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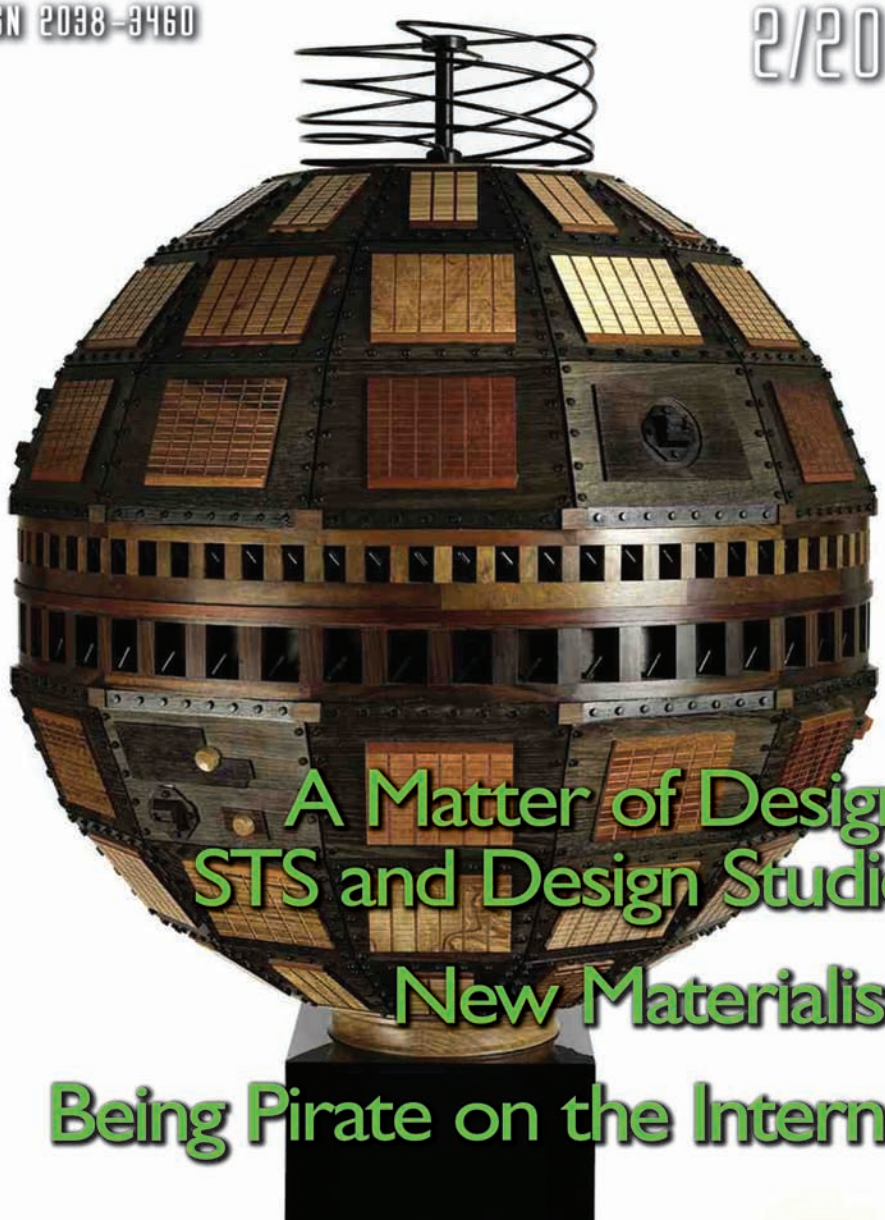

A Matter of Design : STS and Design Studies

New Materialism

Being Pirate on the Internet

Telstar (Wisdom) 200 (Dark bog oak, various sustainable exotic wood veneers) © *by Paul Fryer 2008*

The *Telstar 1* satellite was planet Earth's first orbital communications platform. This artwork is an exact copy of that satellite, the body of which is rendered in partially fossilised wood which is thousands of years old.

When *Telstar 1* was launched in 1962 it captured the worlds imagination. TV signals were sent live from America to Europe using the satellite as an orbital repeater station in space. It heralded the beginning of the information age as we know it.

The work *Telstar (Wisdom)* is an interpretation of this device as an object more akin to an ancient reliquary or fount. It highlights the very short distance in time between this moment in human technical achievement and the earliest technical drawings of Da Vinci a mere four generations previous. We have come a long way in a short time, and this was only the beginning of the meteoric acceleration we are now experiencing as humankind. *Telstar* was the product of human hands. Perhaps soon the idea of human handiwork will be altogether redundant as time and technology telescope humanity into the pages of history.

Paul Fryer

Photograph by Tessa Angus; reproduction by permission of the artist.

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Design Worlds and Science and Technology Studies

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Abstract: Design is a notoriously ambiguous word in English. Similarly, it is also an ambiguous research field for Science and Technology Studies (STS). Introducing the special section *A Matter of Design,* the paper discusses the place of design in the overall context of Science and Technology Studies, with an emphasis on relevancies and difficulties in making two different epistemic cultures meet.

Keywords: Design; epistemic cultures; cross-fertilization; objects; artefacts; technoscience.

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1. Designed Objects and Designing Subjects

Design is a notoriously ambiguous word in English. Similarly, it is also an ambiguous research field for Science and Technology Studies (STS). Despite its high relevance, it has only been partially investigated.

In a sense, design has always been a pivotal issue for STS. In fact, STS arose when science scholars realised that no satisfying comprehension of technoscientific processes can be achieved without considering nonhuman actors, artefacts included. A rich STS contribution to the growing field of studies about objects (Shove *et al.* 2007) originated from that turn and has continued ever since. It has included the consideration of the role nonhumans play, for instance, in maintaining a stable collective existence (Latour 1992), in moving power and knowledge (Law 1986), in defining the epistemological framework of a scientific effort (Knorr Cetina 1999), and even in configuring the human–machine interface (Suchman 2007). Objects entail artefacts, namely things that have been designed. They have not necessarily been designed by an acknowledged professional de-

signer or through a conscious and institutionalised process of design. Most of them are the result of anonymous design (Bassi 2007), folk tinkering (Archipov 2006), or 'design by society' (Woodhouse and Patton 2004). Nevertheless, they are the outcome of a design process; they bear a script (Akrich 1992) that is a consequence of their origin from a social world; they are 'designed design'. In this framework, designed objects commonly appear in the descriptions provided by studies in design and technology.

On the other hand, design as a social setting, what we could call the 'designing design' (product design, architectural design, etc.) has rarely been researched through an STS approach. With some eminent exceptions, mainly originating in the sociology of culture (see for instance Molotch 2003; Vinck 2003; Storni 2012), the social worlds of design have not been subjected to a thorough inquiry. Although they are complex social settings involving a broad collection of people far removed from the drawing board (Woodhouse and Patton 2004) and they appear to be places where the interaction between humans and nonhumans strongly comes to light (Parolin and Mattozzi 2013), they do not seem to have attracted the same widespread STS interest as highly technological settings like, for instance, health care or energy production and distribution.

In a very general way, this could depend on a double mental bias. On one side, the concept of technoscience, which has been introduced in the STS debate to underline that 'science and technology' does not coincide with science and technology alone, is often used just as a visual expression of how strongly technology is bound with science (alone). Bruno Latour originally adopted this term (coined by Gaston Bachelard) to summarize "all the elements tied to the scientific contents no matter how dirty, unexpected or foreign they seem" (Latour 1987: 174), i.e. to underline that there is no scientific enterprise without the participation of technological devices, inscription devices, ordinary objects, professionals, laymen, political institutions, organizations, animals, and other contributors. That is to say that science and technology are always associated with non-scientific and non-technological actors, if they are to occur. Nevertheless, (see for instance Hackett *et al.* 2008) the same term has often been used afterwards just to implicitly point out that new scientific knowledge is produced through technological enterprise, underlining a growing trend of innovation processes (Etzkowitz 1990). This use of the term involves the idea that there is no science without technology, and that technology, conversely, is tightly bound to science. I suspect that this apparently tight relationship with science, which is closely reminiscent of the economic concept of R&D (research and development), alienates the designers' interest for a genuine STS analysis of technology.

