RASK 51
SPRING 2020

How to account for tacit knowledge in innovation processes: the concept of 'network within'

LAURA LUCIA PAROLIN[1] & ALVISE MATTOZZI[2] [1]

[1]University of Southern Denmark
[2]Free University of Bozen-Bolzano

ABSTRACT
This article aims to address the issue of describing innovation beyond the individualistic viewpoint. Focusing on the work of a craftsman supplier developing a new product, we propose a way to account for an emerging innovation within the production supply chain. The article shows how the design of a new artefact involves a multiplicity of actors (both human and non-human). The craftsman rearticulates the relationships between bodies and materials through trials and attempts, while developing his tacit body knowledge to appreciate and sense these relationships. We propose the concept of a 'network within' to account for how innovation emerges in the shape of new configurations of the network of (human and non-human) bodies. In so doing, we contribute to the debate on innovation by showing that, instead of considering knowledge as something transported by the networks, we should rather consider it as the outcome of transforming the networks' relations.

KEYWORDS
innovation; tacit knowledge; Actor-Network Theory; inter-bodies knowledge; 'network within'.

1. Introduction

In his introduction to the *Oxford Handbook of Innovation Studies*, Jan Fagerberg (2005, 2) underlines that innovation is still often described from an individualistic viewpoint, although by now it is generally seen as an organizational phenomenon. The focus on the individual, Fagerberg (2005) continued, has meant that innovation studies, even when they go beyond the individual dimension, still show a fragmentary understanding of how knowledge works at the organizational level. With the present article, we meet Fagerberg's challenge to further investigate the

1 The article is a collaborative work and has been thought and planned by both the authors. In any case, if for academic reasons it has to have a specific individual responsibility, consider that Laura Lucia Parolin, who has also carried out the field study on which the article is based, has written the following paragraphs: § 2, § 4; Alvise Mattozzi has written the following paragraphs: § 1, § 3.; the conclusion (§ 6) and § 5 have been written by both together.

parolin@sdu.dk & amattozzi@unibz.it

relationship between knowledge, organization, and innovation, and suggest a possible way to go beyond the impasse he detected.[2] We introduce this possibility by taking into consideration an artisan who works in the Brianza furniture and manufacturing district.[3] The fact that we are focusing on one specific person in order to redress the individualistic interpretation of innovation could seem to be a paradox. However, as we will see, this person is nothing but an actor within a broader network who, at the same time, is a network of its own with a specific work and entrepreneurial format.

In the social sciences, and especially in social network analysis, networks are usually considered as configurations of (pre-existing) actors or nodes that enter into relations or form links with other actors. We consider, instead, the becoming of actors that constitute a network, considering their configuration as constituted first of all by relations whose points of convergence "individuate" actors (Latour 2005)[4]. In other words by following the work of an individual we are able to trace the reconfiguration of the network that constitutes an innovation (a new product). Using the tools and the descriptive apparatus of Science and Technology Studies (STS), in particular of Actor Network Theory (ANT), we will describe, and account for, the origin and rise of a specific element of innovation, namely *tacit knowledge*.

2. Tacit knowledge

In recent years, practice-based studies of work and organization have drawn attention to the importance of the body as a site of knowledge and knowing (Parolin & Mattozzi 2013; Hindmarsh & Pilnick 2007; Strati 2007; Yakhlef 2010), stimulating a renowned interest in craftsmanship and craft practices (see Bell & Vachhani 2019). On the one hand, these authors underline how craftsmen's work is characterized by tacit corporal knowledge (Strati 1999; 2008); on the other, relying on the concept of community of practice (Lave 1991; Lave & Wenger 1991) they stress the process of knowing while activities are being performed (Gherardi & Perrotta, 2014). In this article, we are addressing both reflections (though from a particular point of view).

Tacit knowledge is "informal know-how rather than explicit, systematized belief; it is unverbalized and perhaps unverbalizable" (MacKenzie 1996, 11). It is a knowledge of a practical character, tied to a non-formalized knowhow that is not easy to formalize or to express verbally – in other words, it is *embodied* (Pavitt 2002). Here, we will deal mainly, even if not only, with what Collins (2010) calls "somatic tacit knowledge". Through our analysis we will provide a way to make such somatic tacit knowledge explicit, as Collins (2010) proposes. However, differently from Collins, we will not assume an asymmetrical, "Cartesian" approach (Collins's expression), exclusively focused on the human body. We will also consider the bodies of the artifacts; for us, somatic tacit knowledge is not just an issue of embodiment, but of inter-bodiment or affect.

2 In Parolin & Mattozzi 2014 we answer a similar question. However, in this previous article, the focu was more pointed at the peculiarities of what we called the "Italian way of innovating".

3 It has to be noted that the research at the base of this article has been carried out in the Brianza furniture district. Thus, a place characterized by productive localization (Crouch et al., 2004).

4 For a similar definition of networks as a mesh, see Ingold 2013.

Tacit knowledge is tied both to the person who owns it and to the group through which it is spread in the course of complex processes, characterized by co-presence and the partaking of a specific practice (Brown and Duguid 1991; 2001; Lave and Wenger 1991). It is for these reasons that tacit knowledge is strictly bound to the territorial environment of its production; as such it has been defined as being "spatially sticky" (Gertler 2003)[5]. As MacKenzie (1996) noticed, referring to Polanyi (1967) who introduced the concept, and to Collins (1992), this kind of knowledge plays a relevant role within scientific practices, in particular within the experimental ones that normally depend on exact statements (as is the case, for instance, for engineering practices, which are based on quantified scientific research and on explicitly defined protocols; MacKenzie 1996). By contrast, tacit knowledge has an important role in practices that do not require such levels of explicitation but are, on the contrary, more informal in their constitution and practices.

