance of project portfolio management in evaluating, prioritizing, and selecting projects in line with strategy (e.g. Archer and Ghasemzadeh, 2004; Cooper et al., 2001; Englund and Graham, 1999). It is pre-eminent in choosing the "right projects" and therefore an important part of strategic management in organisations. Then, portfolio management (Archer and Ghasemzadeh, 1999; Artto and Dietrich, 2004; Dietrich and Lehtonen, 2005; Patanakul and Milosevic, 2009) is a matter of strategic choices and balancing

among a number of projects, resources and capabilities available. Portfolio management is a dynamic and uncertain process whereby new projects are evaluated, selected and prioritized, and resources are allocated among different initiatives. (Cooper, et al, 1999).

According to project management literature, a portfolio has to be balanced along a range of dimensions to provide the best value to the organisation (Archer and Ghasemzadeh, 1999; Cooper et al., 2002; Killen et al., 2008). However, there is no consistent convention on the dimension to cover. According to Chao and Kavadias (2008) and Chao et al. (2009) success for project portfolios on new product developments requires the balancing between short-term benefits from incremental improvements of existing products and long-term benefits achieved through radically new products and services. The objectives of project portfolio management suggested by Cooper et al. (2002) are well established in the project management literature (Coulon et al., 2009; Elonen and Artto, 2003; Killen et al., 2008; Martinsuo and Lehtonen, 2007). The main goals are: maximization of the financial value of the portfolio, linking the portfolio to the firm's strategy, and balancing the projects within the portfolio in consideration of the firm's capacities.

However, the NPD process management problem is more complex when companies manage a portfolio of NPD projects at once. In a multi-project NPD environment, organizations tend to micromanage their NPD portfolio, ignoring the interactions and interdependencies between projects. Instead, scarce development resources should be managed from a NPD system perspective and allocated to maximize the value of the whole portfolio. Many different authors have provided models, tools, and techniques to help managers to control NPD projects more effectively. As Chao and Kavadias (2008) pointed out, the critical features affecting NPD portfolio are:

- strategic alignment: NPD activities influence the firm's strategy in the medium and long term future;

- resource scarcity: resources allocation and their scarcity are a critical factor in NPD portfolio success. Project managers need to allocate resources effectively among different projects;

- project interactions: managers should consider NPD technical aspects related to synergies or incompatibilities among different projects;

- outcome uncertainty: NPD outcomes are highly uncertain. NPD Managers face technical risks related to the overall functionality of the product, and market risks related to the adoption of the product by the costumers.

NPD portfolio management faces a difficult challenge because resources must be allocated between innovation programmes and each program may represent conflicting directions in terms of corporate strategy. It requires a critical trade-off: short-term benefits accrued through incremental improvements versus long-term benefits achieved through radical or new-to-the-world products and services (Tushman and O'Reilly, 1996).

2.2. Corporate control systems in managing NPD projects portfolio

The effective use of MCS at different organizational levels is a critical matter to ensure strategy implementation, to enable coordination and to ensure the achievement of a multidivisional company long term objectives (Anthony, 1988; Ouchi, 1979; Otley and Berry, 1980; Mintzberg,1979; Child, 1977). As a firm grows in size, top management has to avoid the coordination of different divisions, especially among R&D departments involved in NPD projects. Headquaters multidivisional firms control over their subsidiaries has been recognized by researchers both in the literature of

organization theory and multinational management (Hulburt and Brandt, 1980; Negandhi and Baliga, 1979; Tannenbaum, 1968; Jager, 1983; Baliga and A. M. Jaeger, 1984) and in management accounting literature (Argyris, 1953; Simon et al., 1954; Hopper, 1980; Sathe, 1978; Boland, 2001; Carmona et al., 2002; Ezzamel and Willmott, 1998; Miller and OLeary, 1994; Bloomfield and Combs, 1992; Granlund and Malmi, 2002; Quattrone and Hopper, 2001, 2005). Nonetheless, these studies suggested the relevance of corporate control systems in fostering control between HQ and divisions; however, a lack knowledge still remains on how corporate control systems exert control over innovation initiatives and, in particular, in NPD projects managed around the subsidiaries. Moreover, recent empirical studies investigating on how MCS affect innovation, have focused on the corporate level (e.g. Mundy, 2010; Bisbe and Otley, 2004; Mouritsen, 2009) or the business-unit level (e.g. Davila, 2000; Ditillo, 2004; Jorgensen and Messner, 2009, 2010), paying less attention to the interplay between the two levels.

Control over NPD portfolio management involves both corporate level and of course, the divisional level, since the projects are managed around different subsidiaries. Still, a lack of knowledge remains on how corporate MCS influence a NPD portfolio's projects in multidivisional companies. In such contexts, the corporate level or top management control exhibits higher need for aligning and motivate the resources involved in the different initiatives, communicating the project objectives, analysing and comparing the outcomes of the portfolio's projects (Chiesa et al., 2009; Godner and Sodequist, 2004; Sivabalan and Bisbe, 2012), and enabling the coordination and the achievement of the multinational company long term objectives (Anthony, 1988; Ouchi, 1979; Otley and Berry, 1980; Mintzberg, 1979; Child, 1977). The identification of the main stuffs implicated in the design and implementation of MCS in a multidivisional

company can be referred to as two streams of research. On the one hand, to the traditional organizational model in ways that suggest important links among strategy, environment, technology, organizational structure and MCS (Langfield-Smith, 1997; Chenhall, 2003) and the MCS literature on innovation, especially in multidivisional firms, which emphasized the coordination, the level of autonomy and the control of subsidiaries as critical matters (Ehrman and Fischer, 1980; Håkanson and Zander, 1986; De Meyer and Mizushima, 1989). On the other hand, another stream of research has focused on the use of management control mechanisms at corporate level (Bromwich and Bhimani, 1994; Gioia and Chittipeddi, 1991; Gioia et al., 1994; Gioia and Thomas, 1996; Isabella, 1990; Tillman and Goddard, 2008) and on the use of strategic-related information in NPD decision making (Hertenstein and Platt, 2000; Poskela and Martinsuo, 2009).

In the current literature, many influential studies have focused on detailed descriptions of control mechanisms used by corporate management to regulate and coordinate subsidiaries units (Mintzberg 1979; Baliga and A. M. Jaeger, 1984; Child, 1977; Bruns and Waterhouse, 1975; Chenhall, 2003; Merchant, 1981). In such contexts, the most important aspect of control is the level of autonomy given to the R&D units and how head quarter managers influence them. Particularly, in multinational company managers often use various coordinating mechanisms, as direct observations, standardization of input skills, processes and outputs to integrate various units. These studies have increased the current understanding of MCS at corporate level, giving valuable insights into the applicability of three main modes of control in multidivisional firms: centralization, formalization and socialization. These modes are generally established in the organization theory literature (e.g., Etzioni, 1961; Ouchi, 1981; Pugh et al., 1968; Vancil, 1979), and they have been used to model parent–subsidiary

relationships in multinational companies (Cray, 1984; Gates and Egelhoff, 1986; Ghoshal and Nohria, 1989; Hedlund, 1980). In the centralization, decision-making power is retained at the headquarters, in the formalization mode, the decision-making is routinized through rules and procedures. Finally, in the socialization mode, organization members develop common expectations and shared values that promote decision-making. These contributes are basically contingency studies which focused on cultural and bureaucratic control as the dominant control systems used by corporate management to control their subsidiaries (Baliga and Jager, 1984). In these studies the centralization vs. decentralization debate is the main matter. The age of the organization, its size, the industry in which it operates and the relationship between the environment and the organization affect the degree of bureaucratization and centralization (Khandwalla, 1977; Stinchcombe, 1959; Kimberly, 1976; Blau et al., 1976; Reimann, 1973; Pugh et al. ,1968; Merchant, 1981; Chenhall, 2003). Bureaucratic control (Child, 1972, 1977; Ouchi, 1979), influenced by the ideas of Weberian bureaucracy, is based on a set of impersonal and codified rules and procedures which allow to monitor and direct subordinates. Individuals must accept the organization's authority, learn organization's rules and follow them.

A number of contributions (Merchant, 1981; Simons, 1994; Hopwood,1976; Johnson and Gill, 1993; Ouchi, 1977; Machin, 1979; Dermer and Lucas, 1986; Marginson, 2002) state that the use of hierarchically based administrative controls facilitates the devolution of role responsibilities through the firm and enables managers to monitor and evaluate their subordinate performance. In the bureaucratic system, the interactions between headquarters and subsidiary occur via consultation of rules and regulations, formal and impersonal contacts such as reports and written directives. It is based on a greater usage of company manuals, and a higher degree of impersonal

communication in the form of written reports. This form of control is generally equated with the notion of centralization. The authority of middle and lower managers is limited. Unskilled tasks and standardization of work processes and outputs allow the authority to achieve coordination between subsidiaries and headquarters, which in order to effectively exercise power, tends to centralize operations at corporate level.

Cultural control or value control refers to the use of different mechanisms based on values, beliefs and expectations shared by the organization's members. These studies recognize the role of corporate culture as adaptive and regulatory mechanisms (Peters and Waterman, 1983; Ouchi, 1981; Pascale and Athos, 1981; Jaeger, 1983; Stopford and Wells, 1972; Edstrom and Galbraith, 1977; Smircich, 1983; Baliga and Jager, 1984).

Compared to bureaucratic control, cultural control is generally related to high levels of delegation. Control is more implicit and informal, and even if explicit and formal control mechanisms are applied, cultural control is essentially based on a pattern of practices, values and beliefs which guide the employee's behaviour in line with the organization objectives. Individuals develop a moral commitment to the organization (Etzioni, 1980) and the communication between headquarters and subsidiary is monitored through interpersonal interactions and personal contacts, such as visits and telephone calls, meetings and retraining sessions. Moreover, the transfer of managers from subsidiary to subsidiary is a control strategy which allows the firm to create international and interpersonal networks (Edstrom and Galbraith, 1977; Jager, 1983).

Finally, another line of inquiry has highlighted the nature of centralization-decentralization dichotomy according to a different concept of geographical distance. In fact, previous contingencies contributions ignored virtual distance and how it is created by organisational practices and accounting categories (Briers and Chua, 2001; Kirk and

Mouritsen, 1996; Robson, 1992; Cooper, 1992; Ezzamel and Willmott, 1998; Miller and OLeary, 1994; Bloomfield et al., 1992; Granlund and Malmi, 2002; Quattrone and Hopper, 2001, 2005). The dichotomy between controllers and the controlled and the distance between them is based on a recursive process of constructing and accumulating information. As Quattrone and Hopper (2005) pointed out , advancing a non linear notion of space and time, accounting numbers, budgets and other management control tools promote long distance control and at the same time crate it. Furthermore, a critical issue, at corporate level, concerns the use of MCS to strategy formulation and implementation. During the past decades, the turbulences and changing featured competitive and technological environment have stimulated a great deal of interest about the use of management accounting practices to support strategic involvement in and support of management decision-making. Especially, for firm operating in high-tech industry and investing in innovation activities, the effective use of MCS at corporate level is strictly related to strategy formulation and implementation. Several characterizations of strategy processes have been proposed by strategy researchers since the early 1980s (Bhimani and Langfield-Smith, 2007). One stream of research studied strategy in a prescriptive view, whereby strategy is regarded as a statement of intent that is proactive, consciously, formally and rationally planned prior to decisions and actions in a sequential process of formulation followed by implementation (Langfield-Smith, 1997; Tucker and Parker, 2013).

On the other hand, other researchers have thought of strategy as adaptive, incremental, and emerging spontaneously in response to unpredictable external threats and opportunities, through experimentation and trial and error (Mintzberg, 1979, 1987, 1994). For firms operating in non stable environments, adaptive strategy is needed to achieve success and competitive advantage over time. Where strategy formulation has

less of a predetermined and deliberate orientation, the constraints and discipline imposed by formal MCS are likely to be counterproductive (Langfield-Smith, 1997, 2007). For these reasons managers are likely to be more predisposed to require less formal forms of MCS (Auzair and Langfield-Smith, 2005; Tucker and Parker, 2013). The use of management accounting and control systems to this end is generally called strategic management accounting (SMA). Simmonds defined it as "the provision and analysis of management accounting data about a business and its competitors, for use in developing and monitoring business strategy" (Simmonds, 1981: 26). Nonetheless, the term SMA is used to a number of variations, because there is still no agreed conceptual framework about what constitutes SMA. SMA embraces the management accounting techniques with a clear strategic focus, with future-orientated stance and explicit external focus. Additionally, SMA relies greatly on non-financial measures in contrast to the traditional management accounting systems, which tend to be mainly financially oriented, putting on more emphasis to financial evaluation. Reports and other management control tools rely not only on financial information but, more importantly, on non-financial indicators of strategic priorities (Bhimani and Langfield-Smith. 2007; Seal, 2001, 2006).