On the design side, a similar but reverse bias is the effect of the half-hidden opposition between design and technology. It becomes visible in academic settings through the antagonism between design and engineering, which are conceived as two different cultures, and in economic set-

tings through the contrast between the designers' creativity and the engineers' and managers' technological innovation (Gold 2007). Such everyday life frameworks induce an attitude in the field of design to legitimize the profession by means of juxtaposition to sheer technology (like, for instance, in Brown 2009 and in Verganti 2009). In this respect, long-time opposition between the fields of design studies and technology history has been part of the culture (Katz 1997). Such opposition is related, I suppose, to the conventional association of several design fields (like product design, architecture, urban design), in some cultures, with the fine arts rather than with science and technology (Moore and Karvonen 2008).

As a consequence of these biases and for many other reasons as well, technology studies and design studies have often looked in opposite directions. Although objects are pivotal ingredients in technoscientific processes according to STS, a deep and wide consideration of the design processes that underlie the emergence, the form-and-function, the biography of artefacts is often missing in the studies of science and technology. The very concept of design finds inadequate consideration in the reconstruction of the networks, alliances, and controversies in which those artefacts are involved. Equally, although technology is a key ingredient of design (product design, service design, communication design, etc.), social studies of technology are not housed within design research, not even in the frame where they should appear, what Frayling (1993) calls 'research for design'.

To integrate what I have said above, the cautious emergence of a new interest for STS theory in the field of design studies must be emphasized. It came to light principally in the decisions of some key institutions of the field in the last decades. In Summer 2004, *Design Issues* published a special issue titled 'Science + technology studies', edited by the Department of Science and Technology Studies at Rensselaer Polytechnic Institute. In September 2008, the Design History Society invited Bruno Latour to give the keynote lecture at the conference *Networks of Design* (Latour 2009). In 2014, the journal *CoDesign* released a call for papers about 'Intersections of Co-Design and Actor-Network Theory'.

In this general framework, STS Italia, the Italian Society of Science and Technology Studies, decided to dedicate to design its fifth conference, titled *A Matter of Design: Making Society through Science and Technology* (Politecnico of Milan, 12-14 June 2014). *Tecnoscienza* has the privilege now to publish the keynote speeches of that conference[1]. The talks have been revised or redrafted for the written medium by the authors.

[1] A wider selection of papers presented during the conference is contained in the book *A Matter of Design. Proceedings from the V STS Italia Conference*, edited by C. Coletta, S. Colombo, P. Magaudda, A. Mattozzi, L.L. Parolin and L. Rampino, Milano, STS Italia Publishing, 2014. The book is an open access publication and it can be downloaded from www.stsitalia.org.

The videos of the live speeches are available on the association's website (www.stsitalia.org).

To tackle the issue of design in a conference does not just mean to discuss design among STS scholars; this is even more germane if the conference is held at a School of Design, as happened in Milan. It means rather experimenting with creating a convergence between two very disparate and distant disciplinary groups. Not an easy job. From this point of view, the STS Italia conference and the present special issue of *Tecnoscienza* represent a new setting with respect to customary situations where one community deals with the other or gently hosts it at some event.

Actually, meeting other communities and taking advantage of their perspectives is a fundamental characteristic of the STS approach, especially of actor–network theory. Accordingly, the self-awareness of designers about their own work, their practices, and their attitudes is pivotal to reconstruct a reliable view of their worlds and networks. Paraphrasing Latour (2005: 97), we have to study the design worlds *up* instead of studying them *down*.

But such encounter of communities is not that easy, especially when real people have to meet in real places carrying out real practices, as happens at a conference. As a matter of fact, in organizing the conference in Milan, we soon had to tackle the problem of mediating between two different epistemic cultures (Knorr Cetina 1999). An epistemic culture is not a collection of thoughts or theories on how to produce knowledge, rather it is a set of practices, a series of action chains, a network of players, and a sequence of situations. These situations convey the actions, thoughts, and knowledge claims made by those social players toward a certain idea of how things are to be done, of what makes for good research, what makes for good design, what makes for a good paper, and what makes for a good conference. Karin Knorr Cetina (1999: 3) described these epistemic cultures as machineries, specifically as knowledge machineries composed of practices. She stressed that epistemic subjects, i.e. knowledge producers, are essentially mere derivatives of these machineries. So, there is an epistemic culture of STS and there is an epistemic culture of design, and the task of enabling them to meet and communicate appears to be much harder and more important than those of studying design worlds *outside down* or absorbing STS theories into design theory. It is about a task and an opportunity for cross-fertilization between worlds that are not well mutually acquainted, except for some rather marginal fringes. As Michèle Lamont (2009) quite ably showed in her discussion of the American academic evaluation system, it is when academics find themselves having to draw equivalences between their standards for how things are to be done – in highly interdisciplinary contexts, for instance – that situations arise that provide the greatest cognitive yield and intellectual satisfaction.

2. On This Special Section

The articles collected in this special issue do not presume to outline an overview of the STS interest for design, nor to document the designers' interest for studies of science and technology. They rather tackle in different ways some issues that are topical discussions in this field. In this way they advance into the above cross-fertilization. I will try now to highlight the dynamic background of each contribution.

A recent and very lively debate concerns the issue of design ethics. This is an increasingly discussed issue in design studies in the 21st century, although an ethical problem is implicit in the very origin of design itself. As a matter of fact, design grew out of the industrial revolution and the rise of a capitalistic system of production. However, only in recent times have the designers started systematically questioning their relationship with industry's needs and developing new attitudes under the concepts of user-centred design (Norman 2013 [1988]) and lately, human-centred design (Cooley 2000; Norman 2005; IDEO 2011). Designing, they mean, is not engaging with objects but with human lives. It is as a consequence of this focus on the human being that the issue of design ethics has come to the fore. In this context, STS has offered a useful conceptual framework for design scholars. In a way, in fact, STS has historically provided some basic elements for a moral examination of technology itself. Focussing on controversies, and therefore criticizing technological determinism, STS could bring to light the multiplicity of subjects that are engaged in innovation processes; consequently, it could highlight that technoscientific processes have wide social and political implications, and basically generate new awareness for issues like risk, user–technology relationship, and public participation in technology policy decisions. For this reason, design studies often draw on STS reasoning to discuss the fundaments of design ethics (see Verbeek 2006; Shilton 2012; Steen 2014).

From the point of view of design history, this growing interest for ethical issues is echoed with new excitement for sustainable design history. This is the matter tackled by Kjetil Fallan in his article *Our Common Future*. He focuses on the interdisciplinary common ground between design history, design studies, history of technology, and science and technology studies. Pivotal for the inception of a history of sustainable design are the changes that have taken place in recent years in the environmentalist culture. As long as environmental awareness had privileged issues related to the protection of wild nature, no room for an appropriate consideration of design was available. Indeed, to design is equivalent to modifying the environment, altering nature. However, the sustainability turn produced a change of perspective and paved the way to historical studies of sustainability in design discourse that in turn require engaging with studies of science and technology. It does not matter, according to Fallan, that historians are interested in settled traces from the past, whereas STS scholars

in practices and networks-in-action. The artefact is an object of research to which both historians and ethnographers can meet and relate.

In the article *On "The Design of Everyday Life"*, Elizabeth Shove also deals with the interdisciplinary common ground among STS, design studies, and other fields of interest. Particularly, she draws insight from the sociology of consumption, theories of material culture, and her own concept of social practice (Shove, Pantzar and Watson 2012). Putting forward some practical examples, like varnishing or digital photography, she draws attention to the competences that they require and discusses where such competences are located. This opens a critical view upon some traditional ideas in design theory and STS as well. Her main target is the concept of 'the user', that is still predominant in design studies, notwithstanding the impetuous development of design forms in the last decades. Actually, this is an opinion that can be shared since even in the concept of participatory design is still implied the idea that two subjects, a professional designer and a user, collaborate in producing a designed result. Participatory design implies the idea that competence lies in the person, even if the person does not necessarily coincide with the designer. STS has shown instead that competence is a quality that emerges from hybrid situations, not being part of the object or the user. It descends from contingent connections of 'objects' and 'users' (and 'designers'), all of them contributing to the production of a meaning.

