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Managing innovation based on studies on science, technology, and society: toward a constructivist and critical perspective of innovation management

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Abstract

This study elaborates a theoretical reflection and discussion about the comprehension and research of innovation management. The discussion builds on innovation management literature according to Dodgson, Gann, and Phillips (2013). The article analyzes the impact of literature on innovation management epistemology, and of understanding the world using the lenses provided by constructivist and critical studies on science, technology, and society. The analysis shows the possibility of opening new directions for innovation management, and the result shows the need to use performativity and reflexively to better understand the phenomenon. Such operation involves the necessary connection between capital and work for a thorough understanding of innovation management.

Keywords: Innovation management. Critical analysis. Performativity. Reflexivity.

Gerenciando a inovação a partir das lentes da ciência, tecnologia e estudos da sociedade: a partir de uma perspectiva construtivista e crítica do gerenciamento da inovação

Resumo

O presente trabalho elabora uma discussão teórica e reflexão sobre a maneira pela qual a gestão da inovação pode ser compreendida e pesquisada. Esta discussão baseia-se no conceito de gestão da inovação definido por Dodgson, Gann e Phillips (2013). O texto analisa, em particular, o impacto da epistemologia e da compreensão do mundo apresentados na literatura de gestão da inovação, usando lentes que dão um estudo construtivista-Science, tecnologia e sociedade e crítica dele. A análise mostra a possibilidade de abrir novos rumos para a gestão da inovação. Como resultado, mostra a necessidade de compreender, de forma performativa, reflexivamente o fenômeno da gestão da inovação, uma operação que envolve o agrupamento necessário entre capital e trabalho para uma compreensão completa do gerenciamento da inovação.

Palavras-chave: Gestão da inovação. Análise crítica. Performatividade. Reflexividade.

Gestionando la innovación desde la óptica de los estudios de ciencia, tecnología y sociedad: por una perspectiva constructivista y crítica de la gestión de la innovación

Resumen

El presente trabajo elabora una discusión y reflexión teórica sobre la manera en que la gestión de la innovación puede comprenderse e investigarse. Esta discusión se realiza sobre la base del concepto de gestión de la innovación que han definido Dodgson, Gann y Phillips (2013). El texto analiza, en particular, el impacto de la epistemología y comprensión del mundo que se presentan en la literatura de la gestión de la innovación, utilizando para ello la óptica de un estudio constructivista –Ciencia, Tecnología y Sociedad– y crítico de la misma. El análisis muestra la posibilidad abrir nuevos rumbos para la gestión de la innovación. Como resultado, se muestra la necesidad de comprender performativamente, reflexivamente el fenómeno de la gestión de la innovación, operación que conlleva la necesaria agrupación entre el capital y el trabajo para una comprensión cabal de la gestión de la innovación.

Palabras clave: Gestión de la innovación. Análisis crítico. Performatividad. Reflexividad.

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FROM THE POSITIVITY OF INNOVATION MANAGEMENT TO THE CONSTRUCTIVISM OF SCIENCE, TECHNOLOGY AND SOCIETY STUDIES

Innovation management is doing well. The Academy of Management has a division called Technology and Innovation Management, which consists of over 3000 members (DODGSON, 2017). Additionally, and from a close but different epistemic community, Fagerberg, Mowery and Nelson (2006) argue persuasively that innovation studies have always been transdisciplinary. They call for a closer study of innovation that follow the intricate paths on which this phenomenon emerges. The present text recognizes the need for this transdiscipline and the importance that such transdiscipline may imply for the epistemic community that studies the phenomenon of innovation management (DODGSON, GANN and PHILLIPS, 2013).

Innovation management is understood as a study focused on the way the managing of novelty is done, so that companies can survive, but also achieve the objectives they have established. As Dodgson, Gann and Phillips (2013, p. 12) mention, the analytical lenses that have given a clearer understanding about innovation management:

> […] are dynamic, responding to contextual change and disruption, and involve the search for and creation of variety and options; selection from within that variety from which to deliver and capture value; and propagation of successful choices creating resources and learning with which to re-invest into the cycle. Each involves learning as a core process and outcome: at the level of the economy, in the capabilities and routines that organizations possess, and in improving the management of innovation.

Accordingly, the theoretical analysis presented in this text focuses on the way the understanding of how companies meet their proposed objectives with resources from innovation management has been sought, i. e., on the technological as well as strategic management components of the emergence of novelties within organizations.

However, the literature on innovation management has been done based on the distinctive classification of assets –both technological and complementary- that are established as central to the development of the same. This classification, first presented in the work of Teece (1986, 2006), has remained over time in the conceptual framework of dynamic capabilities and innovation in business models. Works like the one by Osterwalder, Pigneur and Tucci (2005) for the case of innovation in business models, Tether (2014) for the case of innovation in services, and even the well-known work by Hippel (2005) about the democratization of user-led innovation and their communities, keep the aforementioned classification which divides technological from complementary assets. As argued in this text, this classification has been built upon a positivist epistemology of the innovation phenomenon.

The positivist view in which the subject is separated from the object, both in the study of the phenomenon and the relationship that exists among the technical components – objects – and the complementary components – subjects and knowledge – has failed in a complex world where the technical and social aspects go together. This is why an alternative will be sought in a view created from Science, Technology and Society Studies (STS). It is expected that STS allow to do a constructivist analysis of innovation management, where the technical and social aspects are not separated from the analysis of the phenomenon (LATOUR, 2005). Such "non-dual" analysis offers new possibilities for innovation management. Considering innovation management in this way, the path for a critical theoretical option is opened. This allows to analyze the inseparability of work and capital, which is regarded as central to the phenomenon of innovation management.

There is a history of the analysis of innovation from constructivist perspectives based on STS. In fact, certain literature (CHRISTIANSEN and VARNES, 2007; AKRICH, CALLON and LATOUR, 2002) has understood innovation projects, and in particular innovation technology, as a myriad of micro actions, negotiations, and decisions that are developed in practice and that are directly connected with the macro aspects of the phenomenon of innovation. According to these authors, the phenomenon of innovation may be observed, for instance, when start-up companies managers and workers organize the heterogeneous network of entities involved in a given technological innovation project. This analysis has studied the phenomenon of technological innovation with a constructivist epistemological approach. It is precisely from this constructivist analysis that it is possible to better understand the current trends in innovation technology, such as design thinking, which from an interpretative epistemology, presents some problems when converging with strategic management and innovation studies.