Precisely because tacit knowledge is not formally expressed or codified, it is not easily verbalized; for the same reason, it is not recordable, and hence difficult to detect and analyze (Parolin 2012). Consequently, many innovation studies have either disregarded this dimension as not being particularly relevant (Krugman 1991, 53; but see Breschi and Malerba 2005), or have been looking for indirect indicators (such as citations inside patents) in an attempt to stress the relevance of proximity relationships for the circulation of knowledge (Ramella and Trigilia 2010; Zucker, Darby and Armstrong 1998)[6].

3. The methodology: analyzing tacit knowledge in action

The data we are introducing stems from a case that can help us discuss the characteristics of the innovations that are the outcome of the design and the productive work that takess place inside a particular *locus* of tacit knowledge. Our study is part of a broader research project on the inter-organizational relationships in the Brianza furniture district carried out by one of the authors (Parolin 2010a; 2010b; 2012). In addition to what was mentioned earlier, this research included not only a documentary analysis and dozens of interviews with privileged witnesses who were active in the district associations, at fairs, in Small and Medium-sized Enterprises (SMEs) involved in the supply and sale chain of the furniture sector, but also observation of the

5 Over thirty years have gone by since when the economist Giacomo Becattini, after having re-discovered Alfred Marshall, re-launched the concept of the industrial district (Beccatini 1979). What ensued has been a localization of our attention on the economy, pivotal for the research on territorial development (among others, Crouch et. al. 2004; Pichierri 2002; Trigilia 2005), capable of offering keys for the interpretation needed to read the dynamics of innovation. An important element in order to understand not only the economic resilience of districts, and more in general, of territorial agglomerations, but also their innovative capacity, regards both knowledge and the competences that are generated and spread inside of them. If on one hand the access to explicit, verbalized, and codified knowledge is increasingly simple, also thanks to the presence of means that allow for a broader circulation and publicity, what qualifies innovation is "tacit knowledge" that, thanks to its characteristics, cannot but be spread on a local basis through contact and sharing (Maskell and Marmberg 1999).

6 It has to be noted that in the past fifteen/twenty years, various approaches to the study of innovation have started to focus their attention on the spatial distribution and grounding of innovative processes (Aydalot 1986; Camagni 1991; Florida 1995; Krugman 1998; Morgan 1997) by studying in particular the agglomeration of the enterprises within which and among which such processes are defined (Asheim and Gertler 2005). The network is identified as a locus for innovation capable of granting the integration of forms of inter-disciplinary knowledge at a high variability (Powell and Grodal 2005).

interaction in a firm's stand at the Salone del Mobile di Milano. Data were collected through ethnographic observation, by recording the informal conversation that occurred while observing the work of several craftsmen who were suppliers of an important firm operating in the design furniture sector.

The observation was conducted in a non-continuous way for a period of about two months; the intention was to investigate the relationship patterns between a firm and its supply chain while starting the production of a new model of chair. Our initial attempt, which consisted in a 'shadowing' of the product manager (also called the buyer) and of the chair whose development he was following, was often interrupted because of issues of privacy and industrial non-disclosure. For these reasons, too, our study is not only kept anonymous – the various authors' names are not revealed, contrary to common practice –there also are no pictures.

The current case, which has been extracted from the broader research, allows us to focus specifically on the role of tacit knowledge in innovation processes. As initially stated, Fagerberg (2005) complains about the lack of empirical accounts of the actual exchanges between the nodes in an innovation network. Here, while trying to overcome the impasse identified by Fagerberg, we adopt a viewpoint that is slightly different from the one he suggested. Rather than assuming knowledge to be content that is exchanged on pre-existing networks, the observations offered below aim to describe the deployment of innovation as an assemblage of relations and their transformations. As shall be seen, we do not consider knowledge as something transported by the networks, but rather as the outcome of the transformations of the network's relations; we see innovation as the emergence of new configurations of a network.

A framework like ours originates in Actor Network Theory (ANT; Latour 1999; 2005), an approach that offers the advantage of taking into consideration networks, not so much as made up of knots and of relations among knots but rather as configurations of relationships in a transformation or in a reciprocal translation. Moreover, ANT offers the further advantage of taking into consideration not only human actors, but also non-human ones and, in particular, objects and materials that have high relevance in the innovative processes we observed. ANT attributes, above all, relevance to relations (Latour 2005, 217), which it is interested in describing independently from the kind of actor (human or non-human), which constitutes them or from which they unfold.

4. The case: Carlo and the chair seat

Carlo[7] is a chemist. He once worked for one of Europe's largest chemical industries that sells some of the most widely distributed synthetic polymer kits used in molds. Today, Carlo owns his own small enterprise and produces semi-finished synthetic polymer products. The distinctive feature of his enterprise is the know-how of using basic chemical elements (rather than the most widely distributed pre-packaged kits). This has allowed him to create ad hoc mixtures to use in molds.

7 All names of people, firms, and products have been invented.

Stefano works for the production department of his firm (which is the object of this study) as buyer (or product manager) of semi-finished products. The firm, one of the best known enterprises in the Brianza furniture district, produces furniture. Being in charge of the production of a new kind of chair (that we will call Calepina), and seeing Carlo as a crucial resource for his firm, Stefano went to his workshop in order to assign him a commission; for this, he brought along several blueprints of renderings of the new chair, together with a prototype of the seat, made of a thin wooden plate covered by plastic material. When Stefano showed Carlo the project, he described and commented on the blueprints of the renderings and the prototype. The chair as resulted from the drawings and from the wooden model of the support – both designed by a famous design studio not part of the firm – was of a structure in tubular steel with a polyurethane foam seat on a metal plate, all of which to be upholstered in leather. Stefano's commission was for Carlo to develop the seat. By commenting on the prototype with wooden support, Stefano illustrated to Carlo the characteristics the new chair should have. His specific request was to develop a seat that should be "soft but supportive". [8]

The renderings, the prototype with the wooden support, Stefano's requests regarding the materials to be used and the overall effect of the chair– as an outcome of the relations between the materials – made up the issue that Carlo's enterprise had to tackle by finding a specific articulation of the "thing" (Storni 2009; 2012), so that it could become a stable object (Parolin 2010b; 2015). Doing this, Stefano introduced a series of elements and relations among these elements, such that the loose network would become a cohesive one.