However, Shove suggests focusing not on the hybrids but on the practices embedded in the artefact and embodied in people. Practices are not something that can be decided at any one moment. Many times we are carriers of practices rather than real actors. Practices set constraints to our behaviour. The relationship between designers and clients is mediated not by the artefact but by the practice. Practices, though, are not steady. People are not just carriers of practices, they are also performing them and through such performances changing them at any moment. This draws attention to the role of design as an intervention in practice rather than upon an artefact. I think that this approach could help design in conceptualising the idea of a design-driven innovation (Utterback *et al.* 2006; Verganti 2009). What representatives from the influential design consulting firm IDEO usually repeat in their discourse — namely that after the transition from designing products to designing services, a further transition to designing entire customer experiences with products and services must follow — could find a sound theoretical basis here.

The last contribution, Charis Thompson's article titled *Designing for the Life Sciences*, deals with the buildings where science is carried out. Consideration for the physical places where science-in-action happens is at the very origin of STS (Latour and Woolgar 1986 [1979]; Knorr-Cetina 1981); and architecture has been a special issue in STS for a long time (Brain 1993; Aibar and Bijker 1997; Galison and Thompson 1999; Hommels 2005; Yaneva 2005 and 2012). Nevertheless, science buildings as 'physicalized architecture of knowledge' (Galison 1997: 785) remain to be

studied in detail. The fundamental laboratory studies do not thoroughly consider the lab's architecture while describing the contextual location of scientific action. They instead focus on social contingencies and on material culture. However, a relationship between the building design and a certain idea of science will not be surprising. It could be expected, for instance, that some typical features of physics laboratory buildings, where theorists are usually accommodated on the upper floor (Palmer and Rice 1961), are connected to a recurring social stratification structure in the related community where theorists are considered a sort of physicists' 'upper class' (Volonté 2003). Evidence should be collected about how design processes, as well as science practices, reflect interests, values, and expectations of implicated social groups and stakeholders.

In this context, Thompson discusses how very recent buildings for the elite life sciences reflect shared ideas about science at the beginning of the 21st century. The analysed buildings materialize the transition from an old idea of science as a detached sphere ruled by its own ethic and own imperatives to a new vision where science is deeply involved in social life and widely open to social issues. This occurs for the increasing importance that entrepreneurial science (Etzkowitz and Webster 1998) plays with respect to 'big science' (Price 1963) as well as for the growing commitment of nonexperts in decisions that regard fostering research and assessing its outcomes (Bucchi and Neresini 2008). Reading elite life science real estate, concludes Thompson, is a conceptual tool to follow the evolving epistemology of science, the changes in science policy, and the development of the public understanding of science.

As a whole, this special issue does not aim to only reinforce a particular research area in science and technology studies. Nor does it simply want to bridge the gap between two epistemic cultures and provoke cross-fertilization. It strives to strengthen an 'open' approach to STS. Despite its name, science and technology studies is not characterized by its subjects, science and technology. Quite the opposite. What distinguishes STS is its specific *approach* to the sociotechnical world; that is to say, the idea that human actors and technological structures, nonhuman objects, and political institutions contribute in an intimately connected fashion to building the world we live in. Such an approach is promising when applied to several different subjects. Making it available to multiple communities and spreading it wider is the main task for an STS community. Accordingly, it can be said that this special issue is ultimately aimed at fighting the corruption of STS by the deleterious hyperspecialization typical of mainstream science.

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Our Common Future.
Joining Forces for Histories of Sustainable Design

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Abstract: A common ground is emerging for social and cultural studies of design. Design history is exploring the socially constructed and networked nature of our material surroundings; at the same time, STS is investigating design as the interface between humans and technology. This common ground is particularly interesting where it intersects with the rapidly growing fields of environmental history and environmental humanities. Today, environmental concerns, especially issues of sustainability, are essential parameters in all design practices. However, this 'green revolution' is a glaringly white spot on the design historical map, still awaiting its scholarly historicization. Historical understanding of, and critical reflection on, the rise of sustainability as the primordial trope in design discourse is essential to building a solid knowledge base and to underpin present and future decision-making. This article will argue for the urgency of charting this terrain, and call for design history, design studies, STS and environmental history to join forces in the pioneering efforts at studying histories of sustainable design.

Keywords: STS; design studies; history of design; environment; sustainable design.

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1. Introduction

> There are professions more harmful than industrial design, but only a very few of them. […] Today, industrial design has put murder on a mass-production basis. […] [B]y creating whole new species of permanent garbage to clutter up the landscape, and by choosing materials and processes that pollute the air we breathe, designers have become a dangerous breed.
> (Papanek, 1971, xi)

These lines from the opening of Victor Papanek's book *Design For the Real World* are as provocative today as they were when the book was first published in 1971. Therefore, they also serve as a reminder that the history of sustainable design remains to be written. The provocative power of Papanek's audacious assertions can be attributed to how they run counter to the common conception of the designer as problem-solver; a humanist engineer improving bottom lines and user experiences alike. But from a sustainability perspective, this do-good image is turned upside down: "One of the key and celebrated mantras of design practice is that it is a 'problem solving activity', whereas in so many ways the designed has been problem-creating" (Fry and Kalantidou 2014, 5). And because design history largely has adopted design's self-fashioning as an intrinsically benevolent force, this diametrically different perspective has radical implications for approaches, ideologies and politics of design history as well. Histories of sustainable design, therefore, should be quite different from traditional histories of design.

Papanek, the Austrian-American vagabond designer and theoretician worked on what would eventually become *Design For the Real World* from 1963, and much of it took shape in Scandinavia, where he was guest lecturing at design schools in Stockholm, Helsinki, Oslo and Copenhagen. Papanek's persistent and public call for a radical change in design culture made him a key figure as visions of sustainability gradually rose to the fore of an ideologically and morally charged design discourse (Papanek 1983; 1995; Whiteley 1993; Fry 2009). Over the course of the 1960s, the (blind) faith in progress and prosperity – served up by seemingly endless innovation in science and technology – which had fuelled modern design since the industrial revolution, took some serious blows. In design discourse, what started as a form of consumer activism soon evolved into environmentalism (Fallan 2011), and this transitional phase could serve as a good point of departure from which to explore how visions of sustainability have been formed and mediated in the history of design.

Today, sustainability is an essential parameter in all design practice, education, research and mediation. However, this 'green revolution' is a glaringly white spot on the design historical map, still awaiting its scholarly historicization. Tony Fry's depiction of design history's understanding of design as "historically decontextualized" and "a particularist concern" (Fry 2009, 122) is quite exaggerated and unwarranted in light of the field's development over the last decades, but he does have a point that it has hitherto not contributed much by way of connecting design's pasts to its role in creating sustainable futures. Design history would do well to accept his challenge. But the importance of charting the history of sustainability is not just the purview of historians of design. Firstly, it should concern historians of ideas, technology and the environment as much as it should design historians. Researching the design history of sustainability requires new, interdisciplinary collaborations and approaches, as well as

new methods of inquiry. Secondly, in the current climate it is hard to imagine a field of historical scholarship with greater contemporary relevance: historical understanding of, and critical reflection on, the rise of sustainability as the primordial trope in design discourse is essential to building a solid knowledge base and to underpin present and future decision-making. Scrutinizing past ideologies and policies can provide a unique vantage point for asking tough questions of current and future ideologies and policies (Cox 2013). As such, the history of sustainable design might also be thought of as providing the kind of instrumental legitimacy that some design studies scholars keep demanding from design history (Tonkinwise 2014). But even beyond such blunt instrumentalism, this field of inquiry may prove to become that common ground – the interest in our common future – which will make design history more relevant to the humanities and social sciences in general (Margolin 2009; Fallan 2013b). Given the immense societal significance of sustainability and the crucial role played by design in its past, present and future, histories of sustainable design should resound well both in contemporary discourse and cultural history broadly defined. It should be evident, then, that "making society through science and technology" – sustainable or unsustainable – is "a matter of design".

