

Information Infrastructure(s)

Information Infrastructure(s):
Boundaries, Ecologies, Multiplicity

Edited by

Alessandro Mongili and Giuseppina Pellegrino

Foreword by Geoffrey C. Bowker

CAMBRIDGE
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P U B L I S H I N G

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Boundaries, Ecologies, Multiplicity,
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In memory of Leigh Star

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FOREWORD

THE INFRASTRUCTURAL IMAGINATION

GEOFFREY C. BOWKER

In a classic from 1959, pragmatist sociologist C. Wright Mills wrote of the pressing need in the face of constant change and strife to develop a sociological imagination through which: “men and women hope to grasp what is going on in the world, and to understand what is happening in themselves as minute points of the intersections of biography and history within society” (7)¹. There is no reference to computers in his tome. Actually, I found that out at the touch of a button by deploying an infrastructure he could not have imagined – the inescapable, highly problematic, deeply rich, politically wrought infrastructure of Google Books. How could Mills have foreseen this consummation not so devoutly to be wished - it was a commonplace at the time that a mere handful of computers would meet the world’s needs. The millennial generation (and indeed the new millennialists such as Ray Kurzweil) cannot picture a world without the web and it is hard for them to imagine ways of forming personal, intellectual and social relations without passing through an information infrastructure.

Bruno Latour used to say that society was about the size of a pumpkin, since whenever speakers referred to “the social”, their standard gesture was to bring their opened hands together in a forceful movement that left a virtual space between them about that size. It was his way of saying that society is a vacuous concept. However, I can think of no gesture and few stories that easily summon information infrastructures. And yet they are not vacuous. They are invisible, they melt away, they are what you use in order to do something. We don’t think about the road when we drive our cars (except, as Star and Ruhleder would point out, when there are potholes – then we curse the local council). We all too rarely think about the ways in which our social, cultural and political values are braided into the

¹ Wright Mills, Charles. 1959. *The Sociological Imagination*. Oxford: Oxford University Press.

wires, coded into the applications and built into the databases which are so much a part of our daily lives. We are all today not citizens pure and simple - we are data citizens; and our data doubles (uncanny doppelgangers) are an integral part of our lives.

Mills' biography, history and society could all seemingly be experienced without a technological substrate. For my own life, my "minute point of intersection", I know that I spend more time with my computers than with humans - dearly as I occasionally love the latter. I talk more often and more deeply with distant rather than proximate interlocutors. And it's not just about the words and such - I feel an ache in my fingers if I have been away from the keyboard for too long ... Yet this mediation through computers is indeed hard to grasp. The perspectives of design, ecology, mobility and multiplicity developed in the four sections below are a rich way in.

It is fitting that contributors to this volume, inspired by STS Italia, include contributions from four other countries. Just as it is increasingly difficult to imagine our infrastructures today stopping at any one country's borders, so is it clear that theorizing infrastructure is a distributed task. The geographical as well as the analytical range of this work is most impressive.

Susan Leigh Star sadly and suddenly died in 2010. Her next book would have been entitled "Infrastructural Poetics". The contributions to this volume would have been richly interwoven into that text. Her and my time in Sardinia sipping Prosecco on balconies; talking with Alessandro in a polyglot mix of Italian, French and English with a touch of Russian; exploring the traces of Nuragic civilization; and meeting the scholars of STS Italia was a transformative part of our lives - even if the internet connection wasn't so hot. I speak for her, and join my own voice, in thanking Alessandro and Giuseppina for bringing this collection together. I speak for many future readers in saying that if you want to exercise infrastructural imagination, this is a marvelous place to start.

Long Beach, 23 July, 2014

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THE BOUNDARIES OF INFORMATION INFRASTRUCTURES: AN INTRODUCTION

ALESSANDRO MONGILI
AND GIUSEPPINA PELLEGRINO

1. Where this book comes from

Reflections and research which have converged and are summarized in these pages started a few years ago and – like the topics of this book – circulated across multiple locations.

The “material motive” was provided by a series of panels at different Italian and European conferences, organized and co-chaired by both of us.