3. **Research methodology**

In social science, there exists a certain tension between the research object and the analyses implemented in order to appreciate a given phenomenon. In this perspective, Quattrone (2004) underscores that research method is not a neutral tool, but rather itself addresses the research. During research analyses, authors try to figure out how they make sense of their firm understanding. Beyond the technical criterion of

research methodology, rigorous studies have to provide good justifications of methods implemented to reduce the above mentioned tension.

This paper is based on a qualitative case study. The exploratory nature of our research question, together with the complexity and embedded nature of the phenomenon under study, are the main drivers of this methodological choice. We focus on a single case in the hope of providing distinguishing insights. We maintain that the use of a case study approach is suited to the purpose of exploring the use of inscription to manage the multifaceted, situated, embodied aspects of MCS in NPD projects.

We take into consideration the interactions among the various actants (human and non human) involved in NPD settings. That means studying the actors' relations and paying attention to the network in which they work (Callon, Law and Rip, 1986; Czarniawska, 1997; Chua and Mahama, 2007). In focusing on the interactions between actors, we are interested in paying attention both to individuals, objects and inscriptions (costing systems, reports, material documents, machines), bypassing the distinctions between "technical" and "social" accounting factors (Latour, 1987; Callon and Latour, 1992; Law,1992; Ahrens and Chapman, 2004; Chua and Mahama, 2007).

In order to investigate the research subject, a micro research approach is mobilised. In accordance to this statement empirical data are analysed as collective products created by practical procedures and background assumptions of participating actors. (Knorr-Cetina, 1981: 13).

3.1. Theoretical sampling

Given the aim of this work, "to optimize understanding of the case rather than generalization beyond" (Stake, 1995), we conduct an explorative study in *AB Micro-*

conductor[2], a multinational company, which allowed us to develop an understanding of the way in which corporate may be helpful in managing the tension between centralised and decentralised control, conflicts in resource allocations and interactions between various NPD projects executed in different business *AB Micro-conductor units.*

The breadth of business portfolio includes: *Industrial and Multisegment Sector, Home Entertainment, Automotive Product Group and Computer and Communication Infrastructure*. We underscore some characteristics of *AB Micro-conductor* that support the choice of our case setting:

1. *AB Micro-conductor* operates in the semiconductor industry, where competition is based on competitive and technological innovations;

2. *AB Micro-conductor* is highly focused on product innovation;

3. the company's NPD processes are highly structured and their protocol certified.

The observations at corporate level allows us to analyse how both the social and technical aspects underpins the role of control in innovation activities. Specifically, the case research allows us to recognize the appropriateness of corporate control mechanisms in fostering NPD portfolio management, and so to shed light on further aspects neglected by the theory.

3.2. Data sources and protocol of analysis

According to the unnecessary separation between description and explanation claimed by the theoretical perspective adopted (Briers and Chua, 2007; Latour, 1991), we will analyse the product development stages in the next section, constructing the story as a theorized account (Alcouffe et al., 2008). Our analyses concerns the NPD projects at corporate level.

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[2] Pseudonym

We collected the field material reported in this study over a ten-month period from September 2012 to July 2013. In line with the ANT ontology calling for the 'symmetrical' approach of humans and non-humans, we do not rely on humans as the main information source, but we recognise people, texts, symbols, and technologies play an equally essential part in the construction of actor-networks (Cressman, 2009).

Since we acknowledged most of the empirical material in the aftermath of events, in order to avoid possible mistakes in their recall from our informants, we used multiple data source and processes of triangulation throughout the whole fieldwork and afterwards, so as to be more confident of conclusions. This process of cross-verification not only included the use of different sources, spaces, methods and categories of actors, but also implied the return to some of the same interviewees at different time intervals between 2012 and 2013, especially when contradictions occurred. Our data-base is composed of 15 interviews: 10 one-on-one interviews and 5 group interviews. In order to facilitate the analysis of the material gathered, we tried to maintain, as much as we could, the same broad questionnaire structure for each of the categories of actors identified and engaged. For example, whereas the first question was usually an open and general one concerning the way in which control influences NPD projects, the next gradually tended to turn into more specific network-related issues. Most of the interviews were recorded, so we were able to compare the notes we collected during the meetings with the transcribed information extrapolated from the interviews. This way of collecting data, helped us to confirm or reject the knowledge about the field, avoiding risks of influencing our informants.

Additionally, we spent about 30 days in direct observations within the firm using ethnographic approach. We made field notes of the observations of project selection meetings, product development meetings, functional and executive manager meetings,

interviews and other discussions related to product development activities. Finally, we analysed other various sources such as: company archives, reviews, manuals and other internal documents.

4. **The control of multiple new product development projects. An Actor Network Theory approach**

In this section, the collected empirical material is presented in accordance with ANT framework . We report on the NPD portfolio management in *AB Micro-conductor*. ANT framework is fruitful to explain the way in which corporate control system affects NPD portfolio. To this end, we refer to control system as well as NPD portfolio as ongoing socio-technical networks.

Thereafter, we worked back and forth between the empirical data and the theory (Ahrens and Chapman, 2006) which was aimed at reconstructing and explaining the role of corporate control system in NPD portfolio. According to this theoretical perspective, we can refer to NPD portfolio management as a matter of control at a distance and power mediation between centre and periphery, i.e., the NPD portfolio at corporate level and the NPD projects managed at business level by different divisions.

We assumed that ANT (Callon, 1986; Latour, 1987) would be particularly useful for our study for three reasons. First, it provides a framework for conceptualising NPD portfolio (the whole of firm NPD projects) and corporate control systems as socio-technical networks including humans and a series of heterogeneous animate and inanimate elements, i.e., "actants". Second, ANT proponents refuse to pre-empt the identity of actors independent of the relations or effects they might have within a

network (Latour, 1988). In addition, according to general symmetry principle, actants are assumed to be equal to human actors.

The dichotomy between the social and the technical traits of control system and the company NPD portfolio is solved by the perception that both are intertwined. With a view to understanding the role of corporate control system in NPD portfolio, these actors need to be studied without imposing a priori definitions or expectations on them in order to avoid a priori distinctions between the technical and the social. Indeed, actants are both technical and social. This ontological symmetry is fruitful to conceptualise the role of control in NPD activities as a socio-technical creation. This implies that this network of alliances is created because people and things are "aware" that the project can advance their own interests, according to the role in the project they have been assigned.

Drawing on ANT framework we conceptualise NPD portfolio as an actor creating an actor-network by which individual interests are aligned with the organisational objectives. The documents related to the NPD portfolio are therefore inscribed to engage the actors to take collective action and legitimise the action of the focal actant, i.e., the corporate control system, on other actors. Consequently, NPD portfolio itself becomes unproblematic and uncontroversial. At this point the actor-network is stable and irreversible. This is ensured by the presence of a central actant: the control system which acts at a distance and fosters long distance control (Robson, 1992; Quattrone and Hopper, 2005). This is in line with Kirk and Mouritsen (1996) who argue that corporate control system creates and presents certain financial and economic relations which allow to assimilate headquarters and subsidiaries as a set of relationships that are produced to facilitate interaction and control. Management control system in *AB Micro-conductor*, according to the dimension of a multidivisional

company, is implemented according to three organisational levels: corporate level, product group level and divisional level. At corporate level, control system in *AB Micro-conductor* concerns the whole company and is managed by a corporate control manager who supervises the economic and financial performance according to the company's strategic plans. At product group level, the financial controller monitors the key performance indicators related to each product family and refers to the corporate financial manager and his staff. Finally, Divisional control concerns the control of each division and their business units. The Financial Controller at this level ensures that business-level strategic decisions are in line with corporate objectives. The control of NPD portfolio in *AB Micro-conductor* is essentially a matter of economic and financial measures, e.g., growth, profitability and productivity related to the *Enterprise Resource Planning* (ERP) system. Therefore, the main purpose is to monitor NPD projects performance in relation to key financial and strategic measures in order to make sure that the corporation is creating value. Each R&D or NPD project is monitored through a specific software: the *MPT- Master Project Table – Table System*. This software allows to "upload" all the projects managed in the division and it is related, at corporate level, to the *SAP- Systems, Applications and Product in data processing*. The MPT system at divisional level is interfaced with the SAP system at corporate level. When a new project is uploaded in the MPT system, in the SAP system an alphanumerical code, i.e., the internal order (I.O.), is generated and associated to the project. When a NPD project is launched it is formalized in a document called (NPR) *New Product Request* and moved on to maturity level 10. Then, it is inserted into the (PRIS) *Product Referential Information Systems*, which is a software package at corporate level, related to the SAP system, containing a list of all the NPD projects managed in the company.

Fig. 1: Project status

MPT Project Status	MPT Project Status description	SAP I.O. Status code	SAP I.O. Status description
01	Insertion	10	Open
10	Development (R&D active)	10	Open
30	Production (R&D for maint/support)	10	Open
60	Stopped	20	Blocked
90	Closed	30	Closed

Source: Internal document

In accordance with ANT, the SAP system acts at a distance and make NPD projects, managed in different subsidiaries, "visible" to the corporate level. (Kirk and Mouritsen, 1996). Indeed, all the projects are integrated into the corporate management control and reporting system. The report exemplified in fig. 1 points out the data integration between SAP system at corporate level and MPT system at business level. The I.O. code allows managers to allocate the costs over the different projects which are still "opened".

4.1. Managing NPD projects portfolio as a balance between centralisation and decentralisation

The cost control of each NPD project is taken at business level where different projects are run under the supervision of the respective cost centre manager who reports to the Program Manager. At corporate level, the degree of communication on technical and economic information relating to NPD projects is proportional to the project's strategic relevance. The Program Manager draws all information on the resources required, on technical aspects, delivery, needs for modification, etc. Then, he prepares a report and communicate it to the NPD Product Portfolio Manager.

As emerged during the field observations, corporate control over different NPD projects is a matter of mediation between two calls for control: the requirement for flexibility and decentralised control on NPD projects at business level and the requirement for centralised control, as well as call for NPD portfolio alignment to strategic objectives. This is confirmed by one Corporate Financial Controller who reported: "*We rely on NPD protocol prescriptions…but our main request, at business level is to ensure that divisions are running rationally according to set budgets and goals.*"

An illustration is provided by the revising of a relevant NPD project.

This example enriches the content hitherto presented. The situation is that the HQ stressed on high technical project requirements and called for strictly time schedule about a strategically relevant NPD project. Indeed, when one business unit manages a critical NPD project, detailed profit planning and reports, which embrace almost every aspects of projects' operations, convey performance information from the business unit to the corporate level.

However, since the project was extremely complex, the business unit claimed it needed more time to complete it. This time was claimed to be essential to tailor the product to the prescriptions that were necessary for managing all the project phases effectively .

This point was supported by the argument claimed by one Product Engineer. His resistance was expressed as follows: "*The project is technically complex, we need more time for prototypes tests...we need more time!!!...we asked our supplier to provide us a modified component...and we are waiting for it*". And the Program Manager added : "*As you know, this project is a high priority for the corporate (level)... they (corporate managers) ask each month information about it... they are monitoring the project constantly.*" In order to strengthen these arguments, the Financial Officer replied: "*We*

do not have so much autonomy in managing relevant project like this. The financial targets are well established and we have to deal with them. They (senior managers) control the project closely... they impose to deal with budget objectives and no mistakes will not be tolerated". The Program Manager claimed: "*Guys, there is always a tension between respecting financial targets, which lead to improve a project efficiency, and the time needed to be able to work in a creative way. However, costs variation or lead time often mean that we did not work well. However, the main challenge is to respect the directives coming from corporate level in the most effective way.*" Nevertheless, this point was reinforced by one Corporate Manager who stated: "*At corporate level, we tryre to face with the need to apply the rules contained in the NPD protocol and to deal with financial targets. In addition, we try to take into account the freedom requirement and flexibility emerging at business level…we are conscious that, at business level, you deal with uncertainty and, in some case, you need more flexibility…but we have to optimize our NPD portfolio value. That means that decisions regarding prioritization and selection of projects have to fit with our company strategic plans. We need to manage each project according to its strategic relevance*".

