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Epistemic networks

New subjects for new forms of (scientific) knowledge production

Andoni Ibarra (University of the Basque Country, Bilbao/Spain)

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Abstract

The most important contribution made by some recent proposals in the philosophy of science and in the science and technology studies is the freeing from the psychical appeal made to the individual's conscience or intentions in explaining different scientific processes. This is not the same as adhering to methodological collectivism. It is not a question of reformulating the old individualism/collectivism dichotomy. Yet, is it not this community image that affirms the reality of the situation regarding collective subjects – the thought collective, the scientific community, etc. – which constitutes the alternative to methodological individualism and epistemological realism? Rather than continue in this way the aim of this paper is that of situating the alternatives in other confrontations and replacing the subjects of the old methodological individualism with new "actors", with new units of knowledge.

1 Introduction

For at least three decades now, it has been recognized that knowledge is transforming social relations and organizing another type of relations on a radically different basis (Gibbons et al. 1994/Knorr-Cetina 1999/Evers 2000). However, what kind of relations have begun to develop, and which direction such developments will take, is a question about which there is no clear consensus. What is clear, however, is that the role knowledge plays in modern societies organizes a new agenda of problems, which will mean having to rethink the basic diagnoses on which relations between science, technology, and society have to be analyzed. One of these problems is the attempt to identify the epistemic subjects, which produce and use knowledge.

There are several trends in this approach to the new problems. In the first place, the widely used term "knowledge society" (Stehr 1994) has been interpreted as interchangeable with the term "knowledge-based economy" (Cowan et al. 2002, Nonaka/Takeuchi 1995). For this perspective, the knowledge-based economy is a new term, which has been coined as a result of several related processes, such as the acceleration in the production of knowledge, the increasingly intense role of intangible capital (knowledge) in macroeconomic variables, and innovation as the dominant activity (Cowan et al. 2002). Knowledge is therefore considered here basically as a decisive factor in the "new economy" and, in consequence, the conceptual problems are oriented towards the analysis of how to transform tacit knowledge into explicit knowledge, and re-function it in areas of economic production. Approaches to knowledge management may likewise be framed in the sphere of the organizations (basically businesses), the efforts of which are oriented towards making explicit and promoting knowledge management mechanisms and organization in "learning organizations"; i. e., what is important here is the spiral of knowledge creation, in which tacit, individual knowledge is transformed into explicit, social knowledge in the frame of businesses and production systems (Nonaka/Takeuchi 1995).

A second perspective, which subordinates knowledge to economic processes, is exemplified in the widely extended discourse on national/regional innovation systems. The basic argument is that innovative businesses interact in national/regional contexts, not just with other companies (competitors, clients, and suppliers), but also with technology centers, R&D centers, various types of science- and technology-linked agencies, and political authorities. In this way, knowledge circulates more intensely and more effectively, thanks to geographical proximity, which helps to trigger the innovation processes (Lundvall 1992; Cooke 2001). One advantage of this approach is that it includes the role of the institutions and the importance of systemic relations between agents and innovation in its explanation of innovation. However, innovation (as an interactive and learning system) is still considered to be a socio-organizational process integrated in the dynamics based on technological change, organizational learning, and path dependency (Moulaert/Sekia 2003).

From a different perspective, Gibbons et al. (1994) have introduced the concept of production and distribution modes, to favor a social approach to knowledge and its circulation. Even if the metaphor of knowledge production and -distribution has an economic origin, the idea in this perspective is to make an effort to show the trends and the keys in a transition towards a new social scenario in which knowledge is produced in a multidisciplinary way in contexts of application, which include a range of actors and interests on the basis of flat, flexible, and open organizations, and where evaluation is increasingly a competency which is exogenous, rather than endogenous to

knowledge-production centers (universities and other research centers).