First, at the EASST conference “Practicing Science and Technology, Performing the Social” organized and hosted by STS Italia in Trento (September 2010) we held a track on “Performative Infrastructures, Multiple Mobilities”, which put together our respective interest in Information Infrastructures and Mobility Studies.

Two years later in Rovigo, at the 4th STS Italia Conference “Emerging Technologies, Social Worlds” (June 2012) the track on “Information Infrastructures: from Standardization to Multiple Uses” aimed at focusing “on diversity of infrastructure uses, which constrain local contexts, and on torqued infrastructures, emerging from situated activities. In particular, new expertise, power users, development of open-ended information systems and professional communities able to manipulate such systems, shifted the interest towards torquing and reversibility of infrastructures, as well as advanced professional uses, such as design of technology and architecture, scientific and experimental work, medical and diagnostic activities”².

However, all of these joint adventures would not have taken place without the STS Italia founding conference in Cagliari (June 2006) which hosted Leigh Star and Geof Bowker’s joint keynote speech. It was the first

² http://www.stsitalia.org/conferences/STSITALIA_2012/STS_Track3.pdf

time they had come to Italy and also the first time we had the opportunity to listen to them and approach their vision of Boundary Objects (henceforth BOs) and Information Infrastructures (henceforth IIs) in depth. Alessandro Mongili, who organized and hosted that conference as first President of STS Italia – a newly constituted network of Italian scholars in Science and Technology Studies (STS)³ - brought them to us as result of an intellectual interest for both Leigh's and Geof's work. Their lecture in Cagliari was centered on the presentation of their ecological approach to BOs and IIs and particular emphasis was given to the consequences of classification and standards in terms of exclusion, looking at residuality in IIs and the myriad of "orphans" generated by discretization and categorical work.

Since then, Leigh and Geof have embraced and supported the emergent scientific community of Italian STS scholars, including Italy, in their continental contacts already developed in France and in Nordic countries⁴.

As a follow up to that encounter in Cagliari, Giuseppina Pellegrino interviewed both Geof and Leigh on the topic of "Information Society and Inequalities" (Pellegrino 2006), focusing on issues widespread in the public debate, such as the digital divide and information overload. These themes were critically analyzed by Leigh and Geof in light of their approach to IIs and residuality. This is based on a critique towards concepts such as stabilization and principal agent, and a narrative problematizing diversity and orphans of infrastructure through an ethics of ambiguity, conceived as a constant, respectful concern for multiplicity⁵.

Lecturing during a seminar series promoted by the PhD program directed by Dominique Vinck in Grenoble in 2007, Leigh Star resumed on the concept of *boundary object* in all its sociological and STS density⁶. In her intervention, entitled *The History and Boundary of Boundary Objects*, she focused on the "roots" of BOs and the "Limits and Common

³ www.stsitalia.org

⁴ One of the resources which fertilized the Italian field and prepared for the arrival of Leigh and Geof was the work carried out by Silvia Gherardi and her group in Trento on organizations, technology and practice, which developed around the doctoral program on "Information Systems and Organizations".

⁵ On the invisibilization produced by the systematic exclusion inherent to standardization, the article entitled "Enacting Silence" was published in 2007 (Star and Bowker 2007).

⁶ www.cluster-gospi.fr/IMG/pdf/Livret_Seminaire_BO-BW.pdf. This series of lectures produced different reflections on the concept of intermediary and boundary objects, published later in a special issue of the *Revue d'Anthropologie des Connaissances* (2009, 3/1). Leigh Star's intervention was published also in English (Star 2010).

Misconceptions Concerning Boundary Objects”. In this lecture, Leigh summarized some interesting ideas, useful for understanding how BOs and IIs were created to deal with specific sociological and STS problems, which were both theoretical and empirical. As “roots” of BOs, Leigh pointed out critical issues in Symbolic Interactionist Theory, especially those linked to Social Worlds, and all the anomalies and “triangulation” created to examine social intersections among and between them. Furthermore, she emphasized the question of “Borderlands as a Resource”, linked to the idea that BOs are “enmeshed” in standards and classification. This constitutive character of the BOs (i.e. their consistency in standard and classifications) is unfortunately overlooked in many cases, and consequently confused or overlapped with any kind of intermediary object.