As it can be detected from the above arguments, a number of NPD projects managed by the business units are of higher priority. This means that these projects define much of the restrictions for other projects in terms of resources and attention. However, the tension between the pursuit of centralised control at the corporate level and the call for decentralised control at the business level is faced by imposing to all NPD program managers the requirement to use standardized work procedures that allow them to achieve a better control and a more effective resource allocation.

Because of this pressure, NPD managers at business level are forced to prioritise some projects and stop other ones. The tension aroused in such occasion was solved as

follows. Senior managers at corporate level were responsible for planning and scheduling the project, then, managers at business level had to require materials, award suppliers and subcontracts, as well as manage the overall technical operations. Throughout the life of the project, NPD team had to maintain an on-going communications with the corporate level and they could negotiate with senior managers about time schedule or technical requirements, but always respecting the NPD protocol procedures and in line with company strategy.

Therefore, in ANT terms, this implies that the boundaries of control network are not restricted to the management control system at business and corporate level, but they are extended to the strategic control system. Then, the ability of corporate control system to foster that orchestration between centralisation and decentralisation depends on its ability to act according to a strategic view.

The link between strategy and control system, thus, emerges since they are used interactively. Control system configures itself as both processes and instruments through which the organisation identify, communicate and execute its strategy.

Corporate level is involved with the formulation of plans even if the business unit has a certain degree of autonomy for budget proposals. Corporate Managers regularly compare actual results with budget financial and non financial targets. Moreover, they puts high priority on monitoring periodically (monthly) financial results of critical and strategic relevant projects.

The tension arising from decentralisation and centralisation control is balanced through a negotiation of financial and non financial targets. Key activities are standardized and corporate level provides a clear sense of direction and control for critical projects.

Nonetheless, business units need to operate autonomously to maximise projects performance and to search opportunities coming from the projects managed.

Nonetheless, corporate control is essential to prevent dysfunctional behaviour which could destroy corporate value. Moreover, this evidence is consistent with the work by Cooper et al. (2002), which is one of the main contribution to the project management literature. According to it, a portfolio has to be balanced along a range of objectives to provide the best value to the organization, i.e., maximization of the financial value of the portfolio, linking the portfolio to the firm's strategy and balancing the projects within the portfolio in order to minimize development time, engineering costs and managerial complexity (Wheelwrigt and Clark, 1992; Sanchez, 1995; Muffato and Roveda, 2000).

From the field evidence reported above, we notice how technical and accounting documents, i.e., cost reports, software control package, etc., foster to exert a centralised control at distance on NPD projects managed in subunits which call for decentralised control.

Therefore, according to Quattrone and Hopper (2005), to understand how distances between centre (i.e. the corporate level) and periphery (i.e. the divisional level) is managed and how the corporate HQ operates controls over NPD projects managed by periphery, attention must be devoted to inscriptions. We recall that inscriptions are ''transformations through which an entity becomes materialised into a sign, an archive, a document, a piece of paper, a trace" (Latour 1999: 306). These signs could take the most diverse forms: wheels, trees, hierarchies, and logical maps.

For instance, the report transmitted by the Program Manager to senior managers at corporate level, especially to the NPD Portfolio Manager, are a clear way of the ability of accounting and control inscriptions (the report in the case above) to allow top management to increase its control and power over NPD projects. Thus, this way of cost reporting allows accountants, situated at business level, to increase visibility over

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projects to corporate managers and reinforce central control over strategically relevant NPD projects. This dynamic reproduces the iterative and cumulative reporting of NPD projects as an ongoing information flow from business level to corporate level and from corporate to business level. It defines the distance between centre and peripheries and, at the same time, allows managers to exert centralised control (at corporate level) through decentralised control tools (e.g. reports or MPT system at business level). In ANT terms, it occurs thanks to the inscriptions ability to represent facts in their absence, and therefore, to allow action at distance or, more consistent to this context, control at distance. Moreover, this is in line with the ANT works by Boland, 2001; Carmona, Ezzamel, and Gutierrez, 2002; Ezzamel and Willmott, 1998; Quattrone and Hopper, 2005, 2006) in which organisational categories such as space and time are recognised as crucial to accounting control. Then, SAP representations, cost reports and other control information emerge after a process of translation involving mediations between various interests and existing technologies that redefine their attributes and why they were introduced. Thus the interaction between SAP (centralised control system) at corporate level and MPT system (decentralised control system) at business level constructs distance and thence control (Ezzamel and Willmott, 1998) in *AB Micro-conductor*. From an ANT perspective, these actions can be seen as strengthening the inscriptions in order to persuade other actors to follow the interests of an efficient NPD portfolio management more closely. Inscriptions produced by MCS at corporate and business levels create a socio-technical distance. (Quattrone and Hopper, 2006). They play an active role in favouring the employment of control practices in a dynamic process of ordering and organising NPD portfolio though a continuous balance between centralised and decentralised control requirements.

4.2. NPD portfolio network instability and the inadequacy of resource allocation procedure

As we detected previously, achieving alignment in the context of NPD portfolio network requires managing the tension between centre and periphery. Drawing on our empirical observations, this is vital for the equilibrium as well as for the strength of the NPD portfolio network. Our perceptions, checked on the basis of data collected during meetings and interviews with different managers, revealed that the allocation of resources exacerbates the tension between headquarters and subsidiaries. However, this is in line with the empirical evidence coming out from meetings where the divisional financial performance and the distribution of resources for NPD initiatives were discussed.

As in such occasion a Division Financial Controller explained: *"...tensions also arise between the NPD projects implemented in our company due to tight competition for resources and priority"*. This argument was confirmed by the tension emerging during the periodic meetings to discuss about the financial performance of the division and the resources assignment for NPD initiatives. Indeed, each division manages different NPD projects and some of them are more profitable than others. Some others demand a long execution time and high technical knowledge, but this doesn't ensure that these projects will be more profitable. To mediate the conflict between the call for more resources advanced by each divisions, the Corporate Financial Controller often replied to the Division Program Manager: "*As you know, we do not have unlimited financial resources and we allocate them according to the division financial performance*".

The financial performance of each division is evaluated according to basic financial ratios, i.e., the ROI and the ROA. Thus, the number and the success of NPD initiatives

managed by each division are anchored to the overall financial resources available. Indeed, resources requests are related to business performance and are the basis for the annual operating budget. Then, each business unit prepares an expense budget for the coming year, including economic margin such as gross margin, operation margin and standard financial ratios, e.g., ROI and ROA.

However, in this way, the resource allocation procedure does not meet transparent and efficient criteria, since key financial indicators do not take into account the effective NPD performance. Consequently, allocating resources on the base of the global divisional financial performance does not clearly define what is meant by NPD performance. Rather, as the above episode testifies, key performance indicators, which place financial objectives at the top, are not related to the overall project performance. Moreover, these measures lead to decrease development costs, especially those that are not capitalized.

In ANT terms, the above evidence are a failure in network convergence making. Indeed, different managers do not agreed upon a relevant organisational procedure, i.e., the resource allocation in NPD projects. Thus, conflicts arise since those control tools, e.g., ROI, ROA and other financial ratios, are not able to foster the convergence between different agencies. They are distortive and do not represent the real project performance. They do not take into account other non financial aspects of the project. They are not able to act as enrolling devices. The network, thus, does not achieve its stability, because there is not a clear *Obligatory Passage Point* (OPP). That means financial measures do not allow the management and solution of conflicts among different agencies since they do not attempt to align agents' goals and expectations to the overall networks' objectives. This does not occur since there is not a "democratic"

and well accepted OPP, i.e., a resources allocation procedure anchored to a transparent project's performance representation.

This evidence introduces a more nuanced way of thinking through the problems faced by Project Managers in resource allocation procedure. They elucidate a crucial point: by simply monitoring the project or the business unit financial performance to ensure adherence to time, quality and cost objectives are inadequate. Consequently, the resource allocation procedures require to be redefined in order to search for efficiency and transparency (as required by Corporate Financial Manager and Divisional Managers), to stimulate product development initiatives performance level (the priority for the NPD portfolio manager), to increase the overall division productivity (as wanted by corporate financial controller), since each divisional manager should be stimulated to improve not only the financial performance in the short run but to preserve the long term profitability. This is possible employing by non financial key indicators which should be integrated to the traditional financial ratios.

Finally, the employment of more reliable NPD projects indicators should increase the competition among different firm's divisions (as pursued by top management at corporate level).

4.3. The need for control in managing interdependencies between NPD projects

Within the *AB Micro-conductor* corporation, each subunit is a multi-project setting where various projects with different lead time and separate or interdependent goals, happen to run simultaneously. The corporate level stimulates the interactions between NPD projects, especially the ones that share the same technological platform. That means pursuing project goals, surmounting the local barriers and looking for potential NPD technical platform sharing. This is confirmed by the Program Manager

who reports: *"Frequently the results we get from our NPD projects are shared with the other divisions because we rely on the possibilities to transfer the technical knowledge accumulated in our business unit to a wide range of development projects managed in other business units."*

Moreover, the argument emerged above are in line with Chao and Kavadias (2008) who pointed out the critical features affecting NPD portfolio: strategic alignment, resource scarcity, project interactions and outcome uncertainty. According to ANT, this suggests that the ongoing interactions between human and nonhuman actors are displaced not only within the confines of the project, but they are also deployed outside its boundaries in order to enrol other projects and their networks. In this perspective, our observation of the influence of control on NPD portfolio at corporate level, stresses the need for exchanges and interactions across different NPD projects. Indeed, *AB Micro-conductor* needs to face the dependency that, in some cases exists between the different projects. That means, for instance, to take into account how a project will affect the other ongoing projects in terms of critical resources or time-schedule. Then, the success of a project is in the interest of other projects. This is in line with one corporate senior manager's argument which emphasizes the need for more communication in managing multiple projects in different business units. He reports: *"The best way is to talk to the project managers about the critical aspects emerging from the projects. Formal and informal information flows are essential for a good coordination between the divisional and the corporate level. "*

This is what occurs in the case of a NPD project which shared a common technological platform with other projects. In particular, some components to be assembled for the final product of the project were the output of a project managed in a different subunit. However, the complexity of the projects differed. The main project,

strategically relevant for the corporate level, was technically advanced with long duration, comprising a large number of different technical sub-systems and components. Moreover, a strong emphasis was put on performance and technical traits of the final products. On the contrary, the project managed in the other subunit was much smaller, had shorter duration time, and was not as technically complex.

In addition, there was a continuously ongoing game of negations between the two business units concerning technical specifications and time scheduling for delivering the components. For the Program Manager of the more complex project, the main concern was the project lead-time. Moreover, the components needed for the main project were not available as scheduled. Due to the critical cause–effects relationships between the two projects, this tension was managed by the NPD Portfolio Manager.

The NPD Portfolio Manager, thus, had to decide about processes and standards for the two projects, their prioritization, selection, and evaluation mechanisms. He was responsible for approving financial as well as technical targets from a strategic perspective. Then, in case of perceived deviations or fundamental conflict situations he had to deliver decisions such as re-allocation of resources or re-prioritization of projects in time. In such contexts of interdependence, where the output of the first project is an input for the second one, Program Managers waive a true full control of the NPD processes. Consequently, they delegated to the NPD Portfolio Manager the role to orchestrate the interdependencies between their projects and to coordinate and supervise all the phases related to each project.

As confirmed by other empirical observation, the NPD portfolio Manager is responsible for NPD portfolio strategic planning and in addition he faces the requirement of control emerging in context of interdependencies. This actor allows the effective management of NPD portfolio and the exercise of control at distance from

corporate level. Therefore, we can refer to NPD Portfolio Manager as the spokesman for the various Program Managers operating at business level. The presence of the NPD Portfolio Manager, is thus in line with the objectives of both controlling at a distance and improving local decision-making.

According to the argument reported above, NPD portfolio emerges as a big network, defined by its relationships with the different NPD project networks at business level. Then, to appreciate the role of control in NPD projects at corporate level, one needs to look into the intra-organisational focus, i.e., the internal dynamics that sustained each NPD project as a single network, and into the inter-organizational level, i.e., the interactions among different projects managed by different business units. Therefore, control on NPD portfolio is not merely a matter of evaluating NPD projects performances and verifying that these are in line with the overall technical and financial standards established at corporate level. It concerns the management of the interrelationships of heterogeneous actor-network groups, i.e., the NPD portfolio thanks to the mediating role played by humans and technology (e.g., control devices, NPD software, etc). With a view to gather support and accomplish NPD portfolio and its alignment to the overall organisation's strategic objectives, MCS needed to mobilise strong networks, select their allies and translate their visions to create interessement for key-actors in the organization.