2. A New Design History

Design history has a relatively brief history as a discipline or independent field of inquiry. It has its roots in the radicalization of the social and human sciences in general and particularly the renewal of art history in the 1970s. Known as "New Art History", this by now established tradition entailed an expansion of art history's subject matter to include also expressions of visual culture that were normally excluded from conventional conceptions of art (Harris 2001). In this context, design history emerged as a field of study in its own right out of a growing dissatisfaction with the theoretical framework and methodological tools offered by traditional art history. Design history acknowledged the many essential differences between the mass-produced utilitarian objects and the unique artwork which have dominated art history's subject matter. As a consequence, it has become a fundamentally interdisciplinary field, drawing on e.g. sociology, anthropology, social history, women's studies, cultural studies, the history of technology and science and technology studies (STS). The last couple of decades have been very eventful in this respect, and international design history has in part ventured quite far afield from its roots in art history (Fallan 2010).

Recently, design history has toned down the conventional focus on persons (designers), objects (artwork), styles, movements, periods, etc., and is instead becoming increasingly concerned with other aspects of and

actors in design culture. There is a growing interest in the roles of mediators, critics, curators, educators, consumers and users, as well as arenas like journalism, exhibitions and education. A similar shift in focus has taken place in the history of technology and STS as well, and also because the demarcations between 'green' technology and 'green' design are blurred at best, there should be much to gain by a joint venture in exploring the history of sustainable design. Building on these historiographical and methodological developments, such a joint venture will contribute to a design history capable of analysing what arguably is the most important shift in design thinking since the industrial revolution. From a design history perspective, this topic can be examined e.g. by asking how designers, educators, theorists, critics, promoters, consumers and users have conceptualized visions of sustainability.

However, researching the design history of sustainability requires not only an expansion of the field's subject matter into hitherto unchartered waters; it also requires a reorientation of approach, from examining primarily the meanings of material culture to exceedingly exploring a far less stable, tangible and contained domain dominated by ideological discourse and moral concerns seamlessly interwoven with oral, textual and visual culture. This reorientation will also demand a new set of methodological tools, and this field of inquiry should entail such a methodological development of design history, e.g. moving the discipline into the era of the Digital Humanities.

3. First Steps Towards a History of Sustainable Design

As mentioned, the historical conditions for, and development of, sustainable design is a glaringly white spot on the design historical map. This is not for lack of interest – quite the contrary: recent scholarship in the field has pointed out the need to pursue this topic, but has thus far made only cursory and minuscule attempts. Purporting to offer an overview of where design history stands today, Grace Lees-Maffei and Rebecca Houze's *The Design History Reader* (2010) includes a section on "Sustainable Futures, 1960-2003". It is indicative of the dearth of historical research on this topic, though, that five of the seven texts included here are primary sources in the form of manifestos or social critique such as those by Vance Packard and Victor Papanek, and the remaining two are excerpts drawn from larger works with a much broader scope in which the issue of sustainability is but one of many facets. The same scarcity is evident in the recently published *The Handbook of Design for Sustainability*. This tome promisingly opens with a substantial section on "historical and theoretical perspectives" (Walker and Girard 2013, 13-99), motivated by the editors by the claim that "the historical context leading up to our contemporary concerns about sustainability is especially important to under-

stand and absorb" (Walker and Girard 2013, 13). However, despite this declaration, the six chapters subsumed under this heading are primarily concerned with the present and the future. The occasional cursory glance at the past notwithstanding, these texts are not histories of sustainable design in any sense that a historian would recognise.

The historical importance of the seminal figure of Papanek has received some attention, but it is still only fragmentary (Clarke 2010; 2013; Fiender and Geisler 2010). That other major ecologically attuned renegade designer of the twentieth century, Richard Buckminster Fuller, on the other hand, has been the subject of a massive surge in scholarly attention lately – and the interest in his remarkably ambitious and comprehensive design philosophy reaches far beyond the field of design history (Sieden 1989; Pawley 1990; Baldwin 1996; Zung 2001). This lopsidedness might perhaps be partially explained by the fact that while Papanek castigated consumer society and proposed low-tech alternatives to conventional industrial manufacture, Fuller, in stark contrast, advocated high-tech solutions that would elevate the standard of living for all and profiteered from the military-industrial complex (Margolin 1998, 84; Anker 2010, 69-72).

Studies of a broader scope, however, are few. Taking a history lesson from how, "[w]ith the exception of Papanek, Fuller, and a few other critics and visionaries, designers have not been able to envision a professional practice outside of the consumer culture", Victor Margolin urges designers to rethink their own profession "to earn their living in the *culture of sustainability*" (Margolin 1998, 86). Pointing at a few moments in the history of sustainable design, Martina Keitsch has provided a brief sketch of its main philosophical concepts (Keitsch 2012). Similarly, Pauline Madge has outlined the recent history of ecological design, broadly characterized as a conceptual move from the commercially embraced "green design" fad of the 1980s via the more ideologically committed 'ecodesign' initiatives of the 1990s through to its recent incarnation as 'sustainable design' as social critique with real potential to encourage comprehensive change in design practice (Madge 1997).

In response to Tony Fry's accusation, mentioned above, that design history is contributing to, rather than challenging, the unsustainability of contemporary design culture, Anne Massey and Paul Micklethwaite offer examples from the history of design and the design history literature that could be said to form a proto-design history of sustainability. They suggest that the significant interest bestowed upon episodes in the history of design, such as the Arts and Crafts Movment's attention to materials and the environment and the efforts at designing with minimal use of resources which characterized the British wartime Utility Scheme, lends itself to a re-reading of design history in terms of sustainability (Massey and Micklethwaite 2009). From an educational perspective, Robert Crocker has argued that the reason why design history has seemed incapable of engaging with sustainability can be traced to an outmoded conception of

what design is, and proposes a new direction for design history informed by social and environmental history (Crocker 2010).

In her introduction to a recent special issue of *Design and Culture* on "Sustainability's Prehistories", Panayiota Pyla (2012) notes that: "now that sustainability has the added burden of no longer being at the margins, but at the center of design concerns, the realm of design has the responsibility to vigilantly consider how this 'magic word of consensus' came about". She goes on to argue that a history of sustainable design is needed:

> because it can introduce critical angles from which to contemplate the ambiguities, limitations, and potentials of sustainability. Not only in a one-way direction, whereby history teaches lessons for today […]. Rather, by critically interpreting earlier conceptions of nature, ecology, environment, and sustainability, history can lead to reconceptualizations of not only design tasks and priorities, but even the methods for history itself. (Pyla 2012)

This latter is a compelling argument, and one that should be responded to. Unfortunately, though, Pyla's own special issue hardly at all discusses sustainability in the history of design, as both she and her contributing authors are concerned almost exclusively with the history of architecture. The same can be said of Peder Anker's otherwise engaging account *From Bauhaus to Eco-house*, which seeks to locate the origins of ecological design in the context of early modernist design theory (Anker 2010). The two discourses – design and architecture – certainly have commonalities and points of convergence – but they are by no means interchangeable.

This tentative treatment, or circumscription, of sustainability in the history of design demonstrates that the topic is seen as urgent in design history today. Twenty years ago, Pauline Madge (1993) provided a pioneering and very valuable historiographical review that sought to link work relating to sustainability issues in design activism and environmental history to design history and thereby provide a basis from which to develop a design history of sustainability. It is high time her call is heeded.

4. Design Culture and Sustainability as Common Ground

Our culture is a culture of design (Highmore 2009; Fallan 2013a). Design is the interface between us and the world. Everywhere. Always. But why, as Stuart Kendall asks, is this so poorly reflected in current research in the humanities, "when design, in all of its myriad forms, is manifestly both the most significant force shaping our lives today and so widely misunderstood?" (Kendall 2011, vii) We might currently be experiencing a window of opportunity for design history, however, as the so-called 'material turn' is spreading across the humanities and scholars from a broad range of fields are converging on a growing cluster of ontological and

epistemological theories known as "new materialities" (Coole and Frost 2010; Dolphijn and Van der Tuin 2012). What we are witnessing is that:

> an increasing interest in material culture among historians in general is generating research output in which design history gains recognition. Not only do books stemming from "outside the congregation" include design historians among their contributors as well as scholars from neighboring fields writing about design […], but some non-design historians even explicitly comment on the influence and significance of design history for history at large. (Fallan 2013b, 17)

Crucially, design culture is not elite culture, but everyday culture (Fallan 2010, viii). As Ben Highmore argues, it is "the ordinary, the ubiquitous and established" – not the spectacular, rare and new – that best illustrates the significance of design culture (Highmore 2009, 4). In a current context, thinking of design culture as mass material culture makes it a very short step indeed to histories of sustainable design. The quest for a sustainable future is, arguably, the most significant aspect of recent and contemporary design culture, and one that is impossible to tackle without conceiving of our material environments on a massive scale and as everyday: the implications that the material environment has for the natural environment (and vice versa, one might argue), are best assessed when design culture is understood as mass culture, everyday culture.