Star also asserted the grounded character of this concept, valid “at a medium level of scale”, and “rarely useful on a global or mythic level”. The use of BOs is situated in a specific history, both material and intellectual. To understand BOs’ uses, articulation and design, “interpretive flexibility” is not enough. Beside semiotic issues, there are other dimensions, often linked to their materiality. According to Star, BOs are impossible to understand “without understanding of infrastructure, information needs, standards and classification“. She underscored very often the “middle-range” and the “grounded” character of her theoretical production, and also in Grenoble she noted that “the concept of boundary objects is grounded, resting in the principles of grounded theory: constant comparison, iterative returns to the data, theoretical sampling, and awareness of the level of abstraction” (Star 2007). This approach also influenced many of this book’s contributors, and not only because of the circulation of texts and ideas, but also because of direct contact with her. With great generosity, which was so typical of her, Leigh accepted an invitation to visit the University of Cagliari, in Sardinia, where a Grounded Theory Workshop was set up in December 2007, directed to PhD students and sociologists coming from many Italian universities. She taught some methods of coding, and discussed her approach to Grounded Theory at a roundtable with a wide range of Italian scholars specialized in research methods.

All the events remembered above, jointly with the readings, writings and exchanges they promoted, paved the road for this book to come out, as a contribution to the ongoing and fascinating debate on the role of IIs and BOs in our lives. On the other hand, many contributors dealt with the same issues during their fieldwork, or during their work on the data coming from their research, and at that point they met the ecological approach as a resource for their analysis. So, this book is placed at a crossroad of various

paths and genealogies, all of them connected with the problem of the intersection among different levels of scale throughout devices and networks.

2. Information infrastructures

Interest in infrastructures and focus on concepts like convergence, intersections, cooperative and distributed activities are two streams that have characterized social sciences since the mid '90s.

Actually infrastructures - and in particular IIs - allow, facilitate, mediate, saturate and influence our material and immaterial surroundings. Furthermore, they are often shaped and intertwined with networks of relations and distributed agency. They even enable the existence of networks, being in turn produced by them, often in a distributed way. Infrastructures are not static and immobile in time and space: they need maintenance and repair, which become an important aspect of their use as well.

Looking for a definition of information infrastructure (II) means facing a phenomenon which displays different characters in time, spaces, uses, design, and scaling. IIs are not mere information artifacts, although they keep a genealogical relation with many information artifacts, or at least they can include some information artifacts, if we consider an information artifact as a "wide array of tools, systems, interfaces and devices for storing, tracking, displaying and retrieving information" (Star, Bowker and Neumann 2003). The main difference between any information artifact and an II is provided by its relational character towards organized practices (Jewett and Kling 1991; Star and Ruhleder 1996, 113). Some information artifacts become infrastructures when under certain events or circumstances they "converge with human behavior to form a (...) whole", Star and Lampland (2009, 20) assert, defining it as "the nesting character of infrastructures". So, IIs carry information out in different spaces, but also in different times, creating an important texture not only for a basic exchange of information or data, but also for work, mobility, leisure, and many activities of everyday life. From a mere technical viewpoint, an II is composed of a list of numbers, technical specifications and hidden mechanisms, more precisely by standards, wires and settings (Star 1999, 377, 379), "incorporating specific elements into the system, to link them together in a specific way, and to codify interactions by a (...) set of rules and procedures" (Turner *et al.* 2006, 91).

The relational characters of IIs were pointed out in a seminal scheme included in Susan Leigh Star and Karen Ruhleder's essay (1996, 113).