4.4. Further insights and case study reflections

From the empirical evidence collected above, three main findings emerge in the context of control of NPD portfolio: the centralization vs decentralization, the conflict between divisions and between divisions and HQ in resource allocation and finally the interactions between NPD projects managed by different business units. The action that

each project actor-network at business level forms with other entities, which may be human, such as the NPD team members, or non-human, such as computer systems, contracts, or control software, is related to the control system at corporate level. Corporate control system thus acts as a *mobilizator* in order to align the interests emerging in the different NPD projects at business level to the NPD portfolio objectives. How does it occur? To clarify this point we need to recall the concept of power.

As empirical observation highlighted, during meetings and interactions in *AB Micro-conductor*, corporate control system in NPD portfolio management deals with power balance. According to Law, actor network is about a movement, a displacement: "the struggle to centre and the struggle to centre and order from a centre" (Law, 1999: 5). This concept is also linked to power and control at a distance (Law, 1986). Consequently, translation represents a displacement, a movement, from one context to another (Robson, 1991). As such, translation and the other ANT concepts of network, actors and actants (such as accounting and control inscriptions) help to draw attention to the issues of control at a distance and to power. Through the constitution of networks made of accounting inscriptions and human elements, one becomes able to influence different contexts at the same time (Robson, 1991). Thus, the power dynamics sustained by control systems at corporate level could be explained relying on the Foucaultian notion of power (Foucoult, 1980). Certainly there are actors in this network that enjoy a privileged position, but this position needs to be confirmed continuously through negotiations, and this case has illuminated how this privilege might be challenged or even revoked by new actors or new constellations of actors in the network. So, power 'travels' and every relation in a network is, by definition, a power-relation. "These power-relations do not emanate from one "unique locus of sovereignty"-but is

constantly on the move, from one point to another. Thus, saying that MCS represents the most powerful actant of a big network formed by control network and project development network, does not mean that the other actants are not endowed with power at all. By definition, every actor is a network itself, therefore, every actor is potentially more or less empowered, too. As our empirical material highlights, when MCS took place over diverse sets of actors, they did so only because groups of other actors agreed with them or chose not to oppose them. Power is an effect that is performed by corporate control system to entail the tension of aligning and enrolling different NPD networks. That means trying to account for matters as resource allocation and control mechanisms over costs, benefits and the development and implementation of projects. Given this view of power and control, the NPD portfolio network, just like any other actor-network, becomes a creature definable as an inherently dynamic and precarious association of hybrid entities. In such context, management accounting and control systems play a central role in fostering NPD portfolio convergence, i.e., the alignment of interests and goals and the alignment of resources, according to the overall company strategic imperatives. Power is obtained during the mediation of various interests. Then, power prompted by corporate control system is contextual, built through carefully constructed associations of human and non human elements (Latour, 1986). Then, what constitutes power is conditional on the ability to coordinate human and non human actors in an attempt to strengthen or weaken existing associations (Lowe, 2001).

MCS, at corporate level, exerts power over NPD project running at business level. Corporate control systems obtain a power position and maintain this position in order to institutionalise their *mobilizator* and assume a role in order to make NPD portfolio network strong and durable. They are powerful because of the relatively sophisticated combinations of resources and people which they mobilise. From this

perspective, control system at corporate level, is a translation centre where information originate from different NPD projects and is accumulated in centres of calculation and then transferred from business level to corporate level. These activities of translation give rise to debates between NPD projects, which we refer to as socio-technical networks, and later result in strengthening the whole NPD portfolio. MCS at corporate level therefore, become a means by which an organisation can create networks of power relations and accountabilities, that 'act at a distance' (Law, 1986). Moreover, the process of accumulating information in centres of calculation allows to exert control (Latour, 1987; Quattrone and Hopper, 2005; Robson, 1991, 1992). That means control of NPD portfolio does not simply concerns MCS at corporate level. It is more than this. Corporate control system allows the control at a distance over NPD projects thanks to the presence of control system at business level. In line with Quattrone and Hopper (2005), corporate control system creates a centre of calculation (the corporate level) but at the same time, it fosters local discretion (Munro, 1999; Quattrone and Hopper, 2001). The local discretion in such context refers to the role of control in fostering NPD projects management in accordance with the financial and technical targets defined at corporate level, and at the same time, takes into account the need for flexibility and "self-government" emerging at business level. Instead, at corporate level, control system verifies that the NPD portfolio, i.e., the whole NPD projects, is running according to the overall company strategic imperatives. Consequently, how corporate control system acts, results in a form of centralized control, through decentralization. That means that the call for increased management control of the peripheries, i.e., the company's subunits, creates a perceived centralisation of power and control (Bloomfield and Coombs, 1992). This is also in line with Orlikowski(1991: 10) who, talking about Information Technology, states that "they facilitate decentralization and

flexible operations on the one hand, while they increase dependence and centralised knowledge and power, on the other". In accordance with this argument, corporate control system becomes an exercise of power to try to establish centres of calculation in relations beyond corporation's control. This is consistent with a notion of control which marks a shift from one centre and one periphery, with heterogeneous interests but shared intents, to multiple centres and multiple peripheries, with heterogeneous interests and intents (Quattrone and Hopper, 2005). As such, our empirical observations confirm a supportive role of control and accounting devices in promoting various goals and interests from actors with opposite views and finally, mobilizing them into a well defined objective: the alignment and managing of the NPD portfolio according to the company strategic imperatives.

In line with ANT assumptions, the hierarchical relationships and the power balance between control systems networks at business level and the corporate control system, as a network itself, enable to control the effectiveness of NPD portfolio management. The combination of the action of the corporate control system and the interest emerging in NPD projects at business level, creates a consortium of actors who bring the NPD portfolio.

However, it is crucial to acknowledge that NPD portfolio as well as MCS are not "a self-containing piece of technology" (Hanseth and Monteiro, 1997: 194). They are heterogeneous actor-networks of aligned interests. In addition, they allow control systems, at business level, to act as centres of calculation and discretion. Then, as we detected previously, the ability of corporate control system to foster NPD portfolio management is allowed by control devices which deal with three needs for control emerging simultaneously at business and corporate level: the tension between

centralised and decentralised control, conflicts in resource allocations and interactions between various NDP projects.

5.   Conclusions

From our conceptual framework, mobilized on a case of corporate control system over NPD portfolio management, we have shown the relevance of exploring social as well as technical agencies in order to understand how MCS affect NPD projects executed at business level.

The implication is that rather than looking only for a human interest to explain how accounting and control systems affect organizations activities, such as the NPD portfolio management, we need to look for deeper explanations based upon the ties between people and technology.

Despite several studies have investigated the role of corporate control systems in innovation activities (e.g. Mundy, 2010; Bisbe and Otley, 2004; Mouritsen, 2009), a lack of knowledge remains about how control can be mobilized to support NPD portfolio management. Therefore, this paper offered an investigation of the role of corporate control systems in NPD projects, carried out in different company sub-units. To this end, we have conducted a field study which allowed us to follow interactions among human and non human agencies.

Drawing on ANT framework, we highlighted how the combination of the action of the corporate control system and the interest emerging in NPD projects at business level, creates a network of actors who make the NPD portfolio management possible.

Field evidence carried out at a division of a multidivisional company operating in the semiconductor industry, offered specific insights into the phenomenon under

investigation and allowed the theoretical framework proposed to be redefined and integrated.

Three main control issues emerged from the case study: the conflicts in resource allocations, the interactions between various NPD projects managed at business level, and the tension between centralised control exerted at corporate level and decentralized control exerted at business level. Moreover, corporate control over NPD portfolio emerged as a matter of power balancing and action at a distance. That means inscriptions enable corporate control system to act at a distance. In particular, we highlighted how MCS allow the control at a distance over NPD projects thanks to the presence of control systems at business level. Then, they foster control systems at business level to act as centres of calculation. Consequently we have shown how corporate control system create a centre of calculation (the corporate level) but, at the same time, they allow local discretion (Munro, 1999; Quattrone and Hopper, 2001, 2005) over the business units which manage various NPD projects.

Our empirical observations highlighted how in the absence of a clear Obligatory Passage Point, i.e., a well defined and "democratic" resource allocation procedure, the corporate control fails to align and manage the NPD portfolio network according to the company strategic plans.

This work makes a contribution to the existing literature on the phenomena since our discussions suggested a central role of control to mediate the conflicts in resource allocations and in fostering the interactions between projects. This is allowed by accounting and control inscriptions which exert power and provide the adequate NPD portfolio management.

In addition to a theoretical contribution, this study provides new insights for practical business management. The study advances the call for an adequate adaptation

of tools and control processes in innovative settings. This work offers a managerial contribution. By exploring the role of corporate control systems in NPD portfolio, we contribute to a deeper understanding of control in multi-project management, especially in a multidivisional context. Moreover, the exploration of the call for coordination between NPD business units and the NPD portfolio at corporate level is useful for practitioners to make an adequate use of accounting and control systems in innovative settings. Therefore, managers may find it a useful way of knowing what they should do, how, where, when and finally why they should do it.

Finally, since this study provides a single case study, as such to ensure the scope of our framework, one needs to extend the analysis to other contexts in order to develop a more complete understanding of the phenomena. Moreover, future contributions on this topic could aim at generating a richer explanation of the socio-technical aspects promoted by the interactions between control over NPD projects at business level and control over NPD portfolio at corporate level.

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THE CHALLENGE OF APPLYING ACTOR NETWORK THEORY

IN ACCOUNTING RESEARCH: SEMIOTIC AND POWER ISSUES

1.   Introduction

A growing interest in the field of accounting in sociology has appeared since the 1980s after, in 1979, Burrell and Morgan published their eminent book, *Sociological paradigms and organisational analysis*. This model deled accounting academics to link sociology in the field of accounting (Justesen and Mouritsen, 2011), persuading accounting researchers to go further the dominant functionalistic approach and to find new research opportunities applying interpretive, radical structuralist, especially Marxist and radical humanist paradigms. Drawing on Burrel and Morgan framework, philosophical and sociological approaches have made a number of appearances in accounting and management accounting since the contributions by Willmott (1983), Hopper and Powell (1984), Chua (1986) and Hopper et al. (1987).

During the 1970 decade, featured by the bureaucracy and Marxism predominance, an increasing academic debate appeared about the process of social construction of reality and the limits of social constructivism approaches to explain it.

Social constructivism, essentially relativist and anti-realist stance (Hammersley, 1992), is linked to the hyperbolic doubt posed by Bacon, the idea about how observations are an accurate reflection of the world that is being observed (Murphy et al., 1998). This approach considers that the constructed reality only exists separated

from the material questions. Against this negation of the role of material questions affecting scientific and knowledge construction, Actor network theory, (ANT), (Callon, 1998, 1999; Callon et al., 1986; Latour, 1987, 1999, 2005; Law, 1999) gives emphasis to the connections between actors (humans) and actants (non humans or technologies), considering also the material devices and boundary objects, and claims the impossibility of existence of actors outside the net.

ANT has stimulated a number of accounting researchers to study how accounting practices are created and modified within the organisation and how they influence human actions.

Several accounting studies (for a review see Justesen and Mourtitsen, 2011) have been informed by Latour theorizations in seeking to understand the role of human relations with non human actors in the explication of accounting practices within organisations and society and the ways through which management accounting innovations are produced, modified and accepted (Robson, 1991, 1992, 1993, 1994; Bloomfield et al., 1992; Ezzamal, 1994; Chua, 1995; Preston et al., 1992; Quattrone and Hopper, 2005; Lowe, 2001; Alcouffe et al; 2008).

This paper seeks to speculate about some open questions related to the accounting applications of the ANT framework. While ANT concepts have been employed to explain a variety of accounting phenomena including: the potential for accounting to be an effective mechanism for achieving long-distance control (e.g., Robson, 1992; Mouritsen, Larsen and Bukh, 2001; Quattrone and Hopper, 2005), the power of accounting to be used as a rationale for institutional or system change (e.g., Chua, 1995; Preston, Cooper and Coombs, 1992), the inter-connectedness of human and non human in facilitating accounting reforms (e.g., Briers and Chua, 2001; Cuganesan

and Lee, 2006), there is a lack of knowledge about the semiotic nature of inscriptions and how power is mobilised by them in accounting practices creation and modification.