But although matter has begun to matter in the humanities, the focus has chiefly been on the meanings and performances of artefacts and their interactions with people and roles in society: "Neither the processual materialization of objects, nor their ecological destiny, seems of much interest to scholars in the humanities and the social sciences" (Bedos-Rezak 2013, 50). Histories of sustainable design, however, will require a broader sense of, and attention to, materialites below and above, as it were, their manifestations as artefacts.

A renewed and expanded notion of materiality does not, however, imply a marginalization of the role of human actors. Peder Anker's plea for a humanist, anthropocentric history of environmental design chimes well with recent developments in design history and design studies, as well as in the history of technology and science and technology studies, towards greater interest in the reciprocal relations between humans and things: "The primacy of texts and natural sciences in the hierarchy of today's environmental historiography […] may explain why design has been largely ignored by historians of environmentalism and environmental historians alike" (Anker 2010, 127). Furthermore, argues Anker, because environmental history largely has "focused on issues related to the protection of wilderness, an idea that by definition stands in contrast to designed landscapes", the rich history of efforts at designing ecologically sound objects, buildings and landscapes has eluded the field (Anker 2010, 7).

Despite this negligence of the crucial role of design, the broader concept of sustainable development has long been a key topic within environmental history. In recent years, spurred by the increasing exchange between history of technology and environmental history, issues related to sustainability and technological design have moved to the forefront of many scholars' work in environmental history (Jørgensen 2011; Egan [forthcoming]). Interdisciplinary research into the histories of sustainable design has the potential to contribute to the critical re-examination of sustainability within all three disciplines.

Historical studies of sustainability in design discourse will also require engaging with scientific knowledge and the history of scientific knowledge. Here, too, there is much to gain from joining forces, not only with STS, but also with environmental history. As Sara B. Pritchard argues, that discipline has generated "fresh understandings of historical phenomena and causality" by "incorporating knowledge from the ecological sciences". It is important to acknowledge, though, she continues, that "at the same time, the environment and ecology are historical categories and objects to be examined and understood. In other words, they are not simply *explanans*" (Pritchard 2013, 9). Pritchard then prescribes varieties of constructivist frameworks drawn from STS as an apt way of uncovering the historical contingencies of environmental knowledge and systems alike.

Some historians of science, though, have lamented that STS recently seems to have taken a "contemporary turn", leading to a segregation of historical studies from STS (Daston 2009). Whereas historical studies were fundamental in establishing the field, much STS has become more concerned with contemporary phenomena and processes. This "turn" has been attributed to the strong position of irreductionist program since the 1980s, especially Actor-Network Theory, and the accompanying reliance on ethnomethodology (Asdal and Moser 2012). This does not mean, however, that STS is no longer relevant to historical studies – on the contrary, STS may indeed prove invigorating and inspire new approaches to the writing of history. Kristin Asdal, for instance, argues that a new and more dynamic understanding of the interplay – or interweaving – of *text* and *context* may be "a crucial and potentially fruitful notion" able to "draw STS and history together": "Rather than drifting apart, historians to the archives and STS scholars to actions as they unfold in an ongoing practice, text is an object of research to which both historians and ethnographers (and others) can meet and (often must) relate" (Asdal 2012, 397).

In light of the above discussion about the "material turn", I would add to this that artefacts might also hold the same promise. When the anthropologically fuelled version of Material Culture Studies emerged in the UK in the late 1980s, it became a major source of fascination and inspiration to a design history moving away from its art historical origins. However, much like historians of science and technology have criticised the

contemporary focus of STS, so design historians criticised the contemporary focus of Material Culture Studies (Fallan 2010, 40). But then the relationship between the historian and the sociologist has always been "a nervous romance" (Myhre 1999).

Over the last decade or two STS has proved highly influential on design studies and design history as these fields have been exploring the socially constructed and networked nature of our material surroundings (MacKenzie and Wajcman 1985; Bijker, Hughes and Pinch 1987; Atkinson 2010), as well as the heterogeneous relationships between people and things (Latour 2005; Fallan 2008). At the same time, STS is increasingly investigating design as the interface between humans and technology (Oudshoorn and Pinch 2005; Oldenziel and Zachmann 2008). As a result of this mutual rapprochement, we now see the dawn of exiting hybrid forms of scholarship that bodes well for future collaborative efforts (Shove *et al*. 2007; Guins 2014).

In his keynote lecture at the 2008 Design History Society Conference, tellingly named *Networks of Design*, Bruno Latour suggested a range of ways in which studies of design could facilitate the "drawing things together" that he so persistently advocates: "The more objects are turned into things – that is, the more matters of facts are turned into matters of concern – the more they are rendered into objects of design through and through" (Latour 2009, 2). Studying design, he said, entails studying "gatherings", entanglements, collaborative efforts, cumulative changes, practical skills and ethical concerns – all issues of great relevance to addressing the ecological crisis.

The insight gleaned from STS that the production of knowledge – as well as of doubt and ignorance – is historically contingent and distinctly social is crucial to studies of sustainability in design history. The climate debate is a prominent and, in our context, pertinent example of such a process in which, "[a]t times, scientific rules even yield to other imperatives – to the need to reduce complexity and to reach decisions within reasonable spans of time, for instance" (Uekotter 2013, 40). Studying the production of deficient knowledge – what is becoming known as "agnotology" – writes Frank Uekotter, "may serve as a welcome reminder that knowledge is more than an issue for academia" (Uekotter 2013, 40). The history of how sustainable solutions have been envisioned in design discourse provides precisely such a real-life setting where decision-making and practical action takes place with more or less conscious reference to a constantly changing, complex, chaotic and partial knowledge base.

That there is a common ground emerging around the issue of sustainability at the intersection of design history, STS and environmental history is convincingly illustrated also by the work of Finn Arne Jørgensen on what he calls "everyday environmentalism":

> "Environmental historians", he writes, "in particular those con-

> cerned with consumer culture, are well advised to carefully consider the complex and changing relationships among designers, consumers, technologies, and commodified products on one side, and environments, natures, and our ideas and values about nature on the other". (Jørgensen 2013, 73)

To do so, though, environmental historians should, I propose, join forces with STS scholars and design historians in a common future for a common past.

5. Possible Ways Forward: Visions of Sustainability

Although the entire field of sustainable design lies open to and uncharted by design history, an exhaustive historical survey of this field is a momentous task. Rather than trying to move forward in all directions, it can be advisable to identify suitable approaches and sectors for a first set of inroads. One such approach could be to focus attention on how sustainability has been envisioned and visualised in the history of design since the 1960s, and how these visions have varied between different (sub)discourses and arenas and changed over time. A major appeal of this approach is its feasibility: delimitating the scope to *visions* of sustainability has the advantage of sidestepping the issue of qualitatively assessing actual consequences of purportedly sustainable design solutions – a task that is notoriously difficult to tackle in historical inquiry. Analysing design culture's past visions for a sustainable future also will provide an appropriate model, and comparative knowledge, for understanding contemporary design culture's visions for a sustainable future. Although by no means a mainstream approach, examples of this type of historical studies of past visions of the future can be found, especially in the history of technology (Corn and Horrigan 1996). It can also be seen as related to the rich tradition of avant-garde studies in art history (Coles and Rossi 2013). That connection is by no means a far-fetched as it might first appear – as Paul Denison asks: "Might we suggest […] that sustainable design is utopia revisited, and that it bears not a little similarity to modernism's call for restraint and economy of means?" (Denison 2008).