In order to make a theoretical contribution to innovation management of a critical and constructivist nature, the paper will proceed in three parts. The first section shows how innovation studies meet strategic management studies since the 1980s

onward, to conclude by showing the emergence of the approximation that came to be called 'innovation management'. The paper then goes on to analyze the turn given by Science, Technology and Society Studies (STS) to the understanding of the phenomenon known as innovation, and particularly, of its management. This is followed by the development of a concept of innovation management based on STS, which will provide the constructivist support for a rather more critical view, where the "process", materialistically understood, allows to develop a deeper deconstruction of the very foundations of innovation management. Lastly, and following the fundamental problem of the inseparability of work and capital in terms of process, the first rudiments of a critical constructivist approximation of innovation management are shown.

INNOVATION MANAGEMENT

The literature on innovation management presents studies that show how companies survive and thrive in uncertain and turbulent environments (DODGSON, 2017). As Dodgson, Gann and Phillips mention (2013), innovation is essential for the survival of organizations. This is why it must be managed. The study of innovation management has been related to the question that links management and strategy with innovation. Even though the concept is relatively new, there are some important studies that have contributed to the building of a body of literature on innovation management. For example, in analyzing organizational behaviour, March (1991) has stated that companies are always managing a counterbalance between exploitation and exploration, where the optimum between the new and the existent is pursued. With this, companies aim not to miss in the election of the technology that support the current technological development or be disruptive. The problem of disruption versus technology sustenance is the one called 'the innovator's dilemma' (CHRISTENSEN, 1997). Without a doubt, the management of the dilemmas that exist when deciding on the development of similar or disruptive technologies, while new paths are exploited and explored, begs the question concerning the achievement of companies' competitive goals. Innovation management literature fills precisely the gap that existed between the question regarding how to manage technology and how this management is related to strategic management, i. e., of the survival and the achievement of the goals set by companies.

What innovation studies seek is to rethink the question about competitive strategy (PORTER, 1980). In fact, six years after Michael Porter inquired about the problem of competitive advantages, Teece published his well-known article "Profiting from Technological Innovation" (1986) – PFI. This article reaches the top 15 most cited papers within innovation studies in terms of its impact (FAGERBERG, FOSAAS and SAPPRASERT, 2012). But the real impact of Teece's ideas relies on the fact that he was the first to combine a view of the management of the technological aspects of innovation with those aspects associated to its business strategy, according to what the famous business researcher Gary Pisano (2006) has commented. The ideas of Teece have had a long-term impact on the literature of innovation management. A concept that derives genealogically from the original work by Teece is "dynamic capabilities". In fact, DODGSON (2017, p. 37) mentions that "The value of the dynamic capabilities framework lies in its attempt to integrate a range of insights that enfold the complexities of technology-based competitiveness, and it thus stands in stark contrast to the majority of strategic management approaches that fail to do so". With this, Dodgson suggests that the dynamic capabilities approach developed in the text by Teece, Pisano and Shuen (1997) strongly contrast with most of the approaches to strategic management which overlook the complexities provided by technology and its management in the difficult task of surviving and achieving the strategic goals of companies.

From Teece's original work, innovation management will look for "victory" in a game that is played considering three factors: First, the firm's complementary assets structure; second, the external contracts with suppliers of other complementary assets; and finally, the market entry management. It is worth noting that complementary assets comprise all those specialized assets that refer to services, such as marketing, specialized production, and post-sales support. These complementary assets are strongly linked to the management capabilities and the strategies followed by the firm. Complementary assets are also different from "technical" assets, which correspond to assets to which technical knowledge is applied, i. e., the kind of knowledge used in the particular innovation developed by the company. Taking into account complementary and technical assets, Teece makes a distinction that will be central to the basic analysis of innovation management. This is why, it is suggested that the literature on innovation management has built a model in which "technology" is understood as a separated element from complementary assets, which are the same as the ones called "capacities" in subsequent studies, as we will see later in this section. This point seems to be crucial for the analysis of innovation management. The complementary assets will be classified as "competitive manufacturing", "distribution", "service", "complementary technologies", and many more labelled as "others". As an example, the software can be classified as an instance of complementary technology.

The classification of assets has remained over the years, and has directly affected innovation studies. In fact, Salter and Alexy (2013, p. 20) have stated that "One idea that has begun to penetrate the protective belt of innovation studies is that managers and researchers should not give primacy to technological innovation over other types of innovation. It is clear that many innovations are not primarily 'technological' in nature. For instance, most service innovations are largely organizational, involving new ways of bringing together information and creative routines" In the text, the authors pose that along with the expansion of the literature on innovation in the last 20 years, several authors in the field of management have penetrated the "belt of innovation studies". These authors have gone beyond research and development analysis, at the level of the state and the firms, toward aspects related to the very nature of innovation and the way innovation relates to its management and the complex reality faced by companies.

Innovation management will seek to understand why some firms doing innovation fail to get returns from such process. This is the question addressed by Teece's seminal work. The question remains unchanged: Why does a quick entrant or even a slower third entrant get better results than a technological innovator? It is strategic innovation management which seems to be fundamental in the generation of economic profit for the firms. The exemplary case of a "winner" is the one of Apple Inc. Even though said company did not develop the touch-screen technology -nor the mouse, for those readers interested in the history of computer technology-, this did not stop the possibility for Apple at all to gain a substantial market share that generated after the change in the industry of electronic devices. Apple was a better follower than the ones who developed and introduced the technological innovation. This problem will remain the nerve center of the literature on innovation management.