My thesis is that, for a more complex understanding of the role of knowledge in contemporary societies, a socially distributed conception of knowledge is needed, one that considers science, technology, and innovation to be something more than a technological process associated with processes of applied science and economic value. To do this, I shall attempt to give an account of this perspective and propose a network approach for knowledge relations, in order to promote a better-structured and more complex view on the role of science and research in knowledge societies. The concept of the epistemic network is one, which – unlike individual subjects or concepts such as scientific communities or other related terms – makes it possible to criticize on the premises concerning epistemological realism and methodological individualism, the more prominent stances in the philosophical and sociological studies on the production of knowledge. How can we characterize such epistemic networks?

In the next section, I will first identify the two epistemological premises, which have underlain our controversial understanding of knowledge production in the 20th century. Next I shall consider some of the attempts, which are particularly well adapted for showing the community nature of the scientific enterprise. In the third section, before going on to propose an image of science based on non-human units of knowledge production, I shall analyze a "collectivist" approach presented recently by Hacking through an introduction to the concept of reasoning style, which stresses the decisive role played by scientific cognition putting the individual off-center. In the fourth section, I shall consider some unresolved problems in Fleck's thought collective theory, in particular, the introduction of the individual subject as a condition for structural change in thought styles. Based on the communicative practice of Fleck's collective actors, I then go on to propose, in the fifth section, the consideration of new units of knowledge, conceived as epistemic networks comprising interactions of a certain type: circulation processes of the type that will be discussed below. I shall conclude with some final considerations about some of the new challenges which that network approach introduces for the study of knowledge in contemporary societies.

2 A change in the mainstream or a change of mainstream?

The study of scientific objectivity in the analytical philosophy of science was dominated throughout the 20th century by theories which have enabled genuinely philosophical problems and issues to be commonly identified beyond the declared death of the "standard view". This would favor communication and consensus, with the conviction that the "philosophical study of real science" would give rise to theories, which are neither metaphysical nor speculative. Such is the mainstream that channeled the philosophical analysis of science in the 20th century (Kitcher 1993).

However, the emergence of the new sociology of scientific knowledge, of science studies, has triggered a branching out of mainstream philosophy into various directions. The result may appear disappointing when we observe the current fragmentation of philosophical and sociological interests, and even give rise to mutual incomprehension of what is understood by the study of science and the nature of problems and issues to be dealt with in it.

The diversity of regional contexts with very differing interests and expectations, which one would expect from this study, and which increases the fragmentation referred to above, should be added. Certain personal idiosyncrasies could also be mentioned, which hinder the continuity of

traditional, sober, and suitable language for the common understanding of scientific concepts, laws, and theories.

Yet the core of the current problem in the study of (scientific) knowledge lies, in my view, ultimately in the persistence of that language – the epistemological mainstream of the 20th century – which constructs a social reality for science based on two premises which are extremely deep-rooted in our times: (i) epistemological realism (which affirms the reality of individual subjects) and (ii) methodological individualism. Something, however, seems to change at the beginning of the new century. Science studies pinpointed traditional certainties concerning categories or *a priori* rules as historically contingent; as a result, the philosophical study of science started to burden the metaphysical principle (MP hereinafter) deriving from those two premises (i)-(ii): the naïve principle that individual, intentionally-guided human actors are the makers of science, the producers of knowledge.

Indeed, has it not yet been taken into consideration – at least since the time of Kuhn (1962) – that it is the scientific communities, the collective actors, who have placed the community image of the scientific enterprise at the center of the debate, and who have ended up the old individualism. As I suggest in the following, this type of proposals does not constitute a viable alternative to the traditional mainstream with realist and individualist roots. In those proposals, it is the individual subject of the community of the group in question who ultimately gives rise to cognition, influenced by the community-institutional context. To put it bluntly: in the current mainstream, the social nature of scientific knowledge is confined to the socialization of cognition produced on an individual basis. Is that false? No, but it tells only half of the story. The other half is that which requires not only a modification in the mainstream, but also a change of the mainstream itself which may enable us to establish the fact that (scientific) knowledge – irrespective of the form in which we conceive it – constitutes its world, identifies its aims and objectives, and determines its values and norms. This must not deem acceptance of the MP, i. e., the idea of duly socialized intentions of individual subjects as determining the objectivity in science. How is this possible?