Recently, another attempt at general definition was provided by Eric Monteiro *et al.* (2013, 576-578). IIs were defined by Star and Ruhleder according to their embeddedness (an infrastructure is “sunk” into other material, technical or social structures), transparency (it is taken for granted by their users, transparent in both temporal and spatial dimension) and reach or scope (in both spatial and temporal terms). Interest in the convergence between infrastructure and human behavior led to the highlighting of two other aspects: the learning of IIs as part of membership in some social world, and the link with conventions of practice already widespread. This last characteristic is mirrored by the fact that an infrastructure “does not grow” *ex novo*, but is built on an installed base and has to be linked and interoperable with its elements. Finally, its transparency is threatened by accidents, and so it becomes visible upon breakdown. Star and Ruhleder’s scheme describes the relational existence of infrastructures paying great attention to other entities and to events wherein the infrastructures exist. In the “working definition” provided by Monteiro *et al.* (2013) the importance of an extended design perspective is emphasized, “to capture how workplace technologies can be shaped across multiple contexts and over extended periods of time” (p. 576). This accentuated chronotopic stance enhances the ecological argument which underscores the fact that IIs provide a set for distributed activities (Bowker, Timmermans and Star 1995; Bowker, Baker *et al.* 2010). The importance of IIs’ design is so equated to their implementation and use:

“As a working definition, IIs are characterized by openness to number and types of users (no fixed notion of ‘user’), interconnections of numerous modules/systems (i.e. multiplicity of purposes, agendas, strategies), dynamically evolving portfolios of (an ecosystem of) systems and shaped by an installed base of existing systems and practices (thus restricting the scope of design, as traditionally conceived). IIs are also typically stretched across space and time: they are shaped and used across many different locales and endure over long periods (decades rather than years).” (Monteiro *et al.* 2013, 576).

metad Infrastructuring is, therefore, an ongoing process of creating, implementing and using infrastructures (Karasti and Baker 2004). So, the role of design and other originating practices in IIs becomes continuous rather than discrete: a large array of actors intervene continuously in changing elements and in fixing them, as a constitutive part of infrastructuring (Monteiro *et al.* 2013, 59).

IIs do not exist but *occur where and when* a series of tensions (between local and global, today’s requirements and tomorrow’s users, research and

development; between project and originating practices; implementation and maintenance/repair; individual and community; but also identities and practices, planned and emergent courses of action) are resolved (Star and Ruhleder 1996, 114; Bietz *et al.* 2010, 249). Infrastructuring is precisely the collective practice which manages all these tensions. It is difficult to ascribe it to some specific actor: maybe not by chance different scholars refer to this collective dimension using metaphors such as *web of computing* (Kling and Scacchi 1982) or *web of users and developers* (Millerand *et al.* 2010). Design, development, use, maintenance, repair, implementation are different practices and, due to the ongoing character of infrastructuring, Bietz *et al.* (2010, 249) use the metaphor of *web of infrastructuring* in order to describe this process where no one can control infrastructures and there is only a visible part (the user-at-terminal), whereas all the overwhelming practices of assemblage and articulation are invisible (Bowker and Star 1999, 319; Star 1999, 386-387).

Studying IIs is difficult work for ethnographers and sociologists. Designers, developers, and other originators often share an institutionalized discourse, which Leigh Star called “master narrative“, that does not problematize diversity (Star 1999, 384). Some local ideological forms are very strong and do not help researchers to understand the multifaceted and relational character of this phenomenon. So, spatially, the participation of a lot of people and terminals distributed in very different places across a local/global axis is underestimated and, temporally, the continuous maintenance, repair, design and change confront the mythopoeitic “eternity dream” of these infrastructures (Edwards *et al.* 2009, 370-371; Star 1999, 383). Studying data diversity, Geoffrey Bowker shifted the focus of his analysis from changes in infrastructural components to changes in infrastructural relations (Bowker 1994). Throughout this *infrastructural inversion*, he opened a new possibility to deliver scholars from master narratives and institutionalized discourses, which usually hide the relational side of IIs, mainly for professional purposes, and to focus on the “whole enterprise”, following an ecological viewpoint (Star and Griesemer 1989, 389). This change drove to construct the question of *scaling up* (Bowker, Star and Neumann 2003) as an object of analysis crucial for this phenomenon, in both spatial and temporal terms (Edwards *et al.* 2009, 370), but also with reference to lack of integrity and absence of defined boundaries in IIs. In fact, different systems of different scales crosscut and intersect, making these infrastructures fragile and dependent on chronotopic contingencies (Mackenzie 2003, 396; Star 1999, 387). Scaling IIs up is not only their condition of existence, but also a necessary heuristic tool in order to