Together with Teece, Pisano and Shuen (1997) and Teece (2007, 2010, 2017) develop the concept of dynamic capabilities. This concept is formulated from resource-based theory, essential literature for those approximations that explain strategy in companies' competitive contexts. The concept of dynamic capabilities will be regarded as a fundamental pillar in order to conceptualize modern innovation management (DODGSON, GANN and PHILLIPS, 2013). Interestingly, the authors build the concept of dynamic capabilities using the fact that "winners in the global market have been firms that prove timely response and fast and flexible product innovation, as well as the ability to effectively coordinate their redeployment of internal and external competences" (TEECE, PISANO and SHUEN, 1997, p. 515). After commenting on that, the authors build their prescriptive approximation on the ability that firms have to build the aforementioned redeployment over a sustained period of time. In this way, authors explain how "competitive advantages" of a firm can be generated. As a consequence, it is again the classification of complementary, technical, and other assets which will allow an adequate management that lead to the achievement of competitive advantages. In fact, the authors establish that those who observe the industry have emphasized that companies can accumulate a great amount of technological assets, but they have not yet developed useful (and dynamic) capabilities to build competitive advantages.

As Dodgson (2017) comments in his book on the state of the art of innovation research, the concept of dynamic capabilities is certainly written for firms that face rapid technological changes, and yet are able to create and capture value despite their environment. It is the complementary assets and the defined routines and abilities which provide the firm with dynamic capabilities to support its competitive advantage. These capabilities need to be rebuilt in a systematic way over time, due to the uncertainty over permanent technological change in markets. All in all, dynamic capabilities are more a "stimulus to think than a prescriptive model" (DODGSON, 2017, p. 36-38). With this, the author considers that even when the theoretical framework of dynamic capabilities is taken into account based on modern innovation management, the "practice" of the same is still distant.

The business models (OSTERWALDER, PIGNEUR and TUCCI, 2005), a core concept in the current literature on strategic innovation, have also been analyzed from the point of view of innovation (see for instance TEECE, 2010). It can be observed that the impact of the classification of technological and complementary assets is still present in the current literature on innovation management. In fact, Teece has recently stated that there is a close relationship between this type of representation of a company's business and the concept of dynamic capabilities (TEECE, 2017). The interdependency defended by Teece regarding business models, dynamic capacities, and strategy management, is a fundamental aspect on which his management thinking is developed. In fact, his work goes on innovation in business models, establishing that these are the "The business model provides a pathway by which technological innovation and knowhow combined with the utilization of tangible and intangible assets are converted into a stream of profits" (TEECE, 2018, p. 40). Moreover, Osterwalder, Pigneur and Tucci (2005) analyze the model as a representation that classifies, using different concepts, the components and assets that constitute the business model. This way of classifying is also held by Tether (2014), who studying service innovation, comments that

most of the time, innovation is done based on innovation in business models. This is a representation which keeps making a distinction between tangible and intangible assets, which replicates the seminal classification between technological and complementary assets.

The dynamic capabilities approach has been criticized even by its own authors. In a text where Pisano (2006) explained that even if Teece's seminal contribution is still relevant, the concept of 'appropriability' formulated there; and that is found at the center of the classification of assets over which innovation is built; it is nevertheless insufficient to explain innovation processes. Particularly, in Teece's original work, the appropriability regime was considered endogen. Successful strategy considered then developing a vertical integration and a position in complementary assets which consider capacity for earning income. However, there are cases in which such regime is not endogen, as shown in the study on open innovation in the case of free software. In that case, the complementary assets strategy is not followed anymore, and it relies more on the strategy adopted by the company.

The point discussed by Pisano arises from the studies done in the so-called "open innovation" (CHEESBROUGH, 2003; VON HIPPEL, 2001). This literature has roots in business cases related to computer and information technology, sporting products, and research and development practices. In the discourse on innovation management based on an open system, the internally-oriented logic is avoided, with centralized and internal approximations for the development of products. On the contrary, those who argue that innovation management must be open, want that the ideas outside the company's system become part of the company's internal development. User communities generate modifications and share them with other users. It is then when Von Hippel introduces the concept of "lead user" who will guide the "co-production" of the innovation process. Here is where design begins entering the discourses of innovation management.

The entry of the concept of design does not change the continued importance of asset classification made in the literature of dynamic capabilities and innovation in business models. Nevertheless, this new turn reveals a convergence between the ideas of strategic management, innovation, and what can be called the star of the moment, design thinking. These three discourses are in a process of convergence, in which design thinking insists on becoming the quintessential methodology for the development of innovation management (JOHANSSON and WOODILLA, 2009). Without a doubt, as the authors state, design thinking is born in the light of thirty years of discussions started by the work of the IDEO company and the D-school at Stanford University. This thought will cause a change from the analytical, which tries to cut the world into pieces to analyze it and thus make predictions, toward a "generative one", where the aim is to create the future by means of a particular methodology.

Undoubtedly, the three aspects integrated into what has been called innovation management have very different origins. Strategic management is recognized as heir to military practices and to economy. Conversely, innovation studies trace their origins to economic and technological change literature. By contrast, design thinking has a genealogy that identifies with architecture and design. For a long time, the ideas of strategy and its characteristic analytical way of studying the world dominated the way in which innovation management was done. With the advent of design thinking, it is possible to see a way that will transform the way to develop, products, services, process and even their competitive strategies (BROWN, 2009).

However, the question arises concerning the epistemological incompatibility of the mixture generated among strategic management, innovation studies, and design thinking. Strategic thinking shows a clear rationalist, normative tendency with a positivist epistemology. In general, innovation has used a positivist epistemology, being an heir to economy, too. Yet, this has radically changed toward rather humanist and constructivist ways of looking at the world, as is the case of open innovation, where user communities build the knowledge that allows to develop new products, services, or processes in companies. This was confirmed by the coming of design thinking, which presents an open way of thinking, instead of previous strategic models that have a more fixed character in their epistemology.

We face then a moment of change, at least regarding the epistemology of innovation management. The way of understanding the phenomenon of innovation management which implied the search for absolute ideas, arriving at laws that "positively" govern the way companies survive and meet their objectives based on innovation management, might be in retreat. In fact, within the literature on dynamic capabilities, it is necessary to understand a subject separated from the object of study, being able of making a definitive observation of the phenomenon. With a more open epistemology, such as the one given by design thinking, innovation management is never a matter in which the observer can be detached from the phenomenon being observed. This includes the innovation of a new product, an ATM, or a new drug against Ebola virus as well as that innovation

in cases of new business processes. The policies, decisions, tactics, strategies, organizations, finances, marketing, and location of the business of a company have been made together with those aspects related to research, design, and the operations.