If inscriptions, as black boxes, are regularly mobilized in everyday discourse, and are usually treated as relatively unproblematic descriptions of the accounting phenomena in the world, ANT should seek not only to unpack these conventions, but also to examine how these conventions gained widespread acceptance.

A crucial task of ANT is to examine and explain why some accounting systems and practices are created and modified. Why some of them are more successful than others? What makes some accounting systems more widely accepted than others? And, in relation to the organization using these tools, what makes some firms more stable than others? What makes some business more profitable than others?

To this end, this paper attempts to fill this gap in understanding the mobilization of ANT principles in accounting and management accounting field and to throw light on some relevant issues related to ontological and semiotic matters concerning the nature of inscriptions and the mobilization of power generated by them. Since the power balance between different associations of human and non human elements (Mc lean et al., 2004; Mouritsen, Hansen and Hansen, 2009; Poon, 2009; Quattrone and Hopper, 2005) is a central concern in explaining the multiple and unfolding nature of accounting and management practices, and both material and social factors appeared to play a role within a network of power (Callon and Latour, 1981; Latour, 1986; Callon and Law, 1995), this paper aims at exploring the broader ANT concepts of agency, power and control in accounting research.

This work seeks to make a contribution to the existing literature on the use of ANT in accounting and management accounting research.

According to a Grounded Theory (Strauss and Corbin, 1998) approach, we move from the empirical evidence collected in the two previous chapters in order to provide a richer understanding of some ANT theoretical issues. Then, we aim at developing a theoretical speculation which stems from some theoretical fruitful evidence collected in the two chapters concerning the investigation of the role of control in New Product Development (NPD) projects at business level and at corporate level[3]. In particular, the exploration of the socio-technical aspects of control in NPD projects which sustain and are sustained by inscribing processes offers a theoretical contribution, as the ANT interpretation of the role of management control systems (MCS) in NPD settings has implications in providing insights into a deeper appreciation of inscriptions, semiotic and power issues. Consequently, we seek to move from the empirical investigation into the role of control in NPD projects to shed light on ANT semiotic and power issues. Taking part in the debate on the topic, we intend to make a theoretical contribution by examining how accounting inscriptions may be useful not merely as rhetorical devices but possess also a great potential for "power" or action at a distance (Robson, 1992: 701). In a nutshell, this paper seeks to emphasise the huge power of accounting and control inscriptions as embedded in a contingent and relational managerial context.

The balance of this paper is structured as follows. In the next section, the use of ANT framework in accounting research is described. Section 3 addresses two main concerns of ANT: semiotics and power of inscriptions. The paper concludes with a recognition of some limitations of the study and the potentiality to gain new insights from this work.

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[3] Chapter II concerns the role of MCS in NPD at business level. Chapter III concerns the role of MCS in NPD portfolio managing at corporate level.

2.   The use of Actor Network Theory in accounting research

The accounting literature has tended to mobilize ANT principles, drawing on ethnographic case studies, theoretical and historical analyses, to address different questions, such as the introduction of new costing systems within public sector organisations, especially, hospitals (see, for example, Preston, Cooper and Coombs, 1992; Chua, 1995; Lowe, 2001a; b; c). This theory has also been applied to analyse the origins of accounting standard setting (Robson, 1991), the study of the formation of boundaries (Briers and Chua, 2001), the way accounting technologies are able to act at a distance (Miller, 1991; Robson, 1992; Bloomfield and Vurdubakis, 1997; Ezzamel, 1994; Ogden, 1997; Robson, 1994; Quattrone and Hopper, 2001, 2005) or to inform how management accounting innovations are produced, accepted and disseminated (Alcouffe et al., 2008; Chua, 1995; Jones and Dugdale, 2002; Lowe, Locke and Lymer, 2012; Preston and Young, 2000; Quattrone and Hopper, 2005; Busco and Quattrone, 2010; Qu and Cooper, 2006), to name just a few.

Historically, ANT was first introduced to the accounting literature by Miller (1991), Robson (1991, 1992, 1993), Preston, Cooper and Coombs (1992). Moving from an historical analysis, Miller (1991) argues that both accounting and practice of government are effects of contingent, historical processes rather than distinct phenomena. According to Miller, material technologies make it possible to translate "programmatic" ideas of government into practice because inscriptions allow the kind of "governing at a distance" that characterizes the modern state and its relation to its population. Inscriptions make it possible to mobilize and make present absent things and people in "centres of calculation" (Miller, 1990; Latour, 1987; Justesen and Mouritsen, 2011).

In a successive contribution, Miller (1991) draws on ANT to investigate the adoption of discounted cash flow techniques as a tool for making investment decisions, and explain the roles that a group of diverse actors, such as government, academics and enterprises play in promoting these techniques. Robson (1991) examined the genesis of accounting standard setting in the UK including the formation of the Accounting Standards Steering Committee. His work appears to be the first published study in accounting to specifically apply ANT. The main contribution of the paper is the mobilization of ANT approach to explain how the concepts of translation and problematization could be applied to the discursive processes of accounting change. Another paper by Robson (1992) theorised how the use of numbers in accounting practice enables the achievement of long-distance control, that is, their influence over remote actors. This paper examines how accounting inscriptions may serve not merely as rhetorical devices but possess great potential for power and action at a distance. Finally, Preston et al. (1992) through a case study investigate efforts to introduce accounting reforms to the British National Health System in the 1980s. They focus on the "fabrication" of a management accounting systems and on how technologies can become taken-for granted artefacts.

Nonetheless, ANT has been applied issues and settings to a variety of accounting, the most common application is the study of changes in management accounting practices: one main question concerning the diffusion of accounting innovation and changes, explaining accounting and accounting systems as technological black boxes. In particular, such contributions study how accounting technologies, once created, can *act at a distance* through the inscriptions they produce. Ezzamel (1994) uses elements of Latour's theories to explicate the role of inscriptions in the implementation of budgeting systems. In a recent work, the author examines the role of

accounting performance inscriptions and their effects both on stock market prices and shareholder value performance incentives in corporations (Ezzamel, 2008). Quattrone and Hopper (2005) examine how a particular management accounting technology, SAP, mediates organizational and managerial relations of distance, integration and control; they claim that "it is more pertinent to trace continual changes in loci of control rather than trying to identify a specific centre that exerts action at a distance based on modernist presumptions of a dichotomy between the controller and linear and uniform time and space" (Quattrone and Hopper, 2005: 760).

Dechow and Mouritsen (2005) examine two firms pursuing integration of management and control through enterprise resource planning (ERP) systems.

In addition, a number of studies have informed changes in management accounting practices such as the introduction of new costing systems within public sector organizations, especially, hospitals (Preston, Cooper and Coombs, 1992; Chua, 1995; Lowe, 2001a, b). Preston et al. (1992) focus on the introduction of a new budgeting system in the UK health sector. Chua (1995) argues how accounting numbers are involved in the fact production and how a management accounting system can only work if it is part of a larger network in which inscriptions and rhetorical strategies are able to tie together different interests in an actor network. Lowe (2001a, b), as Preston et al. (1992) and Chua (1995), explore the hospital issue in ANT-inspired research in accounting. Like Chua (1995), he studies the introduction of a case-mix accounting system in a regional New Zealand health provider. Furthermore, in contrast with Chua (1995) and other former accounting studies on ANT, which tended to concentrate on networks of human actors, he calls for a truthful representation of Latour's theoretical framework (Lowe, 2001b).

Finally, ANT is used to understand how methods and theoretical frameworks employed in accounting research provide rhetorical devices aimed at persuading the audience within the discipline (Lowe, 2004a, b; Mouritsen, 2011; Quattrone, 2004).

3. The mobilisation of Actor Network Theory principles in accounting field. Open questions and need for further insights

ANT has brought the sociological approach to the management accounting research as it indicates the importance of interaction between non-human and human actants. In this sense, accounting systems and human members of organisations form allies that ANT tries to explain, even if accounting systems are not completely tame and predictable (Lowe, 2001). While ANT-based management accounting research is devoted, for the most part, on accounting innovations, the ontological and semiotic nature of inscriptions and the mobilisation of power by them remain open questions. Generally, in using ANT, researchers take translation and inscriptions as key words, without clarifying what is their ontology and how they act. Besides, they should be mobilised not only to describe the process of interest translation and inscription, but also to expose the factors which allow this process.

To this purpose, we intend to develop a theoretical speculation on these questions starting from the argument investigated in two case studies concerning the role of MCS in new product development (NPD) projects. Particularly, in such contexts, the exploration of the translation processes underpinning NPD actor-networks convergence emphasized how the role of control in fostering innovation activities is embedded in a number of complex, interconnected, heterogeneous *actants*.

However, the question is more complex than this. Indeed, a lack of knowledge remains on how accounting (quasi)-objects (Latour, 1991: 117), constructed as a result of inscribing translation process, perform as diffused agencies within networks and how power is mobilised by inscriptions.

The first issue concerns the ontology of accounting and control inscriptions and their ability to provide visibility and materialization to managerial processes.

Furthermore, going beyond empirical evidence, we aim at developing empirically grounded reflections and new theoretical insights on how inscriptions enact the materialization and visualization of accounting and control practices, such as the control of NPD projects.

The second main issue concerns the exploration of networks of power relations and accountabilities. That means how control systems obtain a power position and maintain this position in order to mobilize and enroll different entities (humans and actants) within strong and durable networks.

Consequently, we recall Quattrone and Hopper's theorization (2006) about accounting and visibility to argue that a fully appreciation of the semiotic features of inscriptions could be fruitful for a deeper appreciation of the way in which they act.

3.1. An ontology of inscriptions. A semiotic approach.

As Latour points out, inscription "refers to all the types of transformations through which an entity becomes materialized into a sign, an archive, a document, a piece of paper, a trace" (Latour, 1999: 306).

Inscription produces objects which, by features of their material qualities (Callon, 2002), are more amenable to organization and management than the phenomena represented by these objects. Inscriptions are "proxies" which act as

agencies in organizations, by their representational and relational capacity to stabilize the dynamic aspects of organisations.

Like other material-semiotic approaches, ANT describes the enactment of material and heterogeneous relations within a network, or socio-technical network, which involves semiotic *relationality* (it's a network whose elements define and shape one another), *heterogeneity* (there are different kinds of actors, human and otherwise) and *materiality* (stuff is there a-plenty, not just "the social "). As Latour claims: "An actor in ANT is a semiotic definition – an actant – that is something that acts or to which activity is granted by another…an actant can literally be anything provided it is granted to be the source of action" (Latour 1996a: 373). ANT is a matter of *relationality*. All that is relational dissolves fixed categories. Different elements have no significance except in relation to others, or to their structure as a whole (Law and Singleton, 2005). This *relationality* stems from semiotics. In this sense, ANT is semiotics. Furthermore, ANT releases some similarities with Michel Foucault's semiotics of materiality, which extends this beyond language to count for all entities. It implies that all entities achieve their significance by being in relation to other entities. A word acquires meaning from its relation to other words (see Morin, 1977). Analogously, ANT claims that objects are defined relationally: an object is never "out there", i.e., standing proud of relations (Quattrone and Hopper, 2006).

Consistent with its etymology, semiotics defines sign as "[..] something which stands to somebody for something in some respect or capacity" (Peirce, 1955: 99). Therefore a sign represents something other than itself which is absent. In particular, by revealing an absent reality or concept, the sign makes it visible and present thus acting as a relevant medium of communication. This is in line with the example provided by Latour (1999: 24) in his story of a scientific expedition into the Amazon forest to set the

boundaries between forest and savannah. At the end of the journey, scientists were able to define the boundary between the two entities and put it on a map on a paper visualizing a boundary which was previously absent. The distinction between two imperfectly defined entities (the forest and the savannah) became a clear difference, i.e., a boundary on a sheet of paper. The references did not just refer to objects – they constituted them (Quattrone and Hopper, 2006). Then, accounting and management accounting categories (e.g., costs, revenues, and income), principles (e.g., feedback control), and techniques (e.g., double entry bookkeeping, cost allocation, etc.) refer to signs which act as inscriptions, as references, in absence of the object, i.e., the referent they refer to. Furthermore, the earnings reported at the bottom of the income statement can be considered as a sign of the firm's profitability over the last year. We cannot observe firm's profitability but that number at the end of the income statement represents a sign of how much the firms gained over the year, thus making firm's performance visible. Moreover, the association between the signified and the significant is somewhat arbitrary and contingent on the social context in which the sign is used and its relations with other entities (Law, 200). At the end of the days, the number in income statement is just a number that, in other contexts, could be easily used to indicate the distance between two cities. Similarly, the line on the map stands for the boundary between the forest and the savannah in Latour's example but, under other circumstances, it might indicate a river as well. Thus, the same sign means different things to different people in different contexts or, by using Umberto Eco's words (1984), "*what is commonly called a 'message' is in fact a text whose content is a multileveled discourse*". The concept of multileveled discourse emerges clearly from the case study concerning the way in which MCS affect NPD initiatives[4]. Since in NPD

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[4] This evidence is reported in Chapter II.

projects are involved heterogeneous actors, i.e., the Marketing Manager, the Designer, the Product Engineer, the Applications and Market Development Manager, the Division Financial Controller and the Corporate Financial Controller, different languages and signs emerge in such contexts. Indeed, NPD managers use different languages and signs, and each one refers to NPD process in a different way. For instance, the Designer refers to NPD as a matter of dealing with creativity and flexibility. On the other hand, according to the Division Financial Controller, managing NPD activities is a matter of productive and financial issues. Finally, the Program Manager has a different vision of such processes, since he tries to reconcile the two views. He refers to NPD projects as a matter of stimulating creativity and dealing with respect for rules, procedures and financial targets.