The various artifacts – including the verbal requests (Cooren 2010) – predisposed Carlo's space of action, although not in a coherent and unique way. Thus, they constituted a 'weak' script (Akrich 1992; Akrich and Latour 1992) that anticipated what had to become the actual script of the seat, once stabilized: "soft but supportive".

Carlo was given the task of combining two features that are, as the use of the adversative conjunction "but" shows, considered somewhat incompatible. It was not only a matter of starting the production of a semi-finished product as part of the supply, but to redefine it, thanks to a specific combination of materials capable of supporting the weight of the user while, at the same time, feeling soft and fluffy when in contact with the body. Following the explanation of the renderings and the prototype made by Stefano, Carlo initially focused on the two materials specified in the design of the seat: metal and polymers. Their relation, as a juxtaposition, seemed clear: the metal core was meant to grant support, while a so far undefined mixture of polymers would provide softness. It was a literal translation of the overall effect the seat was meant to have, and which was implied in the directions that Carlo had received.

The juxtaposition and its diverse variants resulted from Carlo's experiments with the different compositions of foams which he had tested on his own body. It was a sort of "trial of strength" (Latour 1987: 78) to verify the coherence and cohesion of the network that was being gradually articulated between the participating knots, the human body and the "body" of the

8 It should be noted that the face to face relationship plays a relevant role here. Carlo's tasks is discursively con structed within his interaction with Stefano. The various artifacts Stefano brings with him also play a crucial role in such face to face interaction.

seat, the latter made of metal and foam. Or maybe more accurately, it was a "trial of sensitivity" (Parolin & Mattozzi 2013), since the objective of the experiments was not to test the stability of this network (Latour 1987) – which was still far from being stable – but to secure a better stabilization [9] by reciprocally sensitizing the various bodies whose relations constituted the network.

The result of the experiments did not satisfy Carlo and his (human) body: he did not find the combination of materials that affords both support and softness. That is why the juxtaposition of metals and polymers made him reconsider the essential feature of softness: it was not only a question of a greater or less resistance to the pressure of the sitting user's body, but also of the material's capacity for accommodating the shape and pressure of the sitting body. His reconsideration revealed the metal core wasnot only "supporting" but also "hard" and "stiff," since it did not yield to a body pressing on it or follow its shape[10].

The initial network (resulting from the materials and their relationships) established as a literal "translation" (Latour's term; Latour 1987: 108ss) of the juxtaposition of "supporting-metal" and "soft-polymers" was not adequate, or better, not sufficiently sensitive.

Thus, the initial network constituted, as a literal translation, the juxtaposition of the metal (translating "supporting") and the polymers (translating "softness"). In the following experiments, Carlo therefore tried to sensitize the metal 'body', or perhaps more precisely, the area occupied by the metal, to the body of the sitting person, by making the two bodies co-penetrate: the metal plate was pierced in order to allow for the passage of the polymer material from one side to the other, thus introducing inside the very metal some "softness," in order to modulate its stiff and hard character. With these attempts at sensitization, Carlo experimented and verified, through various "sensitivity trials" on his own body, different combinations of metallic frame and polymers in order to realize a second translation, based not on a juxtaposition but on a relation of co-penetration. On the basis of the sensations his body received from each combination, Carlo gradually changed the seat; increasingly, its frame became a flexible element that, once introduced into the chair's structure, was enveloped by the polymeric material.

Even so, none of these combinations gave the kind of outcome Carlo was looking for his semifinished product. Upon testing the product on his own body, Carlo was remained dissatisfied with the seat's ability to accommodate the sitting body. In addition, during the various stages of experimenting the seat's suitability to accommodate the human body had become an increasingly important feature.

The metal core anticipated in the early design had now become a "traitor" actor (Callon 1986): its stiffness, even after modulation, could not be eliminated. Despite his many efforts to "interest the metal" (Callon 1986) and sensitize it to the body sitting on it, it remained not "enrollable", as Callon (1986) notes in his exploration of the "soft but supporting" property. While he was exploring the materials and their relations, Carlo introduced textile fabric to separate the various mixtures of foam, as his observation of the behaviour of the fabric in the mold had made him think of discarding the metal. He inserted an actual textile fabric (a kind of felt) in the

9 Latour (1987) focuses only "trials of strength", however we are tempted to say that also in scientific labs – main objects of Latour's study – "trials of sensitivity" do take place, especially on instrumentation.

10 Our proposal aims also to stress the continuity between signification in the verbal articulations and its translation in specific material articulations.

mold, rather than a fabric of processed metal. This material was considerably less stiff than the metal, and Carlo's hope (based also on previous efforts) was to "interest" it in supportability by placing it in relation with polymeric resins. In fact, felt (thanks to its porosity, which is absent in metal) can absorb the resins in order to harden and become more rigid, thus offering sufficient support to the human body.

Figure 1. A simplified reconstruction of the main steps of the evolution of the supporting element: A. metal plate; B. metal plates with holes; C. metal-mesh; D. felt fabric, to be stiffened.