And still, although generative in its behavior and thus not positive as epistemology, design thinking keeps considering the possibility of separating the material from the non-material -related aspects. In other words, there are objectual -technical- aspects related to the innovation management phenomenon on one hand, and on the other hand, we have those aspects related to the world of ideas, the codes, and the competencies of the people who develop the innovation process. As a matter of fact, it seems that design thinking has not yet totally 'penetrated' in order to prevent the separation between subject and object in the epistemology of innovation management. In fact, said epistemology is directly endorsed by Dodgson, Gann and Phillips (2013). The authors propose that innovation management is fundamentally built from a practical approach based on concepts like the one of complementary assets.

However, everything seems to show that the process that takes place when studying innovation cannot be fully understood with resources in such representation of what happens in the practice. To adequately manage innovation implies more than separating aspects (analyzing). Said process entails to face the complexity which is accounted for by the myriad of aspects included in the process. This is a point in which some thinkers who use a more interpretive, emerging epistemology, like the one developed in design thinking, are already advancing (RYLADER, 2009). Moving forward with the work already started by design thinking, an alternative to this approach is offered from a different tradition. Such alternative it is based on the area of knowledge that has precisely confronted the main problems coming from the positivist and analytical way of understanding science and technology in society. That is Science, Technology and Society studies (STS), which will be developed further in the following section.

THE TURN IN SCIENCE, TECHNOLOGY AND SOCIETY STUDIES

The aim of this section is to problematize the classification of the technology related to production, distribution, and other organizational activities, and the positivism that supports most of the approaches used in the literature on innovation management. In this exact point, STS have clearly shown that a strict separation between the technological and the social aspects within a technology is not trivial (LAW and SINGLETON, 2000; BIJKER, 2010). In short, the leading question in this section is: How can STS contribute to a non-dualistic understanding of innovation management, where the social and the technical are part of the same mixture that is the object of management, and where the distinction between subject and object is certainly in doubt? This question attempts to show that the study of innovation management must reflect on the theoretical principles upon which the object is studied and managed. It is this dual perspective on how innovation is carried out and conceptualized the one that enables the progress toward a critical theory of innovation.

In the sense the question is posed, it is understood in this text that STS may contribute, from a constructivist epistemology, to the understanding of innovation management. With this, STS can bridge the gap to the discussion about technology and economy that design thinking is still unable to deconstruct in the case of innovation management.

Nevertheless, from the point of view of STS, the problem of innovation can never be separated from the non-technological aspects. To prove this point, STS researcher Lucy Suchman, gives us the example of the Xerox photocopying machine, developed with a high degree of detail in her important book Human-Machine Reconfigurations (2006). Following Donna Haraway's work, Suchman highlights the way people define, relate to and think about technology. In her example, Suchman brings up the following questions: What is the border of a machine that washes someone's hands? What part belongs to whom? Suchman explains that the technologies take these aspects of our activities and practices and materialize them, configuring the tools that fit each activity and/or practice.

Returning to the classification of assets made by the PFI program, and in a sort of self-reflection about his work, Teece (2006, p. 1132) has commented that his model "The PFI framework enveloped a far wider panoply of factors than had hitherto been addressed in the economic analysis of innovation." In this sense, the approximation of PFI reads and at the same time is source of other important actors, such as the Organization for Economic Co-operation and Development (OECD). This entity has defined the concept of innovation as "the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organizational method in business practices, workplace organization or external

relations" (OCDE, 2005, p. 45). It is clear that the lineaments to collect and interpret data on innovation (observed in the Oslo Manual) show a deep agreement with this conceptualization and classification of assets. There is a connection between the "wide panoply of factors" and the areas of marketing and organizational innovation. In that sense, innovation management aligns with the 'attractor', which is the OCDE in this case.

Without doubt, both the Oslo Manual, which has become an important "obligatory passage point" (LATOUR, 1988), and the very theoretical development produced in innovation, are defined by the measurability they provide to the results and the process when making their management. The manual has a theoretical framework that puts together a heterogeneous group of innovation authors and theorists. Moreover, it presents a range of authors and theories going from Schumpeter's creative destruction to some theories about organizational innovation (LAM, 2005), passing through economic theories based on industrial organization, sociological theories about the diffusion of new technologies, evolutionist understandings of innovation, and systemic theories like the famous one by Lundvall and Nelson (OCDE, 2005). The works about innovation management developed by Dodgson (2017) and by Dodgson, Gann and Phillips (2013) align perfectly with that way of understanding innovation. The Oslo Manual becomes the way in which innovation studies and innovation management studies institutionalize a mixture at the political-social level, and the management work that the firms do when managing their innovation.

Certainly, the classification of assets made by innovation management presents a very particular way of understanding the industry where the innovation will be developed by the firms. Particularly in Teece's model, from which innovation management studies read, the actors of the industry deploy in a 2x2 matrix that shows winners and losers in the y-axis against innovators and followers in the x-axis. Again the STS, through Pollock and D'Adderio (2012), will help us understand certain implications about this classification and representation. The authors show that this type of tools are active in the world, i. e., there are not only a representation of what happens with innovators and their followers. As Donald Mackenzie said before, we can consider this 2x2 matrix as a machine that is "It was an "engine" in a sense not intended by Friedman: an active force transforming its environment, not a camera passively recording it" (MACKENZIE, 2006, p. 12). The argument is that the matrix works in a performative way with the reader of this particular mixture of innovation studies, competitive strategy, and management and organizational studies (MOS). This idea of performativity comes from the work of the 'new' new economic sociology developed by Callon (2008).

The translation from economic sociology of the thesis about the performativity of economy toward a performativity of management theories has been made also in the field of management, and particularly, in strategic management. In fact, this has been a widely discussed topic within the current literature on administrative sciences. An example of the application of strategic management of these ideas is seen in the work of Kornberger and Clegg (2011), and also in Cabantous and Gond (2011). The work of Kornberger and Clegg focuses on the practice of strategy in the particular project that aims for the sustainability of the city of Sydney in Australia by 2030. On the other hand, and supporting the thesis of performativity, the study carried out by Cabantous and Gond proves that the rationality operating in strategic management is produced from an engineering, commoditization, and conventionalization of the actors, theories, and tools that underlie the decisions and the management. The authors supporting the performativity thesis of management theories prove then that strategy is performative when analyzed from its practice, constituting the subjects who carry out the practice and giving particular shapes to the object it manages.