3 The discursive power of scientific social practice

Hacking has proposed a "new analytical instrument" for the philosophy and sociology of science in the study of objectivity: the "reasoning style" (Hacking 1992a, b). Although he retains certain continuity with the proposals for the analysis of scientific thought styles put forward by Fleck (1935), Crombie (1994), and other authors, Hacking nonetheless suggests focusing the study on reasoning styles in the way that object and objectivity standards are shaped in knowledge-production processes. This is a motivated focus because, in his view, reasoning – unlike thinking – is a more public than private activity; and that is why thinking is certainly required in reasoning, but also communicating, arguing, and demonstrating. Taking this analytical instrument as a basis, Hacking situates his project along the same lines as the critical project of Kantian epistemology, but with one notable difference. According to him, Kant considered scientific reason to be a historical result, but not a collective one. Hacking wants to stress the collective aspect (1992a: 4).

Thus, Hacking orients the analysis of the concept of reasoning style towards the objectual constituents and the object and objectivity standards of the discursive power of reasoning styles. Styles produce, when they prevail, extensions of cognitive areas, or new areas. They are, first and foremost, canons of objectivity; a reasoning style is a standard or model about what is reasonable regarding some matter or

other. They do not only produce new principles, which were hitherto not possible, but they also delve into the domain of "positivities".

Hacking provides a list of new features, which characterize a specific style. Styles produce new types of objects-evidence sentences, new ways of being a candidate for the truth-or-falsehood laws, and new types of modality-possibility (ibid.: 23). With them, new types of classification and explanation also appear. These new features enable a reasoning style to be defined; they establish a condition deemed necessary to be able to speak of a reasoning style, insofar as each style openly and creatively introduces nearly all such new features of the type referred to above. Each style also introduces a new type of object, and the style therefore is not questionable in terms of the existence of that object or type of object – which is, in fact, possible within the framework of style. Indeed, ontological debates may be interpreted as indicators for the introduction of a new reasoning style.

However, Hacking pays special attention to what Fleck referred to as the tendency of a style to persist. This tendency is not only a constitutive element of the style, but also a more decisive one, which enables us to understand the enigmatic quasi-stability of science. In Hacking's interpretation, this relative stability of science is linked to the introduction of new ways of being a candidate for truth or falsehood through a reasoning style. In other words, the new principles are not found within the range of positivities because they clash with an extra-temporal truth and, through that confrontation, attain a value of positive truth. It is rather because reasoning styles give rise to objectivity standards in accordance with which they constitute and enunciate those new positivities, i.e truths-or-falsehoods. Styles are *self-authenticating*, and it is only by virtue of that capacity for self-authentication that principles may be deemed candidates for truth or falsehood (Hacking 1992b). Principles – either true or false – of the type for which enable us to establish the value of truth, irrespective of a specific reasoning style, simply do not exist.

Rather than focusing the analysis on a study of methods and science in general, Hacking proposes researching the self-stabilizing techniques common to each style, based on the notion that reasoning styles build self-authentication strategies. He suggests that we concern ourselves with these techniques, rather than with other epistemic elements which transcend, or are not part of a reasoning style: they are the techniques which enable relative stability and robustness to be associated with new positivities introduced by the style. Taking things even further, they are the self-stabilization techniques, which constitute something like a reasoning style. The analytical tool of the reasoning style thus backs up a historical-epistemological program involving a study of the specific stabilization techniques of scientific knowledge. The self-stabilizing techniques do not become the revealers of objective truth, but rather objectivity standards (Hacking 1992a: 19).

Simple social epistemology? One more turn of the screw in our understanding of how the "social" aspect influences the individual production of knowledge? There is something else in Hacking's proposal than the understanding of how communities of scientists or laboratory cultures affect that production based on the individual subject – something more than drawing attention to how certain social (community, cultural, etc.) actors intervene in the production of knowledge. Hacking's proposal radicalizes the "social" aspect of activity involving community cognition. How is that radicalization expressed within the context of scientific cognition? What does the – doubtlessly ambiguous – expression mean that a reasoning style constitutes objects, ultimately constitutes an independent world? Likewise, is the subject also made up

of style? And finally, how does a reasoning style reason, think, and know?