Therefore as the Financial Manager finds himself in an influential position and tries to mobilise his "social skill" to legitimise his power (Fligstein, 2001), or the Program Manager, who may be considered a strategic actor, deploys a number of tactics to obtain the cooperation of all NPD managers, similarly, inscriptions operate to reproduce or contest systems of power and privilege. For instances, NPD reports are inscriptions which represent the contexts of two categories of actors: the Financial Manager and Controllers dealing with financial and productive logics, and Designers dealing with creativity logics. These reports and other control tools allow financial data to be incorporated into other technical information. Therefore, as emerging in such contexts, the power of a control device, such as a report, depends not so much on the reliability of its content, i.e., the information transferred, but on its ability to represent and align interests of all actors in the network.

As a result, managerial and accounting inscriptions establish their power in the organization, since a managerial background allows managers to legitimate the power of inscriptions. However, what are the antecedents of inscription's power?

According with Orlikowski's (1996, 2000) arguments, technology's consequences for organizations are enacted in use rather than embedded in technical features. (Boudreau and Robey, 2005). Inscriptions power, thus, can be appreciated investigating the way in which they are legitimised within the organization, completely respecting the *Principle of Symmetry* which stems from the diffusion of a managerial language that strengthens powerful interactions between the social and the technical dimensions.

As evidence from the aforementioned case study suggest s, control inscriptions perform as organisational actors allied to many other agencies, particularly managers, since managerial competences (Kræmmergaard and Rose, 2002) and languages allow them to emerge as organisational key actors.

To this end, the above arguments are confirmed in Bechky's (2003b) case study of production floor in a multinational. Bechky (2003b) acknowledges the existence of three different languages within the firm: the language of engineers, technicians and assemblers. Such differences were evident when one asked to each community what is a machine. Engineers describe the machine by referring to their drawings and in technical terms while assemblers consider the ordered stages of production processes. Finally, technicians reconcile the two views. Furthermore, Bechky (2003b) clearly shows how the sign does not have a meaning in and by itself. This argument emerges in the context of control on NPD projects, where the role of control as a balancing between creativity and productive logics comes from socio-technical interactions involving humans as well as technical devices, i.e., reports, software, budget, etc. Indeed, if a sign acquires

meaning by interacting with other entities, both humans and non-humans, and is characterized by multiple meanings depending on whom it interacts with, how can it be adopted to convey information across domains? To this end, we can refer to signs as boundary objects (Bowker and Star's, 1999), namely as objects that mediate different actor-worlds and actors use to communicate across domains. According to this point, MCS act as boundary objects, since their utility in NPD contexts, is strictly related to the existence and/or the possibility to create a common language and/or interpretation among the users (agencies).

However, the point is to identify the features that the sign should have in order to be able to act as boundary object. Nevertheless, once different meanings appear, diverse interests among actors might also come out and have to be solved. When there is a common interest among the actors (e.g., in product development settings), the mutual goals and purposes push the actors towards a process of translation. However, when different interests arise, actors face a pragmatic boundary for which translation and engagement could not be enough. Conversely, a process of negotiation might be necessary during which individuals will negotiate, mediate their interests and, above all, will alter, change and modify the meaning of the sign. Therefore, the process of negotiation will end up with the transformation and development of a new knowledge (both common and local) that takes into account the diverse interests of actors and allows them to continue to interact (Carlile, 2004). Then, when individuals face a pragmatic boundary, a boundary object is effective if it allows individuals to reconcile the conflicting interests and jointly transform and develop knowledge. Consistently with this argument, the same occurs in NPD settings where MCS allied to the NPD network enabling to manage and reduce the tension between discipline and flexibility. MCS enroll different human (users) and non-human (e.g., accounting, excel spreadsheets,

software package) agents in order to prompt the NPD network convergence. This occurs because MCS become the focal actant of a big socio-technical network. They negotiate between respect for rules and procedure as required by the Program Manager; respect for financial targets as called by the Financial Manager and needs for flexibility and creativity required by the Concept Manager.

The discussion has so far pointed out that the role of sign as inscription as well as boundary object is something relational, situational and context-specific. Only when these socio technical relations were established, control system started to play its role of achieving NPD network convergence. Even though the establishment of such relations is crucial in defining the meaning of the sign and in exerting its capacity of inscription and boundary object, the sign does not play a passive role in the connections. As Jones et al. (2004) highlighted, sign is not a mere referral of something else, rather it should be considered as an action or act of engagement, namely, as what makes engagement and interactions among individuals possible. Then sign, by representing something else, allows people to interact. In particular, by representing and affecting something that is absent, sign shapes our understanding of the world as well as social relations and practices[5]. Noteworthy, sign is able to influence the connections, practices and understanding of the world both by revealing and hiding implicit information and by engaging or not individuals and processes. As a consequence, the sign exerts a strong power and has relevant implications for accounting and control practices.

Consistent with the semiotic nature of inscriptions, we thus can refer to accounting and management accounting systems as signs which act by creating material proxy objects, in files, reports and documents that make concrete what is in fact a "sum of social interactions". Furthermore, the objects that are "written down" have a stability

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[5] Furthermore since the sign represents knowledge, power and social relations, its effects in shaping social connections seem even more relevant.

and tangibility, unlike the "service" they represent. How is this possible? It is possible only if we recognize inscriptions as present to act and represent something absent. Accounting describes costs, revenues, and so forth, in their absence (Macintosh, 2002; Quattrone and Hopper, 2006). Accounting is a pattern of absent presences and its abstractions create references that people or technologies could refer to, in the absence of the object that accounting referred to (Law and Singleton, 2005; Quattrone and Hopper, 2006). The ability of inscriptions to act should make us reflect about the powerful of ANT to explain the multiple nature and purposes of accounting and management accounting (Quattrone, 2009). Accounting plays an important role in societies and it is a successful technique spread over time and space. However, the reasons of such success and diffusion are not so self-evident. Indeed, accounting and management accounting signs can be defined as a means to represent firm and its operations, able to convey information that is likely to be used by outsiders and insiders to make decisions and exert control. This definition explicitly highlights the multiple nature and purposes of accounting (Quattrone, 2009) and, at the same time, allows us to point out some issues.

How can accounting refer to such multitude of different 'others' and, at the same time, spread over societies? Furthermore, 'these others' appear to be abstract identities that become "real" through the accounting inscriptions. How can it be the case? Moreover, as a vehicle to convey information, accounting appears as a boundary object. The transfer of accounting and management accounting information occurs within a network of actors and actants. However, this network can be different, involving actors located in different places with diverse interests, purposes and ideas. How can accounting attract diverse actors and actants and maintain the ability of transmitting information?

To this end, we should consider accounting inscriptions not mere means to represent something else or transmit information. On the contrary, they represent reality in order to act on it, control or dominate it as well as to secure the compliance of others to that domination. Namely, they should be viewed as forces, as acts of engagement that make people act, exert power and produce new knowledge. Again, the question is: how is it possible? And furthermore, how can we reconcile these diverse features so that we can explain the ability of accounting to be a successful practice and circulate over societies? The answers to these questions require the investigation of two specific and interrelated aspects of accounting inscriptions: the reliance on images and visualizations and the performative and constitutive power of inscriptions. The analysis of these traits appears crucial to understand how accounting can be homogenous and, at the same time, heterogeneous enough to attract diversity, circulate across societies over time and space (Quattrone and Hopper, 2005)

The first feature is related to the use of visual images. One of the characteristic of accounting is to provide a simplification the "other" is supposed to represent. In other words, accounting inscriptions represent a complex "other" in a simple and linear way. For instance, the documents and the software used to mange the NPD processes offer a simplified representation of a much more intricate organization practice. Instead, Qu and Cooper (2011) demonstrate how the consultant's provision of work steps, deadlines, expectations and costs requirements about the adoption of the BSC made its implementation more real and manageable by the firm. Through inscriptions, consulting project is made to appear to be workable, clear and, above all, controllable by the client.

Simplification, linearity and clarity make accounting appealing and attract actors (Qu and Cooper, 2011). This represents a first step in the creation of the network and, above all, in the translation process described by Callon (1986). Furthermore, the visual

schemes involved in the accounting inscriptions increase the visibility of the organization and, at the same time, materialize something that was intangible before. In both cases, the outcome is a feeling of increasing control that makes accounting inscriptions even more attractive. For instance, Quattrone (2009) shows how the visual images allowed the master to see better the Monastery and the operations of more remote areas as well, enabling, thus, management and actions at distance. Conversely, it has been showed how work steps, deadlines, expectations and costs requirements about NPD projects, made their implementation and control more real and versatile for managers. Through accounting and control inscriptions, NPD project is made to appear to be workable, clear and, above all, controllable. However, visual images are not a mere simplified representation that increases the perception of control through higher visibility. Indeed, visual images provide somewhat general, standardized and separated from any particular situation of the other. This generality permits accounting inscription to be used in different places but, at the same time, implies a process of customization of accounting inscriptions. Visual images suggest a way of organizing, ordering thoughts and represent things through associations between the image and the "general" entity. Nevertheless, these processes need to be applied in a specific context. Thus, clarity and distinction of images and visual elements adopted in the accounting are not the purposes themselves. On the other hand, they require an active action of the actors they were able to attract in order to be applied (translated) in the specific context. The active action consists in using the visual graphs as schemes, in abiding to guides to re-present the particular context and/or organization and make sense of it.

From the above arguments, we should rely on inscribing as a means of creating and circulating organizational knowledge and knowledge of organizations. They are central to the expertise and practitioners management. Systems of inscribing produce

artefacts which can contain knowledge about organizations and practice in a form that it can be transported to different locations and thereby rendered available to the organization. Then, the materiality of text objects, particularly electronic text, makes circulation and distribution of information about work relatively easy, and this distribution also makes phenomena visible across an organization.

3.2. Accounting inscriptions and "net-power" relations

The second relevant feature to reflect on is the *performative* and practiced nature of accounting inscriptions and their "agency power".

As the concept of agency is central to inscriptions, and agency is inextricably linked to power (Giddens, 1984), it is useful to examine some aspects of power. Giddens (1984: 139) defines agency as the "capability to make the difference, that is, to exercise some sort of power". In other words, agency is synonymous to the carrying (or intentionally not carrying) out of an action[6].

In 1986, Callon called "*the sociology of translation*" a new approach to the study of power (Callon, 1986: 196). The "*translation model*", as Latour calls it, sees power as something contextual, which is obtained as heterogeneous associations of people and devices are mobilized during a change process that will fulfil everyone' s plan (Latour, 1986: 264). Latour (1986) urges to extend the notion of agency beyond human activity, because other things impinging on the human world act, and act to assist in the shaping of that world. They solidify networks in which stabilise and constitute power relations.

Thus, we seek to examine the "how" rather than the "why" power of inscriptions. Indeed, in the former accounting studies which use the ANT framework, it

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[6] Nonetheless, in Giddens' Structuration Theory (1984), agency is synonymous with human actors who are engaged in shaping and being shaped by the structure of social systems; in the context of this study, we recognize the interplay between the respective human and non human actions. This means that in ANT, equal weight is given to human and non-human agents.

appears a lack of engagement with the "how" of power mobilization into the network, especially in relation to the concept of inscription.