describe and analyze them. As Ribes and Finholt (2009, 376) asserted, scaling “mirrors participants’ activities” in infrastructuring. These scaling dimensions can be articulated in three different spheres: enactment, organizing and institutionalization. Enacting an infrastructure is a *technological venture*, i.e. “seeking to deploy durable resources to support work, automate (...) tasks, and enable collaboration”. Organizing refers mainly to these organizational arrangements that make long term projects possible: work, organization, repair and maintenance and all those activities useful for fitting infrastructures with people. Institutionalization of infrastructures refers to those activities directed to link them to a “wider longer term goal beyond those of the project team” (Monteiro *et al.* 2013, 581).

If IIs are relational, the kind of relation they establish is crucial to discuss. At large, we can consider two main kinds of relations in order to define IIs. Firstly, the *convergence* with human behavior and social practices and secondly, the fact that IIs take on “transparency by plugging into other infrastructures and tools in a standardized fashion” (Star and Ruhleder 1996, 113; Star 1999, 381): the *embodiment of standards*.

Convergence is a concept which expresses “the double process by which information artifacts and social worlds are fitted into each other and come together” (Star, Bowker and Neumann 2003). Social world, in turn, is a concept often employed to identify groups of people sharing conventions, language, technologies and practices (Star, Bowker and Neumann 2003). This term can express the fact that in many cases humans connect to infrastructures as groups or communities of practice, rather than individuals. In each of them the same infrastructure can be instrumentalized differently and segmented in use, following different chronotopic contingencies (Lave and Wenger 1991; Wenger 1998). This difference in instrumentalization and use among different groups converging at the same II, underscores its intersectional character and the fact that it is not possible to find a corresponding stable organization, but a diverse “constellation of practices” (Wenger 1988, 241). Convergence is necessarily fragile and unstable, and its main form of articulation is *learning* as continuous participants’ practice (Lave 1998) linked to any form of relation and of explicit and tacit practices: use, implementation, maintenance, repair, and design (Wenger 1998, 47; *see also* Haythornthwaite 2006, 1080). Following many scholars, learning is also a necessary part of membership in a community of practice, because technology constitutes both the workplace and the ecology of everyday activities. Becoming a member of a social world or of a community of practice is inherently intertwined with learning (Bowker and Star 1999; Lave and Wenger 1991; Star 1999, 381).

This complex existence of IIs at different scales and in different chronotopes, situates them in different positions towards humans and their lives. The reality of IIs can be considered as variable in social, technical, material and symbolic terms (Latour 1992, 144; Mackenzie 2003, 96). However, many scholars consider instead the importance of those very practices which enact IIs in front of concrete human lives, thanks to specific ontologizing politics (Mol 2002, viii, 44). As Ribes and Bowker (2009, 202) asserted, “participants often refer to ontologies as a technology, tool, or software”. In computing, however, the term *ontology* is common. It is “a *description* (like a formal specification of a program) of the concepts and relationships that can exist for an agent or a community of agents” (Gruber 1993, 199). Making those “descriptions” real is a very dense and important process. Suitably, Bowker *et al.* (2010, 109; *see also* Ribes and Bowker 2009, 215) underscore a double move into this process, *building ontology* and *ontology work*, corresponding to two different aspects of ontologizing practices. With *building ontology* they understand “gathering domain knowledge, formalizing this knowledge into a machine computable format, and encoding it into machine languages”, i.e. assembling an ontology becoming an infrastructure to support the users’ practices in a transparent way; while for *ontology work* they understand an “act of distribution – taking knowledge out of a closed community of practice and allowing for its reuse and reshaping by others in different fields”, i.e. the articulation work of an ontology. The stabilizing strength of this ontological side of infrastructuring is far from being diminished, and it is surely important for the institutionalization of infrastructures and for their “Long Now” (Ribes and Finholt 2009, 377).