Like other discursive forms the reasoning style is made up of an anonymous, unintentional series of representations – of a performative nature, rather than merely specular representations or reflections of what exists – or signs located in space and time. To reduce this to a mere structure of representations would be equivalent to taking a blind alley. The style is more complex than the representations and signs deemed acceptable within the framework of a social structure. It is a *social* practice or, if one prefers, the *social* use of representations that constitute its objects and the world of which they speak. In this practice, stabilization techniques of style and objectivity standards are also formed – in other words, the conditions for making knowledge possible, expressed in a temporal and specific way. There is no place for intentional action by the individual subject in shaping the reasoning style. In a certain sense, this subject, insofar as it operates at the heart of the style, is made up of that style itself.

As in the explanation of other discursive forms, it is not easy to explain the transformations of reasoning styles, taking into account that styles can only be reduced by other styles, and that each style is self-justifiably closed. How can the style be justified, other than by that style itself? Are objectivity standards justified other than by the previously accepted objectivity standards themselves? Hacking, of course, does not attempt to offer such an explanation in his contributions on reasoning styles. Before him, Fleck had directly tackled this problem in his detailed study of the establishment of the scientific fact of syphilis.

4 The ambiguity of the disenchantment of the individual subject

In the core of Fleck's theory it is explained how change is possible in styles, which channel scientific development, and how styles can be displaced by others (Fleck 1935). To avoid circularity Fleck describes the role of the individual subject's action as a trigger of reference changes that allows one style of thought to be replaced by another. Such a replacement demands to establish elements that explain the displacement of one style by another. These elements are forms of communication between individuals who, generally speaking, take part in different thought collectives. The ambiguity of the role of the scientific individual remains, as shall be seen, unresolved in Fleck's thought collective theory. Yet this opens up a channel for us to reformulate the social dimension of scientific knowledge by considering the decisive function exercised by communication and the "circulation" of ideas in scientific cognition.

The most important contribution of Hacking's proposal is freeing the concept of style – be it thought style or reasoning style – from the psychical foundation, which appeals to the individual's consciousness or intentions. However, this is not the same as adhering to methodological collectivism. This may come as a surprise, as collectivism/holism is considered to be the alternative to methodological individualism and realism based on the principle of exhaustion ("individuals exhaust the social world in that every entity in the social realm is either an individual or a sum of such individuals", Kincaid 1994: 499). It is not a question of reformulating the old individualism/collectivism dichotomy, which was prevalent in the sixties. As I shall try to make plausible in the following section, it is more a question of situating the alternatives in other confrontations, and of replacing the subjects of the old methodological individualism with new "actors", new cognitive units conceived as some type of interaction process.

The methodological individualism affirms the "exhausted" reality made

by individual actors in science. It is ubiquitous in the philosophical approaches to science, which make use of social and economic theories of science, such as those of microfoundation and the rational actor, which reduce the collective to intentional actions by individuals (Hodgson 2007). Structuralist analyses and systemic approaches are also naturally oriented towards individualism (Giddens 1987). Similarly, the metaphysics of the individual subject prevents people, who adhere to communitarian approaches, from taking epistemological consequences (Longino 1994; Kitcher 1994). Kuhn (1962) also adopts the communitarian message, focusing on changes, which take place in the mind of the scientist. Kuhn's scientific individual is not a monadic, sovereign subject, but fits into the social processes and structures described in his theory of scientific change. Yet ultimately, it is the scientist who thinks and knows, although his/her thought is mediated by the paradigmatic context.

If individualism is ubiquitous in Kuhn's conception of scientific development (evolutionary or revolutionary), the individual subject fades in Fleck's thought style, a theory of discourse in terms of the production of facts and experience in science – significantly designated as "thought style and thought collective theory" by its author.