It is worth mentioning that given that this study aims not to address the problem of the performativity in strategic management in general, but the one that arises from the theories of innovation management. It leaves this discussion out of the analysis, which according to the author, has a broader nature. However, as shown by Gond, Cabantous, Harding et al. (2016) in their excellent historical-critical meta-analysis of management and organizational studies that have used the concept of performativity, there is still much to be done regarding the understanding of the foundations that are used when studying the performativity of any phenomenon within organizational management. In particular, and building on that discovery, this text will theorize about a performative understanding of innovation management, filling in this way the theoretical gap explained in the introduction.

In that sense, and following the idea of performativity developed by Callon, innovation management studies are, at least in some way, constituting the subjects who do innovation and giving particular shapes to the very object of innovation management. This is an approximation which makes the phenomenon of innovation management emerge with unique characteristics. In this text, we propose that those who participate in management should advocate for the use of a rather more complex matrix than the one present in the literature on innovation management. A matrix able to capture the

fluency and ambiguity of the social world. Only then it will be possible to generate a more general explanation about the phenomenon of technological innovation management. Such matrix should reflect in a careful way, all those assumptions coming from the theory and the classifications made by the researcher. A more pragmatic view (PARMAR, PHILLIPS and FREEMAN, 2016), and hence closer to the approximation of innovation management studies, shows that this way of building the world is based on the "analytical lenses" explained in the previous section. The matrix used makes the invisible visible, and creatively links innovation studies theory with the literature on management, and in particular, strategic management. But at the same time, the authors in this line end up producing an "immutable mobile" (GASPARIN and NEYLAND, 2017) which can be transferred by the group of current and potential readers, both at the firm and more aggregated levels, i. e., the level of industries and countries.

As Bowker and Star (1999) have commented, classifications and categories are material and symbolic tools. These important authors of the field of STS add that the community rebuilds and continually reshapes those tools and the related classifications. This is why it is possible to understand that the relationships between innovators and followers-imitators need to be observed as emerging entities and thus, they can change in the industrial and temporal dynamic. Precisely, the question about how imitators and innovators emerge demands to be put in the center of the analysis. The examination of the construction of the matrix requires a look at history and the development of the categories of innovation and the identities of the innovator and the imitator.

Innovation management has become a mixture that connects spaces such as the best business schools in the world with ex post cases of successful innovators (this is, those companies that have managed to extract higher rents from a technological innovation). The theoretical framework of the three views which Dodgson, Gann and Phillips refer to (2013) is aligned with conceptual frameworks for public policies such as the classifications enacted in the Oslo Manual. This mixture of actors who carry out innovation policy and inform the decisions of top-notch students in the world is powerful. The mixture shows a continuum between the analysis at an innovation management level in the firms and those aggregated economic levels. It is a continuum where the micro-macro distinction has been overcome and it is not problematized. This framework is the one that explains many of the innovation policies in different countries, where the discourse about innovation and business venture is increasingly relevant, both at the public policy and the private practice levels.

Although more interpretative and emergent, the turn of innovation management proposed by design thinking can advance a more complex approach considering its own methodology performativity. Is this constructivist aspect that STS have and the development they have made in the concept of performativity what would allow to build a bridge to think, in a more reflexive way, the tools and theories used in innovation management, from its traditional economic and strategic matrix, passing also through the new trends in design thinking.

The question *What view of innovation management can be then built from the deconstruction made by STS?* has not been fully analyzed yet in this text. In fact, the reflection about the construction of the matrix that classifies the assets which firms confront, *se puede avanzar con más detalle en el desarrollo de las categorías de innovación y de las identidades del innovador e imitador.* This leads to an alternative to innovation management that respects the original concept of innovation, i. e., the Latin root "in-novare", should take into account those "mimetic" aspects of innovation, where the particle "in" presents the work of repetition and improvement. In this way, it is possible to lead this study toward an analysis that take into account the meticulous and repetitive work behind it. A possible solution is to open the practices of said process in order to open innovation management studies to organizations, which is what is proposed in this reflection. Such an approximation to the study of innovation is achieved by analyzing the interaction between the entities that constitute the network of relationships that participate in the event that is technological innovation management. This is the deep constructivist turn that STS contribute/supply to innovation management.

From STS, we embrace the concept of bricolage, which comprises all kinds of materials and intangible resources (PICKERING, 2010) that are used to manage innovation. Pickering demands then the study of mundane activities, such as the ones done by professionals in a repetitive way in their daily routines. In this way, those aspects related to novelty and those from the breaking with tradition within the phenomenon of innovation can be known and understood. To open the black box implies to look at the continuum between tradition and novelty as the center and main difficulty in technological innovation management. That is to say, to carry out the study of the adaptation, flaws, and forces that struggle and interact when new technology is being developed and used (AKRICH, CALLON and LATOUR, 2002).

In some sense, the work related to/associated with user-based innovation, which has been developed by Von Hippel (2005) during/in the last 20 years, shows (us) a type of literature which is aligned with the kind of innovation management here proposed. In fact, while working in the origins of STS, one of its most important authors, Steve Woolgar, has shown how the user is configured jointly/together with the technology and/or product designed (1991). This line within STS has called for a research about "co-configuration" process, understood as the operation which explains "the configuration of users, with the parallel process where designers and engineers are at the same time configured by the users and the organizations where they work at" (MACKAY, CRANE, BEYNON-DAVIES et al., 2000, p. 757). The establishment of the managers, firms, engineers, and technicians' own identities need to be analyzed in detail, every time it is possible to understand the "dance" between the entities that constitute and carry out technological innovation (SUMMERTON, 2004). Although Dodgson, Gann and Phillips (2013) only superficially comment on the importance of users in the development of innovation management, the handbook they edited has a chapter related to user-based innovation. However, the analytical lenses upon which their theoretical framework is built, is still highly idealist and positivist, not holding major/much interest in those daily aspects that make up the bricolage of innovation management in the firm. On the contrary, to constructivisticly understand innovation management would imply to take the already old call that the original development of the actor-network theory seriously. In that text, scholars Akrich and Latour (1992) invite us to explain the adaptation of (the) technical object on the part of the user/by the user, in terms of a "dance" where the inscription, subscription, and its opposite de-inscription are used to describe the relationships between human and non-human actors who can ascribe, reject, or negotiate the prescriptions that objects bring with them.