The felt fabric absorbs the resins that, due to their chemical composition and the characteristics of the used felt (its thickness, density, etc.) enable different degrees of rigidity without completely losing the ability to suit the body. Moreover, because of its thickness, felt allows for internal combinations that are not necessarily possible on the outside, as metal, in order to become more flexible, has to be made thinner, which makes it lose its capacity of distinguishing between what is happening inside of it and on its surface.

Through experimenting with various configurations of the materials and sensing them out, Carlo was led to a new configuration (an integration) of the materials and decided to change his strategy. Rather than having the metal more adaptable by making it less rigid, he made the fabric stiffer and more supportive, thanks to its combination with the resins. Then, after he had changed his strategy of combining the chair's materials from juxtaposition to integration, from metal inside plus foam outside, to fabric inside plus penetrated/penetrating polymers outside (in a "co-penetration"), Carlo experimented further to find the right combination between fabric and polymers, in order to obtain both the necessary resistance to pressure and a suitable adaptation to the user's body.

In this way, the interaction of various (human and non-human) bodies and their reciprocal sensitizing (in various "sensitivity trials" , allowed Carlo to reach a stable configuration of a network whose nodes consisted of various materials, and were linked through mutual interaction and sensation; together, they made up the seat as we know it today. Even despite being somewhat different from the one drawn by the designer, the semi-finished product was initially approved by the enterprise, and eventually not only became the seat's final version , but has triggered an innovation to be used with other products.

5. Discussion

5.1 Why Calepina is a case of distributed tacit knowledge

The case discussed above illuminates the artisanal and aesthetic- sensorial aspects of stabilizing the Calepina artifact. As we have shown, this process is informed by the tacit dimensions of a knowledge distributed among a plurality of both human and non-human actors[11].

With regard to the human actors involved, we have to analyse the distributed tacit dimension of Carlo's and Stefano's relation. When Stefano meets a supplier like Carlo, the way in which he introduces the project, the sketches, the renderings, and the prototypes is decisive for Carlo's involvement in the re-configuration of the semi-finished product. This happens because Stefano is capable of assessing whether the artefact needs a new configuration; which suppliers are more suited to further develop the product; how to involve them; and last but not least, how to coordinate their work, as it happened in our case. Stefano does not only know about Carlo's competences, he also knows how to appreciate and judge the technical details of his work. Moreover, in accordance with the demands of the situation, Stefano is able to coordinate the actors, artefacts, and their different relationships; among other things, his tacit knowledge is crucial in hiring the suppliers to involve them in the reconfiguration of the final output of the new product, whose innovative qualities were due to Stefano's and Carlo's similar views on the needs of the future product; and their common and mutual tacit knowledge led to their finding a new solution for the artifact. Their relationship is based on a trust which is not only essential to their working relationship, but at the same time is enmeshed in their technical knowledge of the materials, their familiarity with the product, and their exchange, based on the direct perception of the various materials at hand, about the need to look for new solutions. In the current case, Stefano leaves it to Carlo to find a new solution; conversely, Carlo trusts his interlocutor's ability to recognize his professional skills and value his contribution to the configuration of the new artefact across organizational boundaries.

The innovative processes that arise from these inter-organizational relations of skills and trust are based on some fundamental ingredients, such as knowledge of the materials and their relative properties, in addition to skills in recognizing quality – not only of the work process, but also of the ability to promote innovation (including the indispensable publicity).

Regarding the distributed tacit dimension among human and non-human actors (here, Carlo and the materials), Carlo's task is to correlate the tactile sensation of the (original) seat with the available materials, sketches, and prototypes, in addition to the verbal exchanges and his own and the others' bodily sensations, while continuing to consider the Calepina artefact in its totality.[12]

Carlo's work on the seat of the chair has availed itself of forms of knowledge that are, for the most part, tacit. His capacity for using basic chemical elements comes only partly from his

11 A feature of Actor-Network theory is to avoid an a priori consideration of human and non-human agency.

12 In a previous article (Parolin & Mattozzi 2013) we proposed a model to account for knowledge through body relations the interactions between craftsmen and artefacts and, more in general, for the creation practices that account for the passage that takes place between the whole and the detail.

formal training. It was his practical working experience with an important European chemical industry that allowed him to acquire familiarity with the chemical substances necessary to create ad hoc compounds. Moreover, as it often happens with a kind of knowledge of the handicraft type, it is through his tactile sensitivity that Carlo judged and worked on the outcome of his own interactions with the materials (Sennett 2008).

Carlo's relationship with the materials involves his capacity to take in consideration their different properties and "behaviours". Through his sensitivity, Carlo was able to enter into dialogue with the materials and put them into a relationship. As we have seen, Carlo first focused on metal and polymers, two materials anticipated by the projected design of the seat. However, he understood that the object lacked the required softness, and he changed the material articulations. Thus, he changed strategy and the articulation of the chair – from metal-inside+-foam-outside to fabric-inside + penetrating polymers-outside.

While trying out the materials' various configurations and sense impressions, Carlo's experiments were guided by the very materials with which he interacted in order to find a new integration. He had to change his strategy: rather than having the metal become less rigid and more adaptable, he chose to make the fabric stiffer and more supportive – something which was made possible due to its reaction with the resins. Through the interaction of the various bodies – human and non-human – and through the distributed process of sensitizing both, he reached a stable configuration: a network consisting of various materials, their interactions, and the sense impressions they produced, all of which together make up the seat as it is today.

5.2 What this case tells us about innovation and ANT

As said above, in our opinion, a network-based approach like Actor Network Theory permits us to account for the emergence of innovation, including its relationship with the tacit knowledge of the actors involved.