This general approach can then be refined in various ways. One option is to device a three-tier structure, examining three different types of visions of sustainability in the history of design in three different locations/arenas:

- Ideological visions: sustainability in design education and research;
- Pragmatic visions: sustainability in professional design discourse;
- Popular visions: sustainable design in mass-media and popular culture.

Adopting this structure will enable us to follow the notions of sustainability as they travel through different layers, or spheres, of design culture and evolve over time. These visions of sustainability can be mapped and investigated chiefly through textual and visual sources, ranging from conventional archival artefacts to ubiquitous online material. A key category, though, would be magazines of various kinds, from professional trade journals to the popular press. Much of this historical material is now digitized and available through online databases, and therefore lends itself very well to interpretative methods drawn from the Digital Humanities. To give an example: using text and image recognition software, we can map occurrences of the word 'green' and the colour green in imagery on the pages of *Time* magazine over time, providing a visualization of when 'green' became a mainstream trope for sustainable design.

From a Nordic perspective, our regional context provides an opportune setting for exploring visions of sustainability the history of design, partly because the ideas promoted by Papanek and others had a massive impact on design education and subsequent generations of design practitioners, but also because the Nordic societies proved a fertile soil for political activism, counter culture and the environmental movement in general, and because Nordic political and academic culture has produced important contributions to the broader international discourse on ecological awareness and sustainable development, such as the 1986 Brundtland commission report *Our Common Future*, Erik Dammann's organization The Future in our Hands (Fremtiden i våre hender) and Arne Næss's deep ecology movement. Again, this is simply a suggested place to start; histories of sustainable design will of course have to wander far wider into the world – in fact, the topic might actually be an efficient way of catalysing another long overdue development in design history, STS and environmental history alike: broadening the fields' geographies.

In methodological and historiographical terms, studying *visions* of sustainability in the history of design ties in with current developments in the field of design history internationally. The emerging interest in the *mediation* of design in various ways and on different arenas (Lees-Maffei 2009) provides a useful context for the approach outlined here. Herein lies the potential to push this development in a new direction through the exploration of digital technology in charting and analysing visions and mediation in design culture – one benefit of which will be adding a quantitative aspect to methodological approaches hitherto fundamentally enshrined in the qualitative realm. The capacity to move research beyond the conventional dichotomy of qualitative and quantitative methods is a defining feature of the Digital Humanities.

The Digital Humanities could be thought of as a trading zone and meeting place for the inter- and transdisciplinary exchanges that histories of sustainable design entail. As environmental history has been a pioneer field in appropriating and contributing to the development of Digital

Humanities, this particular collaboration holds great promise in devising histories of sustainable design capable of reforming design historical methodology through linking it with the rapidly evolving Digital Humanities. The exploration of digital mapping, visualization technologies, and topic modelling opens up for investigating new research methods based on digital technology and their potential application to design history. The Digital Humanities are becoming a new exciting modality of research taking advantage of the computer and the internet in archiving and examining large amount of data, providing and producing various tools that can be used for accessing and examining digital archives (Gold 2012). It seems especially promising for studies that deal with the examination of non-textual material, such as images, time-based media, audio, film and design (Bentkowska-Kafel *et al.* 2005; Bailey and Gardiner 2010). Design is fundamentally *networked* in character (Fallan 2008; 2012), and this feature is what makes it so integral to the Digital Humanities – both as a generative component, but also as subject matter (Burdick *et al.* 2012). There should be exciting potential, then, in exploring the possibilities of Digital Humanities for design history, both for expanding its media of research, for facilitating research exchange and dialog between disciplinary traditions, and for finding new forms of research dissemination (Berry 2012).

Whichever way visions of sustainability are investigated in the history of design, doing so might very well constitute an effort at heeding the challenge posed by Latour to scholars of design in the context of the current ecological crisis: "where are the visualisation tools that allow the contradictory and controversial nature of matters of concern to be represented?" (Latour 2009, 9).

6. Conclusion

Perhaps it is worth returning to the problem-solving ethos of design practice, which got such bad press from Victor Papanek. Re-appraising this attitude and identity might provide an opportunity to move beyond the 'doom and gloom' which has characterized much environmental history. Beyond the many tales of pragmatic, piecemeal problem-solving that design practice is engaged in, design history abounds with accounts of holistic, utopian visions. Fuller, for instance, in all his difference from Papanek, believed that: "politics will be obsolete" by the year 2000, if only designers could be in charge (Fuller cited in Anker 2010, 80). With the crucial caveat that the ecological "design-science revolution" (Fuller 1981, xix) that Fuller preached implied the undermining of democratic society (Anker 2010, 81) – participation is an essential parameter of the sustainable development, without which it could easily slide into "ecofascism" (Madge 1997, 52) – his remarkable efforts at employing design thinking to solve complex environmental problems can serve as an exam-

ple of the kind of positive angle which can be discerned when studying visions of sustainability in the history of design. In the words of Victor Margolin:

> Designers have the ability to envision and give form to material and immaterial products that can address human problems on a broad scale, and contribute to human well-being […] well beyond green design or ecodesign which, thus far, have represented designers' attempts to introduce ecological principles to the market economy. (Margolin 1998, 90)

This re-appraisal of the problem-solving ethos of design practice must not, of course, entail a return to the hagiographic, genuflecting praise of the designer as genius and design as a panacea for everything that is wrong with the world. A design history geared to examine issues of sustainability needs to consider "design as practice of decision-making as well as form-making, and of problem-questioning as well as problem-solving" (Hall 2009, 59). The problem-solving, and problem-questioning, ethos of design therefore warrants renewed attention if this is directed to the ways in which it has been applied to envision more sustainable futures. Exploring visions of sustainability in the history of design, then, could contribute a more positive, solution-oriented outlook for our common future of the past.

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On "The Design of Everyday Life"

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Abstract: The article highlights the intersection between design, STS and consumption outlining practices as the central unit of analysis. The paper illustrates this perspective with reference to a variety of examples, including home improvements and do-it-yourself (DIY) projects, digital photography and plastic stuff. In the paper some questions are raised: where does competence lie? Does it reside in the human or in the non-human, or in the relation between the two? What does the concept of a human-non-human hybrid mean for the sociology of consumption? And how does the human-material distribution of competences affect the details of everyday life and what people do?

Keywords: Design; STS; consumption; material culture; theory of practice.

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1. Introduction

I am glad to have the opportunity to look back to the issues discussed in *The Design of Everyday Life* (Shove *et al.* 2007) and to think about where I now stand in relation to those ideas. In particular I want to highlight points of intersection between design, STS and consumption. I am therefore going to build on a selective history of these fields and pull out some ideas which I think can be taken forward – in short my aim is to identify points of connection and cross-fertilization.

If you look at research in the sociology of consumption and in material culture as well, there is a tradition of thinking about the symbolic significance of objects and a tendency to focus more on issues of acquisition than of use. This is a very simple distinction but I think it helps to set the scene. In science and technology studies there are again many tracks and trends, for example themes of innovation, stabilization and scripting are very well documented. Meanwhile in product design, there is a lot of em-

phasis on the object, on its properties and qualities and on its users. These three fields do not mesh together terribly well, and in *The Design of Everyday Life,* we started to explore points of connection.

In taking this approach we stood back and drew inspiration from a different theoretical tradition. We argued that social theories of practice provide a way of making new connections and generating different ways of thinking about relationships and interactions between objects - not only objects alone, but also complexes of objects and even infrastructures - people and practices.

In this paper I want to outline the potential and the significance of taking practices as the central unit of analysis and enquiry and show how this helps bridge between the traditions outlined above. I will illustrate this possibility with reference to a variety of practical examples including home improvement and do-it-yourself (DIY) projects and digital photography. This second example now looks rather old-fashioned, but when digital photography was new – actually not many years ago – there were many interesting transformations. In effect the elements of photography were completely reconfigured in a very short space of time. I am also going to talk a little bit about plastic. When we looked at material culture studies, one of the striking omissions was any serious or concerted analysis of material as such. By contrast, product designers were interested in material properties, and materiality is, of course, a key concern in science studies. These three examples – home improvement, digital photography and plastic - allow me to explore a number of points of intersection, all of which still deserve more work.