Nevertheless, the matter of power and inscriptions agency is more complex than this. In order to really appreciate inscriptions as agencies, two main questions need to be examined. The first question is related to the nature of inscriptions as a black box. The second concerns the way in which they establish net power-relations.

On one hand, inscriptions could be assimilated to black boxing (Bonner et al., 2005), on the other, black boxing is associated with domination and power (Latour, 1991; Lowe 2001; Lowe, 2000; Chua, 1995; Lawrence et al., 1994; Preston et al., 1992). Black boxing is "…*a process that makes the joint production of actors and artefacts entirely opaque*" (Latour, 1994: 36). It is this opacity that prevents resistance. As such, "black boxed" accounting inscriptions, exerting domination and power (Latour, 1991), enrol and convince actors to be a part of the network. Then, we can assimilate accounting and management accounting devices (chart of accounts, budgets, reports, etc.) to black boxes, since they exert power over local actors. The more intertwined and opaque the black boxes are, the stronger their power. Opaque means that accounting devices are so technically advanced that their users (organisational actors) have only the possibility of following predetermined procedures. This point requests some clarifications about inscriptions power and opacity. If this black boxing process is opaque, then, the visual clarity of accounting inscriptions implies that the representation provided will be imperfect. Indeed, it is the result of a process of simplification and, during said process, details are likely to be lost. As a consequence, a gap, a hole exists and needs to be filled. That gap is what allows accounting inscription to travel, to appeal actors but, at the same time, it is what activates processes of visualization and imagination. Actors interrogate and question that empty space. In

trying to make sense of that emptiness, new knowledge is likely to be created since the association between the image and the referent can be different.

The emptiness left by accounting inscriptions is essential because its fulfilment triggers users' actions and make accounting inscriptions acts of engagement rather than mere signs or boundary objects. The existence of the gaps implies the necessity of accounting to be enacted and engaged with in order to acquire a meaning. Without engagement, accounting inscriptions do not have meaning (Quattrone, 2009). This explains why the visual images, the analytical method and the mediation are crucial elements in the emergence and diffusion of accounting and management accounting practices. This is what happened in the case of control of NPD projects during the meetings that the Program Manager organized each month with all NPD managers. The table around which all participants were siting down, the monitor and of course all the technical and financial reports shown, are typical examples of material objects which exert an influence over human actions. They allow NPD Managers to stay in the same room and debate, discuss and finally achieve network convergence. The evidence from the case study shed light on how accounting and control tools, as well as technical data shown in the monitor are inscriptions which act and influence NPD projects management. In this case, accounting inscriptions are not only a device for recording the activities and making them visible to others but they are also a crucial component of their practical actions facilitating their work and execution of the tasks. Consequently, accounting inscriptions appear as a working space. In this contribution, accounting devices represent the starting point of a discussion and a process of negotiation.

As discussed earlier, the space left by accounting inscriptions to the actions became the ground on which different opinions, points of views were confronted and discussed. The ability of accounting inscriptions to intertwine with other actants and

actors and the possibility to be modified, decomposed and recombined let actors literally work on them. Moreover, because accounting inscriptions can mean different things to different audiences and their interpretations are not pre-determined, they have limited usefulness in the absence of actors and powerful allies support. Therefore, actors are necessary in order to impose, transfer the meaning and convince others in case of a discussion. As a consequence, inscriptions are effective depending on the ability of engaging actors and their effects are contingent on how they are actually interpreted, received and used by actors. This was the main evidence emerging in the case study about the role of MCS in NPD projects: inscriptions travel and ally to human actors, since a managerial background allows them to be legitimised by managers. Consequently, inscriptions as agencies need themselves to be understood as net-power relations. Consistent with ANT principles, Czarniawska introduced the concept of the "action net" (Czarniawska, 1997, 2004). Governance structures, organizations, control structures, or, in general terms, actors, are considered the products rather than the source of organising. In line with this assumption, an actor is what is made by many others in order to act. Cost calculation systems and budget systems, for example, are not the source of an action, but the "moving target of a vast array of entities swarming toward it" (Latour, 2005: 46).

Actor-networks give actors a capacity to act, which is in turn dependent on the actor's relations to other actors (Law, 1999). Actor-networks provide actors with their identity. Thus, the concept of "agency" is not associated with characteristics of individual actors per se, but with the amount of connections that exist in and between actor-networks made by human and non-human actors (Vosselman, 2012). This assumption is necessary to clarify the role of inscriptions as actors, or actants, in relation to humans and the ontology of the network constituted by them. As we reported

in the previous section, an actor, in the semiotic sense, is something that acts or to which activity is granted by others. Actor is accepted to be the source of an action, regardless of its status as a human or non-human. Differences in agency and size between actors are the result or outcome of some process of negotiation involving power relations (Callon and Latour, 1981). All are relational achievements, which are uncertain effects generated by an actor–network and its type of interaction. Such actors are made up as objects only to the extent that the actor–network stays in place (Law, 1992).

The relative durability of actor–networks is an effect of their heterogeneity. Actor–networks come in a range of material forms, such as people, texts, machines and architectures. They are made relatively cohesive and stable by the way they are intimately bound up with the material and the technical (Latour, 1991; Joerges and Czarniawska, 1998). The ordering of the social is never purely social, but rather socio-technical (Law, 1991; Knights and Murray, 1994). The consequence is that, as society and technology cannot be conceptualized as ontologically separate entities (Latour, 1994), accounting and management accounting phenomena should be analysed bypassing the distinctions between their "technical" and "social" factors (Latour 1987; Callon and Latour 1992; Law 1992; Ahrens and Chapman, 2004; Chua and Mahama, 2007). Therefore the relevance, power and usefulness of accounting inscriptions do not rely on a trustworthy representation of the world, on the ability of rendering activities and entities visible or on transferring information. Rather, they are significant because they act as a force that, by engaging and mobilising actors and actants, create a network that allows the emergence and implementation of knowledge, actions, decisions and objects. For example, Ahrens (2008) claims that activity-based costing (ABC) can be understood as an organizational and a global practice which influences and is shaped by

managers, accountants, academics and international consultants with diverse and ever-changing objectives (Briers and Chua, 2001). Then, those objectives may or may not be brought into the network through which ABC systems and practices can become reality.

As reported in the case of control in NPD projects, control systems are able to foster NPD project-network convergence as a balancing process, (or, in ANT terms, as a translation process) between two opposite logics: creativity and flexibility on one hand, discipline and need for rules and control, on the other. As emerged from the case, this is possible thanks to the interactions among SAP, management accounting practices and other control technologies (e.g., reports, budget systems, software, etc.) which allow actors to render entities visible and, above all, to make sense of the information provided. This ability to provide information and to gain knowledge within the network makes inscriptions powerful. During these socio-technical interactions, different agencies negotiate, mediate their interests and, above all, alter, change, modify the meaning of the sign they mobilize. This emerges in the case of control over NPD projects where different points of view about managing NPD processes were been synthesized in a clear *Obligatory Passage Point* (Callon, 1986), which takes into account the calls for creativity and flexibility advanced by the Concept Manager and the respect for technical ad financial targets as required by the Divisional Financial Manager.

The process of negotiation underpinning NPD network convergence, thus ended up with the transformation and development of a new knowledge that takes into account the diverse interests of actors and allows them to interact (Carlile, 2004). This occurred thanks to the presence of inscriptions. They affect human actions and allow the integration of multiple organisational participants' opinions (the different NPD actors) into a pattern of heedful knowledge (e.g., prototypes technical specifications, delivery

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dates, costs and other financial information, etc) which is helpful in managing NPD projects.

In accordance with Busco and Quattrone (2010: 3), we can refer to these signs as "visual inscriptions (see Latour, 1991, 2005) which utilize rhetorical methods to facilitate a continuous work of knowledge ordering and innovation, communication and translation, and organizing". Moreover, since negotiation and transformation are likely to be political processes in which different sources of power and authority will struggle among each other, the sign will inscribe and represent not only knowledge but also social and power relations. Consequently, as Mouritsen and Thrane (2006) pointed out, management controls add to the network and provide it with power.

These arguments are consistent with Foucault's concepts of power/knowledge and the enacting of power through technical arrangements of social organizations. Specifically, Foucault uses this term: "(…) Power is everywhere; not because it embraces everything, but because it comes from everywhere. And 'Power' insofar, as it is permanent, repetitious, inert and self-reproducing, is simply the over-all effect that emerges from all these mobilities, the concatenation that rests on each of them and seeks in turn to arrest their movement." (Foucault 1976: 93). Therefore, entities made of human and also material, are constituted thanks to relationships and interactions with each other (Law, 1994, 1999; Nicolini et al., 2003) within a net-power. Technologies construct and are constructed by regimes of truth or discourses.

As such, the empirical data gathered in the case study concerning the role of MCS in NPD portfolio, confirmed that the hierarchical relationships and the power balance between corporate and business control system emerge as an exercise of power balancing and action at a distance. The ability of corporate control system to foster NPD portfolio management was allowed by managerial software representations, cost reports

and other control information. However, the tension between calls for centralization and decentralization was managed through a dialectic interactions between corporate and business level. This involved both human as well as management accounting and control inscriptions. In this sense, control inscriptions were displayed and modified in accordance with certain calls for control, e.g., centralized vs. decentralized control. Hence, there is a co-constructive relation between power and knowledge and the actor-networks that sustain them. Discursive practices define legitimate perspectives and legitimate knowledge and establish a regime of truth, which mean that it is only "possible" to think of things in a particular way (Foucault 1974, 1979). ANT places the "material" much more centrally in any research setting analysis. Then, power is enacted in the social and technical arrangements of a particular culture, society or institution (Latour, 1990; Law, 1994). Therefore, for a deeper appreciation of how power is diffused and enacted by inscriptions in the network, one needs to open up black boxes, i.e., accounting and management accounting systems, which are simplifications we take for granted. One needs to explore how socio-technical relations are ordered so as to "generate effects like organizations, inequality and power" (Law, 1992: 381). To this end, Latour (1991, 2005) uses the term "quasi-objects" to indicate that even material objects draw their status as objects and their material power from a set of social and technical arrangements.

The nature of objects is not a "given". It is the effect of a process or ordering which is not stable. Finally, Law argues that the powerful are those who can "freeze" a network in order to stabilise the status of objects and knowledge, e.g., a form is an attempt to freeze a network (Law, 1994). Thus, the ability of inscription to enrol practitioners in systems of action, i.e., to prescribe the processes and content of practice, means that it can be used to standardise practice in organizations. Inscription is used in

organizations to create standardised institutional processes that define and stabilise an organization, its routines and actions (Czarniawska and Joerges, 1998; Foray and Steinmueller, 2003).

The power of inscription, as an organising principle, relies upon its authority as a form of representation. Inscription has a cultural authority (Goody 1986; Latour, 1987). Inscriptions command different degrees of respect, trust and authority according to the authority of the discourses they represent and enact. Briefly, inscriptions "stand for" and "speak for" other things. Consequently, reporting procedures are an expression of authority within an organization. Reports, budgets and other accounting tools are inscribing devices which provide material with the status of objectivity (Townley, 2001, 2002; Doyle, 2009). In this sense, inscriptions are enrolled in discourses of objectivity. They become neutral, bureaucratic tools, which have the effect of representing their authority as a given one, as an expression of some inevitable and uncontested aspect of the organization (Townley, 2001, 2002).

The rhetorical power of inscriptions (Busco and Quattrone, 2010) is drawn from their ability to produce objectivity, by reordering the world in line with their representation of the world (Rose, 1999). Inscriptions become the accepted medium of action, and therefore acquire agency. "*Something actually becomes an object only in the context of action and use; it then becomes also something that has the force to mediate action*" (Bowker and Star, 1999: 298). The above discussion shows the way in which accounting and management accounting entities are displayed by the inscriptions themselves since, as acts of engagement, they do not only empower actions and practical procedures, but they also affect them (Quattrone, 2009). Inscriptions actively contribute to processes of knowledge fabrication and control by attracting the interests of actors, mobilizing them in a process of translation and experimentation and, also,

defining the place in which the processes take place. Furthermore, by engaging actors in these activities, accounting inscriptions become material (Quattrone, 2009; Doganova and Eyquem-Renault, 2009). It is this materiality that makes circulation of accounting across societies possible. Then, accounting systems become objects and acquire "homogeneity" not because they constrain but because they have the power to attract diversity. Consistent with their semiotic nature, we should consider accounting and management accounting systems as relational entities, "heteromogeneous" objects (Quattrone and Hopper, 2006), which attract what is different from themselves. This materiality is the result of their "heteromogenous" nature, which allows accounting inscriptions to appear homogenous and appeal actors and, at the same time, to be powerfully incomplete and malleable agencies which suit the diversity they attract (Quattrone and Hopper, 2006)

Furthermore, we should rely on inscription as something which is intrinsically other than itself not because it can be interpreted differently, but for what it is able to do, for its agency power and for the ability to be part of a network (Quattrone, 2005).