Participants get an active position in infrastructuring, not only because they have to take into account the conventional dimension and take on an “unprecedented reflexivity” (Cambrosio *et al.* 2006), but also because they do not have to merely implement and use IIs, but also be involved in “extended design” practices of maintenance and repair (Monteiro *et al.* 2013, 576). These practices are linked to the particular relevance of data exchange and management and the saturation of information infrastructures as a whole. “Any interface between groups and organizations, as well as between machines – assert Edwards *et al.* (2011, 670) – is a point of resistance where data can be garbled, misinterpreted, or lost”. Convergence is far from being a perfect “mechanism” and people and machines do not plug into each other in a neutral way. They propose the concept of *data friction* in order to describe this imperfect operability and functioning of IIs across such different groups and systems. We can observe two different and recursive responses to this lack of automatic

correspondence between heterogeneous elements in II's convergences: *metadata development* as a process linked to data culture and their complex evolution; and *standardization*.

Metadata are often described as “data of data”. They respond to certain classifying principles widespread in computing, producing classes of data, or *taxa*, describing and representing files or other objects, libraries and other data intrinsic to these entities. Metadata refer both to a single file (format, creation date, title, etc.) and to the software and hardware requirements useful for managing extrinsic data (Borgman 2000, 70-80; Bowker 2005, 116; Bowker and Star 1999, 39-40). This inescapable tool in databases is widely used to order the heterogeneity of data circulating in IIs, their chronotopic dispersion, and data disorder. However, there are no unique or standardized metadata schemes. Even if they are very diverse, they do not introduce an element of ordering and organization in data complexity, which are often inconsistent and contradictory. Metadata are “almost standards” (Edwards *et al.* 2011, 684) and are submitted to a process of standardization, in order to improve the data intensive research and use, a crucial activity in infrastructuring. Metadata standardization follows two main streams exemplified by the concepts of *project*, a site where all the datasets related to multiple field campaigns and investigators are associated, and *dataset*, a series of tables recording sets of related measurements with specified units (Karasti *et al.* 2010, 393). However, metadata schemes and their standardization are an unstable phenomenon and can be more correctly interpreted as a process of ordering in data culture (Edwards *et al.* 2011, 685).

Standards are an inescapable passage point in II's architecture and work. Their importance is at the same level as software and hardware in both IIs and computing (Karasti *et al.*, 2010, 386). As Millerand and Bowker assert (2009, 150) they permit interconnection of systems and the flow of data; their existence is possible because many other standards are already in use, and often transparent in extant IIs; they allow the growth and cultivation of shared IIs and collaborative platforms.

Leigh Star and Martha Lampland (2009, 5 *et passim*) characterized standards in this manner:

- They are nested inside one another.
- They are unevenly distributed across the sociocultural landscape.
- They are relative to communities of practice; that is, one person's well-fitting standard may be another's impossible nightmare.
- They are increasingly linked to and integrated with one another across many organizations, nations, and technical systems.
- They codify, embody, or prescribe ethics and values, often with

great consequences for individuals (consider standardized testing in schools, for example).

Standards are points in a process of standardization which is similar to other processes creating networks as well as social and socio-material links across the world. Particularly, standardization is similar to quantification and formal representation as a form of thought and production of a digital, discrete image of social, material, technoscientific as well as emotional and bodily processes (Star and Lampland 2009, 9). Standards are understood as the operational dimension of classifications, and their character of shared regulations is especially useful for producing abstract or concrete objects.

However, standardization leads to the articulation of “the same” technology elsewhere, allowing in particular the embeddedness of an II within other IIs (Monteiro *et al.* 2013, 576). So, this process can be differentiated from quantification and formal representation because of its effects on lives and “reality”. It is true that standardization “stabilizes knowledge, freezes action, deletes outliers and residuals, and facilitates use” (Star and Lampland 2009, 13). Nevertheless, it is not completely coherent with empirical research to think of it as an enactment.