More recent developments, like the ones found in the literature on open innovation (CHESBROUGH, 2003), are welcome too to improve an option that considers the bricolage to understand and then manage innovation. This analysis strongly sympathizes with the idea that open knowledge will in fact allow better innovation developments. Moreover, it can be understood to some extent, that the division between technological, specialized, and complementary assets do not resist, at least partly, when the innovation can be openly done. The point already established by Pisano (2006) is then collected, when he reflects on the idea of PFI and dynamic capabilities, the two analytical lenses upon which innovation management has been built. In fact, although certain phenomena of 'appropriation' of profits do not resist in an open innovation management, this way of managing innovation will continue to consider knowledge and the technological elements in a positivist and non-performative way, unlike STS. The problem of the separation of the social and the technological is still present in recent approximations, such as the democratization of innovation and open innovation.

Furthermore, and considering the interpretivist epistemology of design thinking, STS have also pointed a path from its analysis of technology (WOOLGAR, 1991). The STS expert shows us that the turn from an interpretative towards a reflexive technology understanding, displays a very different epistemology in order to understand it. The reflexive version allows to understand technology from a, say, agnostic position in the ontological. That is to say/In other words, unlike design thinking, which considers an objective and transcendental existence of technology, and that takes into account different 'points of view' for its development, the reflexive version promoted by Woolgar, implies "to understand how is that the reality of technology is itself created, described, and sustained, and in particular, how is that the effects and capabilities of technology relate to the effects and capabilities of other entities" (WOOLGAR, 1991, p. 41-42). Without a doubt, the reflexivity and relationality mentioned by Woolgar join the performativity of management theories, blurring the complete picture of convergence presented by strategic management, innovation, and design thinking. Paraphrasing the important STS researcher Steve Woolgar, it is crucial to understand that the ideas of those who develop an innovation must be considered at the same level as technology. With this, we break the classification of technological and complementary assets that crosses the field of innovation management.

In Box 1, it is presented a summary of the possibilities that STS offers to innovation management.

Box 1

Summary of the possibilities offered by STS in innovation management studies

Aspect	Innovation Management	Contribution of STS to Innovation Management.
Epistemology	In general terms, positivist and non-relational, with some interpretivist cases.	Constructivist – non dualist and relational-reflexive.
Strategic Management	A positivist, normative, and rational understanding of strategy. Analytical approach that tends to separate the parts in order to understand them and manage them.	Performative analysis of the theory. Openness to uncertainty. Reflexivity and relationality in the understanding of strategy. Systematic approach that tends to analyze the whole and its complexities, but also the point of view of the parts.
Technology	Understood as something real and durable, but separated from the ones doing it, with the exception of design thinking, which considers it more as an interpretation of every actor involved in its development.	Technology is built and affects other entities, but at the same time, it is affected by these entities. Technology is real and durable, but it is built in a relational process and never separated from those who built it.
Users	Not really relevant, except in open, democratic innovation literature.	Very relevant, considered at the center and as co-producers of the innovations.
Gestión de la Innovación	Based in fundamental economic aspects and where technology extends as deterministic. Does not consider the performativity of innovation management theory.	Complex process based on the relationship between different entities, be it technical, material, immaterial, human, or not human. Considers the performativity of theory.

Source: Elaborated by the author.

A constructivist type of approximation that consider reflexivity in order to analyze the technology phenomenon and the performativity of innovation management theories, allows to ask other types of questions, such as: What are the material conditions under which we can act as (if we were) innovators? This question promotes an analysis of the activity itself and not only the economic result of competitive strategies. In consequence, the question about the epistemological foundations of innovation management finally leads us to the joint collection of aspects linked to the material and non-material relationships that exist among the entities that produce the phenomenon of technological innovation management. In this way, the inquiry goes into the study of the detailed elections made by those who design new technological products. Actor's constitute their theories developing those innovations, whether technological, organizational, social, open, based on design thinking, or any other type.

FOR A CONSTRUCTIVIST APPROXIMATION AND CRITIQUE OF INNOVATION MANAGEMENT

A theory that has developed under STS and that meet several of the conditions in order to look at innovation management with constructivist, relational, and reflexive lenses is the so-called Actor-Network Theory (LATOUR, 2005). From this theory, we understand any entity as constituted in the interaction with other entities, be it subjects or objects. As a consequence, and as anticipated by the end of the previous section, technological innovation and strategic management become a very different activity and business from the one established by innovation management literature. More than a fixed entity, the manager of innovation is mediated by objects in a network of entities. As Ekbia and Nardi (2012) have commented, in such process the objects are at the center of the construction of the subject – the parallelism between these authors approximation and Serres (1982) is truly remarkable. The cited authors call this process "objectivation" (EKBIA and NARDI, 2012). The process of objectivation explains how a particular technology – for example, a management technology or a technology – based product

– will define the innovator in its co-development. Latour, the theoretical father of the Actor-Network Theory, has conceived a similar idea, framing the concept of "inter-objectivity" (1996).

However, the interesting symmetric-relational and constructivist approach that the Actor-Network theory gives us in the comprehension of the innovation management phenomenon is not enough to provide a critical alternative to the same. As Hull and Kaghan (2000) have commented, innovation is deeply linked with the organizational phenomenon and with management. Consequently, the authors call for the creation of a line of research that questions the effects of any new technology and, in general, of the innovative processes in those who do the work and are connected as stakeholders in the organization that is developing such change. This is because the great absentee in innovation management theories is work and the inequitable way in which the benefits of the innovation done between capital and work are distributed.