The central subject of science is, in Fleck's eyes, the thought collective, the "carrier" and the leading player in a thought style. Scientific facts are characterized as conceptual relations who are shaped according to thought style. The principles of science are capacities which form concepts and shape thought habits; theories are networks comprising knots of sentences; furthermore, clarity and accuracy in terms of knowledge are always relative to a thought style, in the same way that perceptions also prove to be constructs formed by style. Fleck ultimately characterizes reality as a network in a state of continuous fluctuation; the truth about principles only makes sense within the framework of this changing network (Fleck 1935: 131). In this thought-style theory, the individual subject becomes dissolved in the thought community, the new leading actor of knowledge. Knowledge is no longer conceptualized as an individual process, but rather as developing links of representations within a collective. In his view, knowledge represents the social human activity *par excellence*. Cognitive activity can not be within the individual agency. Fleck defines the thought collective through the concept of thought style. The *thought style* is not a particular manner of assembling concepts, but the specific constraint of seeing and acting in one way rather than another. Scientific facts are dependent on the thought style. All knowledge also bears the mark of a thought style in interaction between the individual, the collective, and scientific fact. The *thought collective is* defined as a community of scientists who maintain intellectual interaction involving the exchange of thoughts and ideas. The collective is not an organization made up of simple individuals – it is the "carrier" for the historical development of a field of thought, as well as for the given stock of knowledge and level of culture, i. e., of a specific thought style. "Knowing" and even "thinking" only make sense in relation to the meaning of the thought collective.

Nor is the collective the mere sum of the individual scientists who comprise it. The relationship between the collective and the individual is expressed by the relationship between the passive and active components of cognitive production. "Knowing" means mainly confirming the results imposed by certain given assumptions. Assumptions respond to *active connections*, and form the part of knowing that belongs to the *collective*. The corresponding results are equivalent to *passive connections,* and form what is perceived as objective reality. The act of

affirmation is the contribution of the *individual* (ibid., 16).

However, as it was posited at the end of the previous section, the determinant question concerns the dynamics of thought styles. How can change of thought styles take place, which have been subjected to persistence strategies? How can a new thought style emerge from another? Do bridges exist between styles? How is the history of thought styles supplied with material? Significantly, in order to find an answer to such questions, Fleck identifies an element outside the thought collective and its capacity to shape style. That element is language and the deforming and even neutralizing tendency of meaning common to communication and the circulation of ideas conveyed in that language.

An individual subject does not belong to a single thought collective, but rather to several of them. Fleck thus identifies not only one type of circulation, but two: an intra-collective thought circulation, and another, inter-collective one. Neither of these two types of circulation emerges without transformation and without a remodeling taking place according to the thought style. This is a transformation, which *intra-collectively* translates into reinforcement, and *inter-collectively* into a fundamental change in the thought being conveyed (ibid.: 143).

Thoughts and concepts *circulate* from individual to individual, being modified in the course of circulation, in such a way that other individuals make a type of association, which is distinct from them. Intra-collective circulation thus gives rise to a characteristic stylistic exchange, in which hardly anything of the original content remains. The thought that continues circulating belongs to a collective, not to a specific individual. Knowledge moves within the community, and is polished, reformed, reinforced, or weakened, while at the same time influencing other thoughts and concepts.

In inter-collective thought circulation, on the other hand faces a conflict of thought styles. There is a wide-ranging spectrum of change of thought styles, compared to a small number of persistence tendencies: from small changes in terms of the tone of a style, passing through a complete change in the sense of that style, to the style's total destruction. Lastly, a new thought style may emerge, which finally subverts the existing collective thought construction.

Fleck therefore suggests a social reality of the scientific subject beyond traditional individualism: science is a community enterprise in the public domain. In his approach, the social component is not confined to a mere socialization of the individual's thinking/knowing. He convincingly affirms not only the modeling of individual knowledge via a socio-epistemic entity such as thought style (*weak thesis* regarding the social nature of knowledge), but rather, he also asserts that knowledge of the thought style takes place irrespective of the minds of scientific individuals (*strong thesis*). A thought style constitutes its objects of knowledge, epistemological values and norms, and cognitive assumptions. A thought style *knows* – irrespective of the individuals constrained by it.