Standards are very crucial when they are used to connect different machines or different devices, and in this case they are often legally regulated. Legal regulation of standards improves their social strength as a mandatory way to do something, making change and opposition to standards themselves difficult to carry out.

Relationships between users, machines, designers, standards and design converge towards IIs and IIs in turn mediate and saturate relationships. The interest for a hybrid form of socio-technical alignments, a non-reductionist stance and a viewpoint centered on the collective activity more than on the analysis of the elements and entities involved in infrastructuring is essential for analyzing the enterprise as a whole. However, we think that IIs are not only a “nest” for different boundary objects, but they are in themselves a boundary phenomenon, especially as a constitutive element of the ecology of distributed hi-tech workplaces (Star 1999, 379). To define them as “information“ infrastructures underscores only a descriptive character of them, i.e. to carry information out. But defining them as “boundary“ infrastructures opens up to the intersectional aspect of their existence, probably the one which is sociologically denser, and their importance in building a texture across dispersed locales, in strengthening mobility, and characterizing contemporary society as a world of networks and social intersections.

Let us discuss the concept of *boundary object* before returning to the

idea of *infrastructure-as-boundary*.

3. Note on the Boundary Object. BOs in infrastructures, infrastructures-as-boundary

The concept of *boundary object* is the hallmark of Susan Leigh Star's research program. Her intellectual path is a merging between STS and the tradition of Symbolic Interactionism: a sociology of coordinated action and social intersections strongly influenced by Georg Simmel's classical theories and by the pragmatist philosophy. This path makes STS blossom focusing on the development of cooperative work in absence of consensus, the coexistence of multiple translation processes - whose global coherence constituted an important research theme - and the exclusion and marginality created by those social and technoscientific processes (Star and Griesemer 1989, 388; Star 2010, 604; Trompette and Vinck 2009, 6)⁷. The idea of a *boundary object* was a useful concept to be introduced in Science and Technology Studies in order to explain why in several cases different groups work together without reaching any consensus about the use or the meaning of a device that connects them. Star underscored a dimension often disregarded in STS, i.e. the weakly structured articulation of devices, the lack of stability among different components, and the openness of socio-technical processes to some forms of stabilization, not necessarily corresponding to an overall stability of a device, socio-technical network or alignment (Star 2010, 602).

Studying a Californian Museum and its system of classification and gathering of different materials for its collection, Star and Griesemer (1989) faced the heterogeneity of social worlds involved in this work and studied the mechanisms of their intersection and articulation. The authors were interested in how they created common action, although distributed,

⁷ It is difficult to summarize briefly the sources of Leigh Star's thought. She was a sociologist, a feminist, a poet with many roots, and many leaves. The importance of Symbolic Interactionism, and especially of the work of Robert Park and Everett Hughes, was crucial, though mediated by Anselm Strauss (her PhD supervisor) and Howard Becker, both Leigh's mentors. Their influence is clear in her sociological lexicon (world, conventions, rules, ecology, intersection, etc.) and has been reconstructed in several papers (Trompette and Vinck 2009, 5-8 *et passim*; Clarke 2010; Bowker 2010). The knowledge of Georg Simmel's sociology seems very important in Star's work. His concepts of *sozialer Kreis* (social circle), *Wechselwirkung* (mutual action), the Stranger "which today comes, and tomorrow remains", the excluded, the "orphan", and the "tragic" character of fate seem to resound permanently under Leigh's utterances.

without losing diversity (Trompette and Vinck 2009, 5, 8). They provided a definition of an elementary unit of those intersection mechanisms, which they called “boundary object” in order to explain how Museum workers managed both diversity and cooperation:

“Boundary objects are objects which are both plastic enough to adapt to local needs and the constraints of several parties employing them, yet robust enough to maintain a common identity across sites. They are weakly structured in common use, and become strongly structured in individual site use. These objects may be abstract or concrete. They have different meanings in different social worlds but their structure is common enough to more than one world to make them recognizable, a means of translation. The creation and management of boundary objects is a key process in developing and maintaining coherence across intersecting social worlds” (Star and Griesemer 1989, 392).