Taking into account the call of Hull and Kaghan, Critical Management Studies – CMS – (ALVESSON and WILLMOTT, 2012) can produce this necessary questioning of innovation management. In fact, Hull and Kaghan acknowledge that the criticism suggesting a pro-innovation bias that exists in the literature, tends to separate also the technical from the social, as if these elements constitute two different avenues (2000). This point, already discussed in the section on innovation management and the following one on STS, remains a constant in a significant portion of CMS, which insist on such analytical separation. This separation must be subject to scrutiny in the research process because, as Michel Callon and Bruno Latour (1992) have commented, from STS, the classification that determines what is social and what is technical is an issue in itself. It is not possible then take said classification for granted.

In that sense, authors like Robert Cooper, scholar of organizations and who early adopted and approach which questioned the separation between the social and the technological, comments that the organizations that carry out technological innovation and, in general, any organization, cannot be studied from a "simple location". On the contrary, organizations need to pay close attention to the tendency toward abstraction that is produced when thinking (about) the complexity demanded by the relationship between the social and the technical (as cited in SPOELSTRA, 2005). As Spoelstra (2005, p. 108) has remarked, for Cooper "the entities (and identities) do not have natural locations, and neither have an essence that holds them together […] identities, subjects, and organizations are generated, and require continuous regeneration". This relational approach to the study of organizations promotes a process where the relationship between entities – subjects and objects – produces the phenomenon of technological innovation and, in general, all phenomena in which organizations are involved.

A framework such as the one mentioned, questions the categorization that defines "technological innovation" and "organizational structure" as different entities. Said classification, which underlies the work of innovation management, already explained in previous sections, is a well-known aspect in STS, but as stated above, it is less accepted in CMS traditions. In fact, the approaches to the Actor-Network which are at the center of the STS tradition have been strongly criticized and accused of a total lack of potential to intervene in terms of the debates about innovation and organization (Whittle and Spicer, 2008). Moreover, ANT has shown a radical approximation regarding the relational and constructivist ontology which has been criticized for its "managerialism" (ASHMORE, 1996). However, Kaghan (2000) posits that Latour's "irreductionism" (1988) which is certainly found in Cooper's work on organizational studies and in Callon's work about innovation studies, can enrich the study of innovation management and at the same time, allow some critical management studies that confront also the literature of the line of innovation management which has led to dualist approaches to understand technology and the social.

As a matter of fact, Kaghan (2000) calls for the acceptance of an irreductionist program, where the study of innovation management can desist from the divisions between the social and the technological, the "material" and the "ideal", and the "natural" and the "social", resonating deeply with the symmetrical approaches promoted by the ANT, and with the work of Bruno Latour, Michel Callon, and Jonh Law, in general. In Kaghan's view, such approach can inspire in turn the work of Marx, who resolved these divisions with a dialectical analysis of capital. Goods, among which are technological innovations, can be considered as actants, and the process of commodification as a type of "black boxing". This theoretical movement it is based on the so-called "worlds of research" (LATOUR, 1998) and to place the innovation process at the center of those "worlds". Technological management and innovation are not apart, nor one dominates the other. Kaghan (2000) adds that the literature of the ANT has produced very useful concepts in order to understand said process. An example of useful concept is "distant action", which gives the researcher a framework to understand the importance of objects as a central aspect in the analysis of the social.

For Kaghan, any good can be then redefined as an "actant" en ANT language. Technological innovations are objects that play an important role in the relationships between production and consumption. Humans can also be considered as a good, as in the case of the "Labor Process Theory". Kaghan (2000) explains that both Schumpeter and Habermas understood goods as emerging embedded in a world, and never as "magical" elements. Quite the contrary, every new technological innovation created emerges out of a long process. This is why invention and innovation force a negotiation and renegotiation between a group of heterogeneous entities, as happens in any process of technological change. Within this approximation, money is a device that can be considered as an intermediary in the exchange. Money then will have all the characteristics that Serres (2006) gives to an intermediary, and that later Latour captures in the concept of intersubjectivity, already explained in this text. As a corollary, a critical approximation to the irreductionist -constructivist- approach will include the process of commodification, paying special attention to the moral, economic, technological, and natural aspects, as well as to social interactions and their peculiarities.

A program that seek a constructivist and critical analysis of innovation management allows us to look at the unexpected effects of the management that is done to generate new products, organizational improvements, or any other kind of innovation. This type of approximation seems very far from the program that classifies the assets of a firm into technological and complementary. The differences between the constructivist-critical paradigm and the innovation management tradition are certainly epistemological and political. In the constructivist-critical paradigm, a product, an organizational process, or even a new business model, exist within a network of heterogeneous actants, where material and non-material entities gradually shape it. Innovation is then a punctualization, a relational effect, affecting at the same time, other entities that participate in the network of relationships where it participates. Although the innovation management paradigm recognizes the great importance that the relationships and the contracts between the actors in the value chain have, such approximation never problematizes the relationship between the social and the material which constitute the innovation that emerges in the process in question.

What is more, to conceptualize an innovation as an "actant" allows the research process to follow a constructivist radical approximation, which is possible to read since the processual tradition present in Marx (1972). Said reading can be analyzed by carefully grasping the following statement by Marx (1972 apud KAGHAN, 2005, p. 2): "The evolution of the means of production will serve as a machine through which the relations of production can be transformed", and also, by using the ANT program and its legacy from processual philosophy. An author who has maintained before that there is a relationship between process philosophy and Marx, is Anne Fairchild Pomeroy. The philosopher has explained in detail how abstractions, such as work, entail an ontological mistake. Pomeroy has commented that "Marx's exposition about the exchange of work for wages reflects the division between reproduction and production, and shows us the possibility of treating human beings as a commodity for exchange purposes" (POMEROY, 2004, p. 154). Likewise, the Marxist labor theory of value explains the impossibility of denying the irreducible relationality – irreductionism – of the abstractions made based on dialectical moments of actual practice. As a consequence, in the practice, categories are a mixture.

Whitehead (1985, p. 7-8) further explains that failing in observing this point is a "fallacy of misplaced concreteness". Said fallacy consists in considering the human being as a complete, realized, established entity and the actual result of a process that has taken place in the past. Which not totally incorrect, but incomplete. Pomeroy (2004) states that commit this fallacy is, in some way, being ruled by those abstractions. The fallacy then leads us to think that humans exist outside the processes. Consequently, and taking into account that the aim of capitalism is the valuation of value – or, put another way, the expansion[1] of surplus value – that is made in the productive process when an exchange value is abstracted from its use, it is possible to conclude that capitalism relies on valuation, based on the aforesaid abstraction, and that it is an active and living form upon which said fallacy is built. In other words, the surplus value logic has always required the fallacy of misplaced concreteness.