Yet this collectivist image is subject to the same criticism, which had been addressed at the main driving force of methodological holism in the field of social theory: Durkheim. Parsons (1968), Giddens (1984), and others have identified the difficulty in explaining that specific entity, which acts on behalf of the collective conscience.

In Fleck's image of science this role is played by the instance, which affirms the results imposed by certain given assumptions. But it is not possible to explain who is the actor acting on behalf of the collective in the formation of these assumptions. The crux of the matter can also be found in the actor network theory, put forward by Callon, Law, and others, unfit to distinguish

the individual action within the network – even in its most developed manner of identifying sub-networks within it (Nowotny 1990). Apparently, these collectivist/holist standpoints have to tackle the problem, how to treat the individual subject in a theory which pinpoints a new epistemic subject of a collective nature as central.

5 Epistemic networks as units of knowledge production

Methodological individualism does not manage to observe the autonomous social aspect of science. How can we explain the community nature of science – without risking the negation of individual action? It has already been pointed out that the prevailing epistemological realism affirms the existence of individuals as basic units of knowledge production. Alternatively, collectivism presupposes the existence of supra-individual collective entities – the collective conscience, the thought collective, etc. – as such "primitive" units of knowledge. A "third way" would give equivalent cognitive causal relevance both to the individual and to the collective level (Harré 1981; Jackson/Pettit 1992).

Our proposal situates the social reality of the subject of science beyond these approaches. It is not a question of returning to the dichotomies traditionally associated with the two premises (i) and (ii) of the principle MP, and of opting for the prevailing trends of epistemological realism and methodological individualism or their alternatives, which are equally hardly appealing. It is not a question of gauging the advisability of replacing individual subjects with supra-individual collectives. To start with, identifying the new cognitive unit means reconsidering both the understanding of individuality, and adopting an epistemology, which enables cognitive activity in general – scientific activity in particular – to be conceived as an internal construction of that cognitive unit. This means that three modifications need to be made: first, along Kantian lines, the abandonment of realism and the adoption of a constructivist strategy; second, a move away from the individual construction of the world towards social construction; and, third, identification of the unit of knowledge.[1]

Below, I will apply this strategy to a selective reconstruction of Fleck's historical epistemology, though ontologically deflated., In his realist sociological characterization he defines the thought collective as a community of scientists who maintain intellectual interaction. However, since the social nature of knowledge remains ambiguous, a characterization is problematic. As we have seen above, the assumptions of thought style constitute a response to "active" connections, and are attributed to the collective subject, whereas the confirmation of the results imposed – "passive" connections – are due to the individual. Knowledge ranges between the two subjects – collective and individual – without clarifying the ambiguity of the relationship between an *a priori* regulatory species (the thought style) and the role of the individual scientist. Fleck's relevant contribution is that of freeing the concept of thought style from scientists' individual consciences. However, its weakest aspect is the affirmation of a thought collective based on human actors – among which ideas circulate and is communicated.

The socially-reproductive nature of science only becomes visible if we adopt interactions as basic components of science. In other words: if we conceive knowledge as an essentially interactive process (Hutchins 1995), rather than situated in the mind of scientific individuals. The main problem therefore is to understand the nature of that interaction and to focus

[1] Hacking (1998) refers to a combination of the first two as "constructionism"; Fleck would, in his view, have been the first author who had a totally "constructionist" conception.

our attention: On the elements of interaction, or on the interaction relationship itself? On the materialization of knowledge, or on what Fleck refers to as thought circulation? On the individual or on the social aspects generated in that circulation?

We shall radicalize Fleck's constructionism by also including individuals. This strategy first attempts to unify what is *a priori* the regulatory aspect (thought style) and the thought collective as a set of individuals who establish intellectual and thought-related communication. The concept of the *epistemic netw*ork favors this unification, freeing historical epistemology from its individual or supra-individual foundations.