This concept has had a long fortune not only in STS, but also in Organization and Management Studies, and elsewhere⁸. It focuses on the material aspect of social intersection, elsewhere conceptualized by Vinck (2009, 53) as *intermediary object*, as well as the data density of those coordination tools, named by Latour as *centers of calculation* (Latour 1987). Leigh Star clarified how she did not necessarily understand as “object” a material piece of something, but that BOs are objects “something people act toward and with”, and their “materiality” derives from action, not from “thing”-ness (Star 2010, 603). The multi-layered constitution of this concept is maybe the reason for its own robustness and generativity in terms of its possibility to be scaled, re-inscribed or localized. Leigh Star herself individuated later three components in BOs: *a*) their interpretive flexibility; *b*) the structure of informatics and work process needs and arrangements and *c*) the dynamics between their ill-structured and well-structured uses (Star 2010, 601).

The use of the concept of interpretive flexibility can surprise, because of the differences between Star’s ecological approach and the SCOT approach to STS. Interpretive flexibility is indeed a concept used by Wiebe Bijker in order to describe the different meanings which an artifact assumes among pertinent social groups involved in its use (Bijker 1995). Flexibility here is placed mainly at a semiotic level, and is viewed as a

⁸ A comprehensive review of the “conceptual progeny” of Star and Griesemer’s concept of boundary object is provided by Trompette and Vinck (2009, 3, 15). Particularly important are the concepts of boundary work developed by Thomas Gieryn, boundary shifting by Michel Callon, boundary organization and boundary spanning.

transitional period before the stabilization of an artifact. Differently, Leigh Star points out the *permanent* flexibility of BOs in managing both diversity and cooperation, accompanied by a shared structure composed of classification, standards and norms, which is invisible, “transparent” and not subjected usually to an interpretive flexibility. So BOs contain an interpretive flexibility, but act also as a “robust” coordination of shared action: they are “stuff of action”, not simply an artifact (Star and Griesemer 1989, 388; Star 2010, 601, 603; Trompette and Vinck 2009, 6). During the Grenoble Conference (2007), Star asserted that “interpretive flexibility without understanding of infrastructure, information needs, standards and classification is a misunderstanding” (Star 2007; Trompette and Vinck 2009, 16): in fact, standards and BOs are “inextricably related” because standards allow BOs to work as coordination tools and to provide “robustness” both to the alignments and the distribution of action and knowledge across different worlds (Star 2010, 607; Trompette and Vinck 2009, 3, 17). The concept of BO refers permanently to both coordination and articulation. Articulation is an important concept because it allows the focusing of the technoscientific enterprise not only as a process of translation managed by some heterogenous engineer, but as a collective practice where any actor “contribute[s] to translate simultaneously in order to work together” (Star and Griesemer 1989, 388). This concept opens not only to the role of users but also to the analysis of designers’ work. Other authors emphasized that technicians’ work is not “what their managers believe it to be” (Orr 1996); that plans are characterized by vagueness and inherent indeterminacy (Suchman 1987); and that the role of users in socio-technical processes is far from marginal (Oudshoorn and Pinch 2003). Drawing on Bateson’s analysis, Leigh Star asserted that the relationship between designers and users is a “double bind” (Star 2010, 610), namely a quasi-structural link, and a permanent lack of consensus among them despite their collaboration in use and manipulation of the same devices. Articulation is just the way in which BOs are negotiated, manipulated, activated, used, designed, learned and entangled in different social worlds or communities of practice.

BOs, as said above, are not necessarily material pieces of something, as intermediary objects are. They do not need any “thing”-ness, even if they can be tangible. They can be directories, classifications, maps, design, standardized methods but, following Leigh Star (1989, 37), they can be in turn classified in some types: repositories, idealtypes, terrain with coincident boundaries, and forms and labels. This last type, in particular, is a method of common communication across dispersed workgroups and it produces standardized indexes, i.e. a robust nucleus of data which makes a