What distinguishes ANT from many other network-based approaches [13] is the specific conception of network it proposes. In most network-based approaches, a network is considered to be knots (agents) and connections among these knots (relations); their statuses and roles are clear, distinct, and well-defined from the very beginning; and the knots pre-exist to their relationships. By contrast, in ANT things are a little more complex. The tension between actor and network that ANT alludes to in its very name is a consequence of the fact that actor and network are not defined a priori, but are situationally and processually inter-defined: actors are constituted by their networks, and therefore do not precede them. At the same time – and precisely because of this – each actor is also a network; therefore, any network can be considered in its aspect of actor and vice versa; there is a radical reversibility and recursion between actors and networks. Because of this (as already underlined by Latour 1993; 1999), we should talk of a "rhizome" (Deleuze and Guattari 1980), rather than of a network.

13 As we anticipated, there is a broad agreement on the fact that innovation is a network phenomenon (Asheim and Gertler 2005) that has to do with heterogeneity, as already shown by ANT (Callon 1999; cfr. also Gherardi 2010).

Consequently, we disagree with Russo, who sees the actor-network as a sort of "hub" that "constitutes the fundamental nucleus from which innovative processes radiate" (Russo 2013, 338); even though it sometimes functions this way, in essence a network is a tension between two states, one spread out and decentralized, the other more circumscribed and defined.

Moreover, while statements such as these may appear far removed from empirical research, in reality they are not, inasmuch as they have consequences for the collection, their description, and analysis of data. A stringent actor-network approach cannot determine a priori which are the actors-knots of the network in question; above all, it cannot postulate their dimension, scale, consistency, and cohesion. In effect, if each knot is itself a network, one may often have to describe and define the "network within" that constitutes each actor. Only by taking into consideration this network within, is it possible to account for the various "translations" (Latour 1987, ch. 3) an actor faces (or, in other words, for the ways in which the network constituting a given actor is re-configured upon its entering into a relationship with other actors-networks)[14].

As to our own research, once we had decided that due to the inter-organizational relationships referred to above, its relevance also was affected by the ways in which a certain product is developed. Hence, we could not limit our research to mapping the connections between a limited series of actors-knots, as between the prestigious firm managed by Stefano and referred to above, vs. Carlo's small firm (including his use of several techniques and artifacts). It was necessary to follow also how the very product could emerge as an actor-network constituted by the relations among certain materials, bodies, sensations, etc., as well as by the outcome of these relations, and their successive re-configurations. But this also means that we have to follow Carlo and account for how he, as actor-network, becomes another when entering into a relationship with these materials, bodies, and sensations outlined above.

For example, the Carlo in the final stage of developing the seat prototype is not exactly the same Carlo that he was at the beginning of the process[15]. The relations that define him have changed: they now include a certain knowledge about, and a competence related to, softness, as well as knowledge about, and competence related to, the production of a certain kind of seat that is based on new relations between objects such as felt, polymers, resins, and a mold.

The need to not a priori assume which are the actor-knots, and how they are configured, is even greater when we are analyzing innovation processes. Clearly, the outcome of an innovative project should be the emergence and the constitution of new actors – and, inevitably, of new relations. Although, as Latour (1993, 67) states, what makes an innovative project differ from a non-innovative one is not the actual presence of new actors, but whether the number of actors partaking in the entire project, and the network they constitute, is a given, or was foreseeable from the beginning; such is never the case for an innovative project. In our case, among the actors initially considered, there was a metal plate for the seat. However, the research done on "softness" caused it to be substituted by a piece of felt that, when compared to metal, enters into a different, if not opposed, relationship with the polymers used. Not only did a new actor emerge (the felt that stiffened when impregnated by polymers), but in addition, the network itself ac-

14 The concept of the "network within," in the moment in which it allows to account for knowledge – not as something carried over by the network, but as a transformation of the very network – also allows us to account, in turn, for what is defined, as for humans, "the production of practical knowledge" (Gherardi 2006; Nicolini 2012).

15 He developed his practical knowledge regarding the interactions between bodies (human and non-human ones).

quired a distinct, new configuration. This outcome was not predictable; it emerged only in the specific relation between the participating bodies, such as the one established between Carlo, the prototype, and the materials.

The notion of "network within" allows us to highlight that design when seen as "making sense of things" (Krippendorf 1990; Verganti 2009), is not just a task of designers and managers - as, for instance, outlined by Verganti (2009) - supposedly the only ones to have apt semantic competences to design, but of a plethora of actors distributed in the productive network and who are able to articulate the "network within" of the artefact, within and in connection with the outer network of the industrial district and the beyond one of the market. Thanks to this competence, craftsmen like Carlo and intermediate executives like Stefano [16] can give life to products by coherently translating the semantics suggested by the designer and appreciating its value.

Competence, tied to design, is part of the knowledge that is owned, exchanged, and developed by the suppliers-craftsmen within the innovation network we have studied; as we have seen, this knowledge is mainly tacit, or at least sparsely verbalized. As we have shown, a good part of this tacit knowledge can be hard to formalize verbally or be made explicit, inasmuch as it is spread among human and non-human actors. Tacit knowledge is thus a kind of knowledge that emerges in a relationship with the artefacts with which the suppliers-craftsmen interact. Rather than being simply embodied, it is an "inter-bodied" knowledge, a knowledge situated between the bodies of artefacts and materials, and those of the suppliers-craftsmen. If a certain verbalization is possible – as we have partly tried to do – it is only possible by taking into consideration this inter-bodied interaction. This also means that the knowledge in question is not easily recordable or transferable: not being mobile, it re-emerges whenever it is re-enacted, every time we are in contact with the objects or materials involved.