We shall characterize the epistemic network in a relational vein (Cassirer 1910), not as a set of coercive norms regarding "seeing and acting in a specific way", but rather as a network of elementary actions which give rise to other actions. The basic elements, which make up the network are not individuals, ideas, or norms, but interactions. To be precise, they are specific forms of communication circulation of the type Fleck referred to as *circulation processes*. They are the constitutive elements of the network.[2] The epistemic network is not constituted by norms or communities of scientists, but rather by circulation processes, i. e., epistemic forms of communication. They are related to each other, forming a network, which simply produces new circulation processes. Science is made up of such circulation networks, each of which acts as guidelines for providing characteristic ways of "seeing the world and acting in it" – because the world is constituted by the networks themselves. The circulation process constitutes its own order and the world of objects in science – what Cassirer refers to as *objectual knowledge*. Individuals are also *constituted* in this process. Individuals obviously exist and create circulation processes; however, we are not referring here to the same scientific subjects which we find in the theories of the "standard view", or in the semanticist, socio-historicist, or cognitive approaches in the philosophy of science, or in science and technology studies: the individual subjects of the thesis of epistemological realism – (i) of the MP.

Does the activity of science involve human subjects, scientists? The answer is yes. Does pragmatic observation of the actions taken by these scientists challenge philosophy of science? Certainly, pragmatism today is a battlefield. A subjectivist dogma is prevailing which reduces Peirce's interpretant to an interpretative component, to a psychological individual (or set of psychological individuals) equipped with intentions (cf. Giere 2004).[3] In my reading of Peirce, however, the understanding of a representant is attained by analyzing all possible interpretations and domains of that representant. I do not claim to defend a contextualist and modal understanding, as opposed to the orthodoxy established in interpreting the pragmatic principle. However, let us recall that:

> "Pragmatism is the principle that every theoretical judgment expressible in a sentence in the indicative mood is a confused form of thought whose only meaning, if it has any, lies in its tendency to enforce a corresponding practical maxim expressible as a conditional sentence having its apodosis in the imperative mood." (Peirce 1903: CP 5.18)

Therefore, the pragmatist principle makes possible another approach to

[2] Although at first glance this claim may be familiar with Luhmann's position in his systems theory of science (cf. Luhmann 1995: 138), there are at least two basic differences between the two views. One difference deals with the resulting images of science (system *vs*. network) and the other with the different scope of the theories that must account for them. Both conceptualizations hardly can be integrated.

[3] Giere captures the activity of representing in the formula "S uses M to represent W for the purpose P".

understanding the significant behaviour of individual agents in scientific action. We can interpret the meanings of consequences as separate products, which may be distinguished from the individuals who have produced them. In this case, the object of the study is no longer that of individuals' purposes, but rather, the internal structures of the products generated.

Furthermore, individuals in epistemic networks differ in terms of an ingenious identification with their status as humans, because of their socially established reality. Individuals in science are not humans equipped with a specific psychic organization and intentions. Just as epistemological obstacles separate the "scientific spirit" of psychology from people who have had no access to science (Bachelard 1935), so do human actors in our interaction approach also have a dual identity. Individual actors from the network are constructs in the circulation processes that *socially* constitute the world of science. This constitution is clearly separated from the reality created "solipsistically" by individuals. Both forms of constitution (social/objective and subjective) are juxtaposed, although the actions leading to such constitution processes are not. Individuals are necessary in order to create circulation processes. Thus, we can attribute to individuals a role in the circulation and talk about subjects, i. e. they are necessary for forming the community of circulation processes. However, intentions and the psychical organization of individuals no longer enter into these processes. The same could be said of collective subjects.

The conspicuous function of the interactive circulation process is to organize the *immersion* of subjects – individuals and collectives – in the social (objective) constitution of the world. The immersive experience is an open interactive practice. The communication of thoughts and concepts requires, – which, in Fleck's view, a continuous modification of these "from individual to individual", in order to avoid closing the circulation system. This can be accomplished by recursive application of epistemic skills. The development of these skills in the interactive circulation process makes sense in the context of three differing components which we refer to as the "style" of the network: intervention on the part of the subject in interactions, the material content of circulation systems, and the interpretation of that content.