I am going to start with a very simple example drawn from science studies. Consider someone holding a hammer, and then think about questions of competence and skill. Where does competence lie: does it reside in the human or in the non-human, or in the relation between the two? The notion of a human-non-human hybrid implies that the hammer alone is not enough alone, and that a person without such a device will find it hard to hit the nail hard on the head. Taken to heart, STS based observations about hybrids could and should be picked up in design studies. This is important in that within design, much that has been written about 'the user' wrongly assumes that competence ultimately lies in the person, not in the thing. At a minimum, science studies says that competence is an emergent quality that is not part of the object nor of the user. One implication is that, 'the user' is not a sensible concept for those who acknowledge the intermingled character of human-non-human hybrids.

This is one contribution and at the same time one point of difference and departure. Let me now turn to the same topic but from the point of view of the sociology of consumption and material culture. What does the concept of a human-non-human hybrid mean for the sociology of consumption and provision, and how does the human-material distribution of competence affect the details of everyday life and what people do?

2. Distributed Competence

My next example is drawn from the field of home improvement and DIY. Not so many years ago, to put a good surface of varnish on a door you would have to take the door off its hinges and lay it flat, otherwise the varnish would drip and run and you would have all kinds of problems. To do a really good job you needed practice: to some extent the skill involved was necessarily embodied in the person. This is no longer the case. Modern varnish is capable of drying in twenty minutes, you can apply another coat within two hours and you can be really pretty incompetent and *still* get a relatively good finish on the door. You certainly don't have to take the door off the hinges. What has happened is that the competence that was previously embodied in the person, in the varnisher, is now in the tin. Whilst the concept of a hybrid helps explain this transition, it does not go far enough in such a notion, alone, does not shed much light on parallel transitions in systems of provision and consumption.

To address these questions we need to go further. The modern tin of 'clever' varnish brought the job of doing varnishing and home improvement within the reach of amateurs. In so doing innovations in varnish also constitute innovations in the economy and in the systems of expertise and competence on which divisions of labour depend. The boundary of competence between the person and things moves, and as this boundary moves, so does the idea of what people can do for themselves, and of when they would hire an expert in. In short, the changing contours of hybrid configurations have implications for, and are themselves outcomes of changing patterns of consumption and production.

This is just one example of just one object: a single tin of varnish. If we are to continue with this line of thinking we obviously need to go beyond single objects and think about how collections of materials and tools interact and about what this means for the types of projects that people are willing to take on themselves. Staying with home improvement, innovations in plastic plumbing provide an illustration of more systemic change. Standardised plastic plumbing fittings were so 'easy' to use that one of our respondents contemplated the otherwise risky project of relocating a radiator. When things go wrong with plumbing projects they can go badly wrong – potentially resulting in leaks and floods of water all over the place.

In this case, an entire system of plastic plumbing brought the radiator moving project into the realm of possibility. The fittings clipped together. The job went well and having gained confidence from this project, our respondent's horizons expanded: having shown that he could move a radiator he was eager to take on other more challenging jobs. This was not an unusual experience. When people talked us through the history of the tools in their tool box, they explained that tools and skills were often interlinked. Specific items were acquired for specific projects, and the tool

collection that builds up is both a residue of previous experience and a platform from and on which future projects are built.

Tools boxes proved to be revealing sites of analysis not least because of the extent to which different tools are used in combination. The box and its contents consequently provide some insight into the accumulation of hybrid competencies, sometimes built up over many years. Of course tool boxes also provide insights into failures and into careers cut short by one disastrous project or another. In any event, the point is that understanding these dynamic relationships between people, projects and objects calls for more conceptual resources than those which STS provides.

In particular we need to move beyond conventional concerns with individual objects (scripts, hybrid arrangements etc.) and acknowledge that we are also dealing with the unfolding lives of people and with changing of systems of provision, consumption and competence. In the case mentioned above, our DIY respondent acquired the skills to become an avid consumer of further tools and materials – all of which are just so much metal to those who lack the knowledge of how to use them. His next project, building a Wendy house for his children, led him to add to his collection of tools and materials and to his confidence and skill, again paving the way for the next project.

Through this example I have taken the idea of distributed competence from STS and shown how it can be re-planted in the field of consumption studies. In this role, such concepts provide some insight into the changing contours of embodied and delegated or 'materialised' expertise, and hence into the also changing boundaries of what people are and are not willing to do for themselves. As indicated above, such changes have potentially far reaching impact, being of relevance for the DIY market, and for the livelihoods of professional plumbers, decorators and other trades.

3. Reconfiguring the Elements of Practice: Making and Breaking Links

In this section I focus on the relation between material objects and social practices, concentrating in particular on the idea that social practices are made of ongoing configurations of elements. This takes us into new territory. Social theories of practice do not have the same theoretical lineage, nor do they share the same preoccupations as science studies, design or the sociology of consumption. They are nonetheless useful in conceptualising relations between materiality and competence and in understanding how such links are made and broken. Andreas Reckwitz (2002) suggests that social practices – like digital photography, showering, or doing DIY – depend on the active integration of elements. In *The Dynamics of Social Practice*, Mika Pantzar, Matt Watson and I (2012) worked with a simplified version of this scheme, focusing on just three key elements: ma-

terials, meanings and skills/forms of competence. Where a practice is regularly reproduced, these three constitutive elements are regularly combined. For example, doing DIY projects involves ongoing and continual interactions between material, competence and meaning, including the idea of what a project involves and what it means to do it well. That is the basic starting point. This conceptual scheme implies at least two other possible formulations. One in which elements (material, meaning, skill) exist but are not yet linked in practice, and another in which links which used to exist have fractured or broken, meaning that the practice is no longer reproduced. A further important observation is that 'elements' of practice are not static: they are defined and constituted in relation to each other and as illustrated in the following example, they are constantly on the move.

The recent history of photography gives a sense of these dynamic interactions. What happened when film photography was overtaken by digital photography? Which elements changed and which stayed the same? There are certainly some areas of continuity for example in the 'element' of meaning. Ideas about what makes a good photograph are fairly consistent: there are various shared aesthetic conventions. It is still important to keep the head in view and not to cut peoples' legs out of the frame. However, the practicalities of actually taking a picture, and the material elements involved have changed beyond recognition. Buying film is an odd, and now specialist pursuit and fewer and fewer people know how to manage film-based techniques of handling exposure times and the like. While elements of meaning are relatively stable, those of material and skill are much more dynamic.

Whilst these ideas provide a means of conceptualising transitions in practice, they emphasise features that are underplayed or overlooked in science studies and design. Critically, they draw attention to the ways in which elements combine and change, and to the point that social practices are multiply connected. To elaborate, doing digital photography involves making new connections – drawing on skills previously associated with computing and transferring those over to the realm of photography. When using a digital camera you do not need to know how to balance light and shade: not in the way you did with film. However, to achieve a similar result you probably do need to know how to use software like Photoshop, and how to adjust images to your liking one pixel at a time. This clearly involves competences drawn from another field but carried into and then transformed (to some extent) through new associations, becoming part of a new assembly of material elements.

Science studies and theories of material culture or consumption provide only partial insights into the ongoing flux of contemporary photographic practice. For Reckwitz, and for others who write about the evolution of practice, people (the photographers) simultaneously figure as the carriers and transformers of the practice. It is they who keep it alive, or change it, through their more or less faithful or consistent integration of

more or less changing elements. The concept of a 'user' radically underestimates the constitutive character of peoples' roles as carriers of practice. In other words, in integrating elements in the way they do, photographers are part of making photography and of changing the practice as an 'entity' – that is as something that exists beyond any one moment of performance.

To elaborate, for some people digital cameras substituted for the film versions they replaced. In these cases, some new skills were needed but in general the process of taking pictures was reproduced as consistently and faithfully as possible. This was not so for all. For other people digital photography opened all kinds of new possibilities: messing around with pictures, swapping one colour for another, editing parts of images out and so on. The totality of 'photography' represents these variant forms, some of which are more dominant than others. And of course the story does not end when the image is captured. Digital photography calls for and has generated new ways of viewing pictures, new ideas about what a family 'album' consists of and how it is shared. Whilst some of this is about making new links (with the computer), it is also about breaking old associations (with an album, with film itself).