The above considerations lead us to the final two questions we would like to raise in relation to tacit knowledge. Carlo has several practical competences, but as his practical knowledge develops, the related outcomes are only outlined through experimentation, by trying out the relations among the several bodies. Contrary to what a naïve contrast with explicit verbal knowledge might make us think, Carlo's tacit knowledge is thus not immediate: it only unfolds by going through frequent mediations. Precisely because of this emergence through various trials – observations, comparisons, adjustments, corrections, involvements, and distancing – this knowledge needs time, and freedom to experiment. You need to have the "luxury" of following a wrong path in order to learn, based on that experience, which is the best way. However, this luxury, as all luxuries, comes with an economic cost – in addition to a cost of time; it is made possible by the freedom to explore offered by Stefano, the buyer, in the form of a very loose agreement – we cannot call it an actual contract – by which he trusts the competences and sensitivities of Carlo, the supplier, by asking him to develop the product "as you deem best" (Parolin

16 The technical knowledge of those who take care of the acquisition of semi-finished products is an important skill in the management of a system that can produce innovation. Such system is based on a relationship that relies on trust, which we argue it is not external to the working relationship, but is entwined in the technical knowledge of the materials, of the product, and of the same process of articulation of new solutions. The enterprise entrusts the supplier to find a new solution and the supplier confides in the capacity of his interlocutor to recognize his professional skills, and therefore his contribution to the articulation of the new artifact.

& Mattozzi 2014). This kind of agreement, and the exploration and experimentation it triggers, allow for the emergence of the unexpected, and therefore of an actual innovation (Latour 1993). As recounted by our informants, this kind of agreement is difficult to explain to the top management which has no access to knowledge and skills developed in the production department – a management uniquely reads its relationship with the suppliers in terms of the unit cost of the final, semi-finished product. Only within a relationship based on the trust, grown out of a practical experience with the product, side by side with the producer, is such an agreement possible.

6. Conclusions

The description above has shown how configurating a new artefact involves a multiplicity of actors (both human and non-human); specifically, innovation is not only the fruit of an assemblage, or network of relations, but at the same time the outcome of various Latourian "translations" from and to different instances. In our case, these instances were manifested as prototypes, sketches, briefs, requests, and ways of involvement in which bodies, materials, enterprises, professional figures (such as the buyers, suppliers, craftsmen, etc.) are actors, but also networks, taking part in the action (even if at times just by offering resistance). Each one of these actors emerges from a network of relations, but in addition, they are all specifically constituted by an inside network of relations – the "network within" that was described earlier.

Consequently, the study of innovation as a network phenomenon cannot be limited to tracing relations among predefined knots (agents); we also have to take into consideration those inside networks, if we want to account for how the instances in question transform and re-configurate themselves, by being "translated" reciprocally. Moreover, we should pay attention to how these processes allow innovations to emerge as new instances that, by remodeling the existing instances, re-configurate the very network that has generated them.

This kind of approach and description has been made possible by using ANT, taking into account both the network itself, the actors as networks, and their reciprocate "translations". By following ANT, we have managed not to leave the question of tacit knowledge to a mere hinting, to impressionistic reference, or to a simple mention or quotation, as it so often happens in innovation studies. In contrast, by accounting for the transformations that the networks of relations which are constitutive of these bodies have gone through, we could identify tacit knowledge as an emerging phenomenon between (human and non-human) bodies in interaction.

Taking into consideration tacit knowledge, and in particular what we see as one of its constitutive characteristics, i.e. the fact of being situated and distributed, has also implied that we had to consider design activity as spread among various professional figures. The process that brings about the stabilization of a new artefact is the outcome of the activities of a plurality of actors, including their knowledge and the relationships that are present both inside and outside of the enterprise. Moreover, our approach has shown that the design activity is not the exclusive prerogative of the designer, nor is it limited to the relation between the designer and the entrepreneur-manager [17]. Accounting for the "network within" has allowed us to underscore that

17 As the literature on design driven innovation (De Michelis 2001; Verganti 2009), increasingly relevant for manage-

design, as a "semantic" competence of the artefacts, does not belong exclusively to the designers or managers, but is distributed among all the actors in the productive network, albeit with different directions and emphases. Thanks to this competence, craftsmen like Carlo or intermediate executives like Stefano can give life to a product that coherently translates the designer's semantics, while they appreciate its value [18].

All of this makes for a better understanding of innovation as the outcome of tacit knowledge. The need to follow the networked relations and their translations in detail has brought us to recognize both human and non-human actors that too often not have had the visibility commensurate to their relevance for the innovation process – we are faced with an institutional-organizational invisibility. These actors have also lacked visibility within entire strands of socio-economic research and innovation studies – a scientific invisibility. Our work is thus aligned with the research that has given scientific, and in some cases also institutional-organizational visibility to the (human and non-human) actors that previously have not received any (Latour 1992; Latour and Woolgar 1979; Star 1991; Shapin 1989; Star and Strauss 1999). Having given them some visibility in the present context, our wish is that future research on innovation likewise may increase the interest in these actors, by going beyond the single case introduced above and examining the whole chain of innovation in production, with the aim of showing how it functions.

References

Akrich, Madeleine & Bruno Latour. 1992. A summary of a convenient vocabulary for the semiotics of human and nonhuman assemblies. In W.E. Bijker, John Law (eds) *Shaping Technology / Building Society* (pp. 259-264). Cambridge, MA: The MIT Press.

Akrich, Madeleine. 1992. Semiotique et sociologie des techniques: jausqu'ou pousser le parallele?, in Centre de Sociologie del'Innovation, *Ces reseaux que la raison ignore* (pp. 24-30). Paris: L'Harmattan.

Akrich, Madeleine.1990. De la sociologie des techniques à une sociologie des usages: l'impossible intégration du magnétoscope dans le réseaux câblés de première génération. *Technique et culture. Revue semestrielle d'anthropologie des techniques, 16*, 83-110.