Circulation networks are not systems or subsystems but link agents (or nodes) in a loose coupling manner. These networks function as loose structures within them coexist strong and weak ties (circulations) between nodes. The character of lax structure favors the role of individual agency and, therefore, allows a variety of modes of agent's intervention that set up the style of the network. That style is also shaped by the content of the circulation processes that can be very different: models, concepts, lab results, …. The interpretation of that content is given by the type of circulation: there is no one single source of content production (such as science and its institutions) but multiple sources that generate asymmetrical circulation processes.

How can the structural change in – or of – epistemic networks be explained? It has already been stated that networks are self-validated units. Neither the invocation of superior "subjects" nor an appeal to the relativism of our cultural networks would seem to be suitable strategies for explaining the change. I shall merely point to another possibility. Although it has not been dealt with here, it would be a mistake to think that epistemic networks only comprise privileged collective actors – the communities of scientists. In our societies, science is a public activity, which is extraordinarily productive for innovation and social change. Yet, in the current situation of uncertainty and risk, science cannot claim to monopolize epistemic authority fully (Bechmann 2009). Collective actors, such as associations, trade unions,

companies, and political institutions, etc., generate their own capacities for producing knowledge which are incorporated into epistemic networks – at times, to oppose results that have previously been obtained in them.

This gives rise to hybrid epistemic networks with heterogeneous actors who, on the other hand, form part of other networks. Coalitions of new circulation processes are thus outlined, both between scientific networks and between these and other forms of social discourse. This fragmentation cancels out the claim of the centrality of a single epistemic network for society as a whole. In accordance with the proposal put forward by Hacking, the study of the production of scientific objectivity thus could be a solution for philosophy and sociology of science, owing to the existence of multiple networks. Yet, in addition to analyzing the sanctioning and validation of the knowledge produced, the new challenge in the study of (scientific) knowledge also involves analyzing the *reliability* of cognitive production (Goldman 2003). To a certain extent, a constructivist approach makes it possible to face this challenge reasonably. If the different epistemic reticular organizations produce equally objective knowledge within different contexts, and there is no need to resort to authorities in order to assess or settle the dispute, analysis may focus its attention on the procedural elements of the flow of circulation networks, i. e. on those related to intervention, content, and interpretation. The explanation of assumptions, content, and consequences, which constitute the world of action in the epistemic network, may be accessed through them.

6 Conclusion

The issue of the subject of science remained veiled throughout the past century in the mainstream of the philosophical study of science. Scientific objectivity was an undeniable fact of science, which could be identified via logical-methodological channels and means, which could be adapted to the diverse reality of science. When the study of science is forced to introduce a social reality for science, it can nonetheless not be immunized against the reality produced by other types of discourse sustained under the prevailing premises of the epistemological realism of humans and methodological individualism. Thus, the attempt to produce in the philosophical study of science a collective image of science has been exposed to the interference caused by those premises in well-known theories of social science, economics, and sociology in particular. Despite this, the trivialization, which has undergone the analyses of these theories – above all, in Anglo-Saxon philosophy – has torn to shreds attempts to offer attractive philosophical images of the scientific collective enterprise, and of how it socially constitutes its world.

So what can we learn after half a century of the philosophical study of science? Without doubt, the introduction of subjects has proved a success in recent decades, and has influenced philosophical practice. However, the expectations of a community image of science, it has given rise to – at least since Kuhn (1962) –, have been dashed; one criterion: few sociologists would currently follow philosophers in their attempts to identify "collective subjects" of science from pre-scientific images of the prevailing human agents in philosophy.

Some authors advocate the construction of a new mainstream in the study of science. In this paper, we have situated the social reality of the subject of science in collectivity, in a network organized as a nexus of identity and action. We conclude that the community organization of science is not made up of human beings who act via intentional actions, but rather by networks of interactive processes – namely, by circulation processes of communication, which constitute the network. These networks are units of

knowledge, which know and constitute their objects and their own social reality. This differs from the manner in which their members know and constitute theirs. The social constitution of science is coupled with that of the psychical constitution of its members. However, these are essentially different forms of constitution created through basically different actions. The actions of the network cannot be confined to the individual actions of its members.

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