In the field of accounting, the challenge is to reconsider the ANT concept of inscription as net-power according to its genuine semiotic nature. In this sense, it is possible to open up the accounting "black box". These relational black boxes are "established facts" taken for granted, whose controversies have been shelved and accepted as true. The intention is to re-open up the "black boxes " which keep accounting systems outside the realm of everyday discussion and maintain them in the realm of the taken for granted.

4.   Conclusion

This paper has sought to highlight some relevant ontological and semiotic matters concerning ANT conceptualization in accounting and management accounting research, specifically related to inscriptions as diffused agencies or "actions" and "net-power" devices.

While a growing number of contributions in the accounting literature have embraced ANT conceptual framework, this study has attempted to avoid some limits that characterize previous research. Particularly, we tried to cover the lack of attention paid to the ways in which semiotic aspects of inscriptions and their ability to act are useful to explain how accounting reality is constructed (Baxter and Chua, 2003; Alcouffe et. al, 2004).

This research proposes a proud conceptualisation of accounting and management accounting of inscriptions which have a constitutive power in organizations and really "act" rather than "describe " and "document " organization practice and phenomena. It is suggested that different actors have to be enrolled into the network and accounting systems result in an authentic convergence when sense making between those actors is brought into alignment.

The first contribution is the explanation about the semiotic nature of inscriptions. We have sought to show accounting inscriptions as an effect of the relations with other human and non-human entities. In this sense, this paper contributes to ANT accounting literature as it concentrates on the semiotic *relationality*, *heterogeneity* and *materiality* affecting inscriptions. According to ANT semiotic traits, we rely on accounting and management accounting documentations as a materialization of something intangible. This means that accounting systems act by inscriptions in absence of the objects they refer to. Then, accounting systems emerge as diffused across a network of relationships

involving humans, inscriptions and practices which increase the visibility of the organization and, at the same time, materialize something that before was "absent" or intangible.

The second contribution highlights the ability of accounting systems to influence organization management by drawing attention to the importance of inscriptions in power relations. We shed lights on the "contextuality" of power and the role of non-human elements in building and maintaining power relations within the network. In particular, this paper points out the links between the use of the black box concept and the power of accounting inscriptions on organizational members' behaviour (Lowe, 2001; Lowe, 2000; Chua, 1995; Lawrence et al., 1994; Preston et al., 1992). According to ANT, we show as power is contextual and associated with the notions of control and order. Accounting devices, seen as inscriptions, become more powerful since they are legitimised in organizational settings featured by managerial languages and background. Accounting and control practices, thus, emerge since inscriptions are combined together with organizational members. Particularly, accounting tools, such as report or budget exploit power in transferring information and prompting organizational practices, since they are recognised as "key actors" by managers.

The paper, emphasising semiotic and power traits of inscriptions, contributes to an increased understanding of how organizations' "life" is influenced by accounting and management accounting systems. Then, we advance a more powerful implementation of ANT lenses in studying accounting phenomena. On applying ANT lenses, we call for a re-consideration of accounting inscriptions, not for what they are, but for what they are able to do. In this sense, we suggest a conceptualization of accounting inscriptions as agencies which prompt knowledge creation and integration and thus influence decision-making processes (Carlie, 2002; Quattrone and Hopper, 2010).

Briefly, the achievement of accounting systems goals can be attributed to the nature, straightness and stability of alliances between the different actor-networks. This reflects the translation of accounting and management accounting phenomena through "power-inscriptions" as one of the most important way in which accounting is enacted as a practice and constructed as a phenomenon.

At last, consistent with Latour's ideas, explaining accounting phenomena is not just a matter of fact but a matter of concern (Latour, 2004: 231). This means explaining accounting "facts" not simply getting away from them but rather getting closer to them.

As in any investigation, this study has certain limitations that may nonetheless open avenues for future investigations. The main limitation of this research is related to the choice of the analytical focus. Since it is rooted in the thorough scrutiny of a single, though relevant, component of ANT theorization, the initial limitation of this paper concerns the necessity of extending the investigation to a comprehensive number of ANT concepts: such as the network itself and the translation process, to elaborate a solid base by which we could generate a more exhaustive understanding of the arguments mobilised in this paper. We investigated just one of the main concepts of the ANT framework: the inscriptions. We tried to highlight the nature of inscriptions by focusing on the ontological traits which are seen as the epistemological basis for macro-level investigations. Accordingly, this study is the initial step in the intriguing ANT accounting research field. Further research could extend the arguments of semiotics and power to the main dynamic concept of ANT: the translation process.

Although there is a growing debate on ANT, the nature of inscriptions and the notion of "heterogenous" objects still remain an unsolved issue. Further research in this area could emphasize inscriptions symbolic and semiotic power. This is fruitful to

theorize inscriptions as active objects which prompt actions and render accounting

systems and practice present within organizations (Quattrone and Hopper, 2006).

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CHAPTER V

CONCLUSIONS

1.   Summary of the main findings

Innovation processes and NPD projects in particular, are critical key sources in creating and maintaining competitive advantage. Thereby, further progress in understanding how Management Control Systems (MCS) may support New Product Development (NPD) initiatives requires sustained investigations in the way control systems affect innovative settings.

While management control research has focused on innovation activities (Davila, 2000; Ditillo,2004; Bisbe and Otley, 2004; Davila,Foster, and Li, 2009; Adler and Chen, 2011), the role of MCS in NPD projects remains unclear and ambiguous. However, the mechanism and control tools used and their applicability may differ, depending on the different organisational levels, e.g., business level and corporate level. Besides much of management accounting literature concerning the use of MCS in product innovation settings, merely focused on the human dimensions of such processes.

In order to fill this gap, we call for going further a "human centred" approach where organisational practices are viewed as the outcome of human and social interaction. Thereby we rely that accounting and control practices enact and are enacted by the interaction of human and non human actors. We have seen an open opportunity to dig deeper into the investigation of the role of control in NPD projects, by employing

Actor Network Theory (ANT) (Law and Hassard, 1999; Callon, 1986; Latour, 1987, 1999, 2005) and to conduct a field study which allowed us to follow interactions among human and non human actants.

In offering a contribution to this academic debate, this dissertation has a specific objective: to explore the socio-technical foundations underlying the way in which MCS affect NPD projects at business level and NPD portfolio management at corporate level.

Chapter I has presented an overall introduction of the dissertation. It has established the aim of the thesis and the relevance of the research problem. Then, it has explained the structure of the essay dissertation. It has introduced the ANT main concepts to mobilise for the investigation. Finally ontological, epistemological and methodological issues have been examined.

Unravelling the socio-technical traits of the influence of MCS on NPD projects, chapter II posited that MCS foster NPD network convergence. To this end, we have drawn on ANT framework to conceptualise NPD project success as the result of a process of network convergence. During this dynamic translation process, the NPD network faces "swing" between two opposite logics: creativity and flexibility, on one hand, and discipline need for rules and control, on the other. Field evidence carried out at a division of a multinational company operated in the semiconductor industry and offered new theoretical insights on how MCS become the focal actant and how they allow NPD network convergence. The exploration of the translation processes underpinning NPD actor-networks convergence highlighted how the role of control in foster innovation activities is embedded in a complex, dynamic, fragile and interconnected number of heterogeneous agencies (human and non human).

Furthermore, our discussions suggest a central role of materiality according to the aptitude of control inscriptions, e.g. reports, budget, software, etc. to enact the visibility of the entire NPD process. According to the ANT theoretical lens, the main conclusion is that management accounting and control inscriptions do not exclusively act according to a productive logic of achieving efficiency and profitability. They do not simply represent the loss and profit "reality". Inscriptions really act and play an influential role in innovation settings: they may provide the adequate discipline and flexibility to the NPD processes. In addition to a theoretical contribution, this study provides new insights for practical business management, since it highlighted the need for an adequate adaptation of tools and control processes in innovative settings

Chapter III has tried to offer a deeper investigation of the role of corporate control systems in NPD projects executed around different company' business units. To this end, rather than looking only for a human interest to explain how accounting and control systems affect organizations activities, such as NPD portfolio management, we tried to shed light on the ties between people and technology. We explored the social and technical traits underpinning innovation activities and control systems. To this end, we have conducted a field study which allowed us to follow interactions among human and non human agencies. Drawing on ANT framework we highlighted how the combination of the action of the corporate control system and the interest emerging in NPD projects at business level creates a networks of actors who allow the NPD portfolio management.

The field evidence carried out at a division of a multinational company operating in the semiconductor industry offered specific insights into the phenomenon under

investigation and allowed us to redefine and integrate the theoretical framework proposed.

Three main control issues emerged from the case study: the conflicts in resource allocations, the interactions between various NDP projects managed at business level and the tension between centralised control exerted at corporate level and decentralized control exerted at business level. Consequently, we have shown how corporate control system create a centre of calculation (the corporate level) but, at the same time, they allow local discretion (Munro, 1999; Quattrone and Hopper, 2001, 2005) over the various business units. Our empirical observations emphasized the ability of corporate control and accounting in promoting various goals and interests from various actor-network and then to mobilize them around a well defined objective: the NPD portfolio network align to the company strategic plans.

This work offers a twofold contribution to the existing literature on the phenomena. First, we emphasised how control exercise over NPD portfolio is a matter of socio-technical interactions. Furthermore, our discussions suggested a central role of control inscriptions to mediate the conflicts in resource allocations and in fostering the interactions between projects. As we highlighted in the case study, this is allowed by accounting and control inscriptions which exert power and provide the adequate NPD portfolio management.

Chapter IV has sought to develop a theoretical speculation about some relevant ontological and semiotic matters concerning ANT conceptualization in accounting and management accounting research. The ontology of inscriptions as signs and their attitude to prompt "net-power" relations have been explored. Particularly, we have tried to cover the lack of attention paid to the ways in which semiotic aspects of inscriptions

and their ability to act are useful to explain how accounting reality is constructed (Baxter and Chua, 2003; Alcouffe et. al, 2008).

To this end, relying on a Grounded Theory (Strauss and Corbin, 1998) approach we have moved from some theoretical fruitful evidence collected in the two previous chapters to shed some light on ANT semiotic and power issues. In particular, we developed a theoretical exploration of the socio-technical aspects of control in NPD projects to provide insights into a deeper appreciation of inscriptions, semiotic and power issues.

The contributions of this chapter to to ANT accounting literature are twofold. First, by theorising accounting inscriptions as an effect of relations with other human and non human entities, we have concentrated on the semiotic attitude of inscriptions to increase the visibility of organizational practices and, at the same time, materialize something that before was "absent" or intangible. Second, our investigation about the ability of accounting systems to influence management and accounting practices, has highlighted the attitude of inscriptions to prompt power relations with other human or non human agencies. Consequently, we have shed light on the "contextuality" of power and the role of actants in building and maintaining power relations within the network. In particular, we have pointed out how accounting and control inscriptions become more powerful since they are combined together and how they enable control and order.

2. Further lines of inquiry

This essay dissertation made up of four chapters is able to offer a systematic examination of the way in which control systems foster NPD initiatives since it tries to explore its main socio-technical foundations.

Moving from ANT framework, this study has explored the role of control in NPD projects and both at business and corporate level, it emerges as a multifaceted socio-technical phenomenon which needs for further investigations. We hope that this dissertation may stimulate research on this topic in order to provide new insights for academics and applicable knowledge for practitioners. To this purpose the dissertation opens new and fruitful lines of research.

Firstly, since we identified the main socio-technical traits underpinning the mobilisation of MCS in NPD contexts, it is worthy to shift the focus of research to other levels of inquiry, such as the inter-organisational setting. Particularly, ANT is a powerful theoretical approach to explore the interactions technical issues related to the social needs that arise in such contexts, i.e. contracts, technical specification, as well as standards and criteria for quality management systems.

Secondly, since the ANT key concepts we mobilised in this dissertation are objects of controversial academic debates, we favour the relevance of a deeper exploration of the ontological and epistemological traits of inscriptions and actor-networks.

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