Asheim, Bjorn Terje & Meric Gertler. 2005. The Geography of Innovation: Regional Innovation System. In: Fagerberg, Jan., Mowery, David C. and Nelson, Richard (Eds.) *The Oxford Handbook of Innovation* (pp. 291-317). Oxford: Oxford University Press.

ment practices and the reflection about them (Verganti 2009), seems to suggest. Verganti, recovers Klaus Krippendorf's (2006) definition of design as "design is making sense of things", thus connecting design directly to meanings. Consequently Verganti sees the designers as brokers of language (Verganti 2009).

18 Carlo and Stefano fully partake an "economy of quality" mentioned by Callon, Meadel and Rabehrisoa (2000): they qualify the product and make it progressively become such through various successive interactions between their bodies, the one of the materials, and the objects suggested to them. However, Carlo and Stefano can partake that economy right because they have certain semantic competences.

Aydalot, Ph. 1986. *Milieux Innovateurs in Europe*. Paris: Gremi.
Becattini, Giacomo. 1979. Dal "settore" industriale al "distretto" industriale. Alcune considerazioni sull'unità di indagine dell'economia industriale. *Rivista di economia e politica industriale, 1*, 7-21.
Bell, Emma, and Sheena Vachhani. 2019. Relational encounters and vital materiality in the practice of craft work. *Organization Studies*. Doi/10.1177/0170840619866482.
Breschi, Stefano. & Malerba, Franco. 2005. *Clusters, Networks and Innovation*. Oxford: Oxford University Press.
Brown, John Seely & Duguid, Paul. 2001. Knowledge and organization: A social-practice prospective. *Organization Science, 12*(2). 198-213.
Brown, John Seely. & Duguid, Paul.1991. Organizational learning and communities of practice: towards a unified view of working, learning and innovation. *Organization Science*, 2. 40-57.
Callon, Michel. 1986. Éléments pour une sociologie de la traduction: la domestication des coquilles Saint-Jacques et des marins-pêcheurs dans la baie de Saint-Brieuc. *L'Année sociologique, 36*. 169-208.
Callon, Michel. 1999. Le réseau comme forme émergente et comme modalité de coordination. In: M. Callon et al. (Eds.) *Reseaux et coordination* (16-34), Paris: Economica.
Callon, Michel, Meadel Cécile & Rabehrisoa, Vololona. 2000. L'economie des qualities. *Politix, 13*(52). 211-239.
Camagni, Roberto. 1991. Introduction: From the Local "Milieu" to Innovation through Cooperation Networks. In: Camagni, Roberto (Ed.) *Innovation Networks: Spatial Prospectives* (pp. 1-9). London: Belhaven Press.
Collins, Harry. 1992. *Changing Order. Replication and Induction in Scientific Practice*. Chicago: University of Chicago Press.
Collins, Harry. 2010. *Tacit and Explicit Knowledge*. Chicago: The University of Chicago Press.
Cooren, François. 2010. *Action and Agency in Dialogue*. Amsterdam: John Benjamins.
Crouch, Colini, Patrick Le Gales, Carlo Trigilia, and Helmut Voelzkow. 2004. *I sistemi di produzione locale in Europa*. Bologna: Il Mulino.
De Michelis, Giorgio. 2001. La creazione di conoscenza e l'innovazione design-driven nei distretti allargati. *Studi Organizzativi, 1*. 121-136.
Deleuze, Gilles. & Guattari, Félix. 1980. *Mille Plateaux*. Paris: Minuit.
Fagerberg, Jan. 2005. Innovation: a Guide to the Literature. In: Fagerberg, Jan., Mowery, David C. and Nelson, Richard (Eds.) *The Oxford Handbook of Innovation* (pp. 1-26). Oxford: Oxford University Press.
Florida, Richard.1995. Toward the Learning Region. *Futures, 27*. 527-536.
Gertler, Meric. S. 2003. Tacit knowledge and the economic geography of context, or the undefinable tacitness of being (there). *Journal of Economic Geography, 3*. 75-99.
Gherardi, Silvia & Perrotta, Manuela. 2014. Between the hand and the head: How things get done, and how in doing the ways of doing are discovered. *Qualitative Research in Organizations and Management: An International Journal, 9*(2). 134-150.
Gherardi, Silvia. 2006. *Organizational Knowledge: The Texture of Workplace Learning*. Malden, MA and Oxford: Blackwell.
Gherardi, Silvia. 2010. L'innovazione come processo continuo. *RA, 1*.15-29.