In order to understand and deconstruct the fallacy, the study of valuation processes or "economization" in performative economic sociology language, becomes crucial (ÇALISKAN and CALLON, 2010). The study of economization may be seen as a program to understand the most critical aspects that are generated in the technological innovation process. At the core of this constructivist-critical program, to understand how the process of commodification is done and how the heterogeneous entities it comprises participate in it will be sought. In this way, it will be intended to avoid the fallacy of misplaced concreteness, which Pomeroy warns us about.

[1] This expansion is the result of gods and workforce salaries interchange. A prerequisite of the expansion is the abstraction of goods calculation.

In order to understand technological innovation management in the context of the creation of new products, it will be necessary to scrutinize the process by which work (human activity, in a broader sense) is intertwined with the objects that those who work use and produce. If we do not do this, we are at risk of abstraction and immediately leading the results toward a fallacy that look at humans being outside the process they carry out. This is the real added value of the approximation/approach offered, analytically, by the ANT.

Obviously, the constructivist approximations such as ANT, must be problematic when the question moves toward the study of the identity of the worker and other humans who participate in the organizational phenomenon. Just as Stenner (2008) has explained, the recent social theory movement seeks to use a flat ontology for the analysis of the phenomena, blurring the distinctions between subject and object, and moving the focus of analysis toward the term "subjectivity". However, las mismas "risk going back to a bleak anti-subjectivism" (STENNER, 2008, p. 92). The author adds that for Whitehead, the relationship "subject-object" is found at the fundamental structure of experience" (STENNER, 2008, p. 93). It is not possible then to get rid so easily of concepts like subjectivity. The sense of self-identity demands a thorough and meticulous study.

Notwithstanding, a constructivist and critical program moves us to solve several of the problems that the innovation management approximation offers. Firstly, the problem of the subject who participates in the technological innovation process, and that is related to its management. For the innovation management program, the subject is certainly not part of the problem. Following an individualistic and non-reflexive economic configuration -homo economicus- innovation management builds a model that separates the subject from the object developed by the subject itself. This criticism echoes other areas of economy, where such separation has been strongly criticized by the performativist economic sociology program (CALLON, 2008).

CONCLUSIONS AND SUGGESTIONS FOR FUTURE STUDIES

This article aimed to generate a discussion and theoretical reflection about the way in which innovation management can be understood and researched. After said reflection, it is observed that the approximations to innovation management generate or enact – as Law would say – or even perform – as Callon and the performativists in the world where those practices are carried out would say. Is this performative power the one that should be taken into account when we theorize innovation, and particularly, its management. As we have seen, approximations like the PFI program and the one of dynamic capabilities, are at the center of the modern literature on innovation management. To consider the performativity of the frames upon which innovation management is built, and hence the type of world being built when they propose classifying into innovators and followers, is an aspect that STS allow to better understand. Moreover, the approximations and tools on which the literature on innovation management has been built, should consider, at least in part, a fair reflexivity regarding its generative power on innovation managers.

The argument of the text is that the way in which innovation management has been conceptualized is based on a very particular classification of the assets - technological and complementary – involved in the process of innovation. Said classification has been maintained over time as to linking innovation with the very business models of a firm. From a critical and constructivist analysis, a deconstruction that aimed at showing a non-dualist management of innovation, from Science, Technology and Society Studies (STS) was carried out.

Even though the reflexive effort of using STS to understand innovation management is an improvement compared to the application of the current lenses of innovation management, the reflexivity developed through the use of STS, and the analysis that these enable are not enough. In order to understand many of the unexpected effects of innovation management, a critical program is needed, that is to say, a program where the constructivism showed by the performativity of the ideas and material objects meets the study of economization and the deconstruction of the fallacy of misplaced concreteness. This is the project that this text has started to outline.

Regarding the suggestions for future studies, it can be deduced from the presentation here made, that open and democratic innovation is seen as an interesting subject for the empirical work. This is because it decenters the purely homo economicus approach, which is generally considered as naturalized in innovation management literature. From there, to study the mechanisms that explain the participation, how those who manage the creation of new technologies work and operate, understanding that the relationship between subjects and objects is closely linked to the ideas and theories with which these

managers comprehend the world. If we want to build an economic system where people and nature be considered as central axes of it, a constructivist and critical approximation allows the necessary descentralization of innovation as an emerging process of purely human nature.

Another area that a constructivist and critical theory of innovation may contribute to from a empirical point of view, is the one related to the innovation of organizational processes and the innovation of management practices. The problem of innovation management has increasingly been considered in the field of organizations and business literature. In this sphere, it is clear that reflexivity and the relationality-performativity of the innovations being managed/managed innovations studied there, could gain significantly if the lenses of a constructivist-critical approach were used. In particular, since the question may be asked about the subjectivity that arises when in a firm, certain management innovations are disseminated/spread, and how these translate the subject who uses them, and the very firm that puts them into practice.

Concerning the methodology, there is still much to be done. Specifying, for example, methodologies to follow a road that allow to undertake empiric studies for the constructivist-critical approximation. Together with the methodology, it is also necessary to move toward a comprehension of practice that allow those who do the process of managing innovation, reflecting on their job. It is here where the constructivist and critical approximation outlined in this text has to be used more carefully. This is because, even if it is clear that in order to solve the fallacy of misplaced concreteness, it is necessary to decenter the subject, this does not imply that we should forget about the same. The task is to understand the phenomenon of innovation management without returning to a 'naive' humanism, which has been and still is so utilitarian to those seek to build the power of capital over people.

Staying in the interstice, that is, the mixture of the technical and the social, the blend of objects and subjects, it is possible that the analyst can have greater clarity in the process that makes engineers, technicians, and managers be what they are within the organizations they work at. From there, it will be a little more attainable the necessary reflexivity that can become the basis for a deeper change in the work-capital relationship for the generation of new innovations. This is the invitation extended by this constructivist-critical approximation. This would be the first step to build a plausible alternative to making innovation management.

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