Hindmarsh, Jon & Pilnick, Alison. 2007. Knowing bodies at work: Embodiment and ephemeral teamwork in anaesthesia. *Organization studies 28*(9). 1395-1416.
Krippendorff, Klaus. 2006. *The Semantic Turn*. Boca Raton: CRC Press.
Krugman, Paul. 1991. *Geografy and Trade*. Cambridge, MA: The MIT Press.
Krugman, Paul. 1998. What's New about the New Economic Geography?. *Oxford Review of Economic Policy, 14*(2). 7- 17.
Latour, Bruno & Woolgar, Steve. 1979. *Laboratory life. The social construction of scientific facts*. Princeton: Princeton University Press.
Latour, Bruno. 1987. *Science in Action*. Harvard: Harvard University Press.
Latour, Bruno. 1992. Where Are the Missing Masses? The Sociology of a Few Mundane Artefacts. In: Wiebe E. Bijker & John Law (Eds.) *Shaping Technology/Building Society: Studies in Sociotechnical Change* (pp. 225- 258). Cambridge, MA: the MIT Press.
Latour, Bruno. 1993. *Aramis ou l'amour des techniques*. Paris: La Decouverte.
Latour, Bruno. 1999. On Recalling ANT. *Sociological Review, 46*. 15-25.
Latour, Bruno. 2005. *Reassembling the Social. An Introduction to Actor-Network-Theory*. Oxford, NY: Oxford University Press.
Lave, Jean. & Wenger, Etienne.1991. *Situated Learning: Legitimeate Peripheral Participation*. Cambridge: Cambridge University Press.
MacKenzie, Donald. A. 1996. *Knowing Machines. Essays on Technological Change*. Cambridge, MA: The MIT Press.
Maskell, Peter. & Marmberg, Anders. 1999. Localised Learning and Industrial Competitiveness. *Cambridge Journal of Economics, 23*. 167-86.
Mattozzi, Alvise. (2011). Roberto Verganti, Design driven innovation: Changing the rules of competition by radically innovating what things mean, Boston, Harvard Business Press, 2009, *Tecnoscienza*, 2/1, pp. 125-129.
Morgan, Kevin. 1997. The learning region: Institutions, innovation and regional renewal. *Regional Studies, 31*. 491-504.
Nicolini, Davide. 2012. *Practice Theory, Work, and Organization: An Introduction*. Oxford: Oxford University Press.
Parolin, Laura Lucia. 2010a. L'innovazione nelle relazioni tra i nodi di un network. Il caso dei fornitori artigiani nell'industria del mobile. *Studi Organizzativi, 2*. 55-74.
Parolin, Laura Lucia. 2010b. Sulla produzione materiale. Qualità sensibili e sapere pratico nella stabilizzazione degli artefatti. *Tecnoscienza - Italian Journal of Science and Technology Studies, 1*(1). 39-56.
Parolin, Laura Lucia. 2012. La localizzazione dei network innovativi. In: Perulli, Paolo (Ed.) *Nord. La città-regione globale* (pp. 131-154), Bologna: Il Mulino.
Parolin, Laura Lucia. 2015. Designing a New Chair: Transgressing Organizational Boundaries. In Bruni, Attila, Parolin, Laura Lucia & Schubert, Cornelius (Eds.) *Designing Work, Technology, Organizations and Vice Versa* (pp. 117-136). Malaga: Vernon Press.
Parolin, Laura Lucia & Mattozzi, Alvise. 2013. Sensitive Translations: Sensitive Dimension and Knowledge Within Two Craftsmen's Workplaces. *Scandinavian Journal of Management*, *29* (4), 353–366.

Parolin, Laura Lucia & Mattozzi, Alvise. 2014. «Come meglio credi»: Conoscenza tacita ed innovazione nel distretto legno e arredo in Brianza. *Polis, 3*. 365-392.
Pavitt, Keith. 2002. Knowledge about Knowledge since Nelson and Winter: A Mixed Record. *Eletronic Working Paper Series*, No. 83. SPRU, University of Sussex, June.
Picherri, Angelo. 2002. *La regolazione dei sistemi locali*. Bologna: il Mulino.
Polanyi, Michael. 2009 [1967]. *The tacit dimension*. Chicago: The University of Chicago Press.
Powell, Walter W. & Grodal, Stine. 2005. Networks of Innovators. In: Fagerberg, Jan., Mowery, David C. and Nelson, Richard (Eds.) *The Oxford Handbook of Innovation* (pp. 56-87). Oxford: Oxford University Press.
Ramella, Francesco & Trigilia, Carlo. 2010. *Invenzioni, inventori e territori in Italia*. Bologna: Il Mulino.
Russo, Antonio. 2013. Cooperazione e regolazione nelle politiche per l'innovazione. *Polis, 27* (3). 333-362.
Sennet, Richard. 2008. *The Craftsman*. Yale: Yale University Press
Shapin, Steven. 1989. The invisible technician. *American Scientist, 77*(6). 554-563.
Star, Susan Leigh & Strauss, Anselm. 1999. Layer of Silence, Arenas of Voice: the Ecology of Visibile and Invisibile work. *Computer Supported Cooperative Work, 8*. 9-30.
Strati, Antonio. 1999. *Organization and aesthetics*. London: Sage.
Strati, Antonio. 2008. Aesthetics in the study of organizational life. The SAGE handbook of new approaches in management and organization, (229-238) London: Sage.
Star, Susan Leigh.1991. The Sociology of the Invisible: The Primacy of Work in the Writings of Anselm Strauss. In: Maines, David. (Ed.) *Social Organization and Social Process: Essays in Honor of Anselm Strauss*, (pp. 265-283). Hawthorne, NY: Aldine de Gruyter.
Storni, Cristiano. 2009. Sulla nascita degli arte-fatti. *E/C Serie Speciale, 3*(3/4). 225-238.
Storni, Cristiano. 2012. Unpacking design practices: The notion of things in the making of artifacts. *Science, Technology and Human Values, 37*(1). 88-123.
Strati, Antonio. 2007. Sustainable knowledge and practice-based learning. *Management Learning, 38*. 61–77.
Trigilia, Carlo. 1986. *Grandi partiti e piccole imprese: comunisti e democristiani nelle regioni a economia diffusa*. Bologna: Il Mulino.
Trigilia, Carlo. 2005. *Sviluppo locale*. Roma-Bari: Laterza.
Verganti, Roberto. 2009. *Design Driven Innovation. Changing the Rules of Competition by Radically Innovating What Things Mean*. Harvard: Harvard Business Press.
Yakhlef, Ali. 2010 The corporeality of practice-based learning. *Organization Studies, 31*, 409–430.
Zucker, Lynne G., Darby, Michael R. & Armstrong, Jeff. 1998. Geografically Localizated Knowledge: Spillovers or Markets?. *Economic Inquiry, 36*. 65-86.