In exploring transitions to digital photography I've moved from a discussion of competence embedded in things and embodied in people to a more complicated account of the changing relation between 'elements' including material, competence and meaning. I have also noted that the practice of digital photography is made and reproduced by cohorts of 'carriers' whose varied performances constitute what digital photography is at any one moment.

4. Material Relations

In this section I comment on what this analysis of elements and practices might mean for an understanding of materials and material culture. To explore this interface I make reference to plastic, considered as a material or, more accurately, as a vast family of materials. In the 1940s plastics were heralded as materials of the future and were valued for all sorts of different qualities: there were discussions of the wonderful possibilities of 'dirt proof windows', of 'silent, dustless floors', and of how people might live in the 'plastic age' (Yarsley, Couzens et al. 1941; Yarsley, Couzens et al. 1943). The qualities of plastic were, of course, identified in relation to the materials for which it substituted. Hence in comparison with metal, plastic does not rust; in comparison to wool it is not eaten by moths, and in comparison with ceramic it is 'unbreakable'. The plastic world was, in addition a world of colour, in contrast to the more monochrome materials that it replaced.

Wiebe Bijker's very nice history of Bakelite (Bijker 1997) is a classic tale of how the material came to be as it did. This narrative reveals the so-

cial groups and interests that had a bearing on how problems were defined and framed and on the solutions that were constructed in response. In staying with the topic of Bakelite, and in treating this as a bounded material and as something that has an existence in its own right, Bijker's account belongs in the genre of innovation studies. As such it does not follow through the changing relationship between the material and the many different products – and hence product-material relations involved. For example, in the form of a radio casing Bakelite is positioned in relation to wood, and to walnut wood in particular. But in its role as an insulator (for example in electrical components) the qualities of Bakelite are considered in relation to those of ceramic.

On the one hand, focusing on the history of Bakelite *as a material* is important and revealing – there really are innovations to be explained and described. But on the other hand it is also misleading: in the world of artefacts people encounter plastic, or Bakelite, in the guise of an object or product and not in some pure material form. In daily life, plastic is a telephone, a hair-brush, a hair-dryer, a set of buttons, a television, and so forth. There is therefore something elusive about how we know and engage with materials. From this point of view, the qualities of a material are not fixed or inherent: they are an outcome of the various product- or object-encounters through which the material is known. The idea of what plastic is good for consequently comes from nothing other than this multiplicity of material/object relations. In very practical terms, conceptualising the defects and the properties and performances of different materials – wood, steel, plastic, etc. – is at the same time a matter of conceptualising the properties of specific artefacts again not in the abstract but as they are mobilised in the course of accomplishing specific practices.

The key point is that this calls for an analysis of relations and forms of co-existence between systems of objects and practices. There are examples of work which takes this challenge on. For example, Susanna Handley's book on Nylon (Handley 1999) provides a compelling account of how synthetic materials transformed the realm of clothing, bedroom furniture and fashion. Amongst other things, she suggests that synthetic materials had the effect of democratizing the idea of owning a whole wardrobe of clothing that you could change and of having a variety of different clothes from which you could pick and choose to suit the occasion. As she explains, nylon entered everyday life through a variety of routes: the price of individual garments dropped, the variety of garments increased, the idea of wearing different colours for different occasions became established, and so on. Critically these material relations operate at a systemic scale: the story is thus not just one of how nylon came to be (interesting though that is), nor is it an account of scripting, domestication, or appropriation.

One further example gives a sense of the under explored challenges of conceptualising multiple co-existing relations between materials, technologies and practices. I am not sure that it makes sense to talk of electricity

as a material 'element', but the existence of an electricity infrastructure is evidently crucial for the conduct of many practices around which daily life revolves. Understanding the role of energy in contemporary society is an important task, not least because of the challenges of climate change. But none of the fields discussed – material culture, consumption studies, science studies and design – have quite the range of conceptual resources required to grasp the interaction between infrastructures (grids, networks etc.), the appliances that are plugged into those grids and that are the front line 'terminals' of use, and the various practices to which these powered appliances and devices relate and of which they are a part.

Many areas of daily life depend on variously invisible infrastructures, and often on the coexistence of several such networks. The habit showering arguably depends on the coexistence of electricity, gas and running water: without these infrastructures in place the practice would not take the form it does today. In this case, focusing on the design and use of the shower fitting alone would provide limited insight into the full range of materiality on which the practice depends. Within science studies/history there are excellent accounts of how infrastructures especially of electricity have developed (Hughes 1993 [1983]). As with the story of Bakelite, the emphasis is on how such large technical systems have come to be configured as they are. But again these accounts stop short of explaining how these arrangements are embedded in practice, or how they coexist and interact.

As I have already mentioned there are already many ideas about competences, projects, practices, careers, the multiplicity of relations between materials and the roles of infrastructures. These have been developed in different fields and in ways that reflect previous preoccupations, for instance with technological innovation, the status of 'users', and so forth. Further creative work is required to bring these resources together and to capture and represent those multiple, co-existing and overlapping relations between materials and practices that constitute the 'design' of everyday life. I have argued that social theories of practice provide an exceptionally useful point of reference and a framework that allows us to capture some of these interconnections. However, some questions remain and one of these has to do with the role and contribution of product design.

5. Conceptualising the Role of Design

Many objects are produced without input from product designers so just what is it that product designers really do? In promoting and selling their services professional designers imply that they have something extra to add, but what is this added value? Designers themselves have certain ideas but how does 'design' figure in representations of materials and ob-

jects of the kind developed in science studies, consumption or material culture? There are different options on offer.

One view is that design is in some way injected into an object, which is in some or in many respects 'improved' as a result. The idea that designers endow artefacts with specific qualities is widespread. There is rather more uncertainty about exactly what qualities these might be, but in general, such an approach suggests that the designer has a rather powerful role, and that the object itself does not.

A second family of ideas starts from the proposition that 'value' is not a quality of the object itself, but is something that is accorded to an object by many actors – not by designers alone. From this point of view designers do not have a unique role but are instead one amongst others involved in the ongoing activity of attributing and removing judgements of quality and value. By implication, the value of an object does not last forever, it changes all the time as the different actors circulate around it adding and taking away different sorts of meaning. At a minimum this means that if they are to add value or to contribute, designers need to understand how objects are positioned and how values and meanings are attributed by others.

A third possibility, and one that is consistent with a theory of practice, is that designers have a part to play in configuring the materials, ideologies and competences of which social practices are made. In other words, engaging with objects is at the same time engaging with elements of competence and meaning. There is some point of connection between this idea and the conclusion that artefacts actively configure experiences, images and forms and competences. From this point of view it makes sense to conceptualise design as an intervention in practice. Ironically, this depends on turning attention away from 'the' object or its purported qualities and properties, and on focusing instead on objects-in-action, that is in their role, along with co-requisite elements of meaning and competence, in the ongoing reproduction of practice.

Some designers already make such claims. For example, representatives from IDEO explain that "we think of product in terms of verbs, not nouns, not cell-phones but cell-phoning" (Kelley and Littman 2001: 46). Of course their role in *making* cell-phoning is limited: at the end of the day they work with the object itself, and with a product that is sold. As such they cannot literally *make* the practice of phoning but they can and to some extent do realise the significance of taking phoning as the central topic and focus of their work, not the phone itself. Reference to the 'user' restricts the full force of this realisation and it is worth underlining the point that what we might think of as *practice* oriented design involves much more than taking users into account – instead it calls for understanding and intervening in the lives of practices, the elements involved and the changing cohorts of 'carriers' who keep such practices alive.

In conclusion if you go along with the view that things have some kind of absolute quality, then you might well conclude that designers (or users,

or somebody) provide that quality and add that value. If you focus on things as part of situated practices/actions, it is obvious that there are no lasting qualities and that 'properties' change all the time. From this point of view it follows that design does not have a special or unique role alongside all the other processes that are going on. Finally, if you consider objects as material elements of social practice, it would make sense to suggest that designers are involved in shaping not just material elements, which have no role in isolation, but the entire complex of elements (including competence, meaning) of which practices are made. Taking this idea forward, designers, amongst many others, are engaged in making and reproducing complexes of social practice.

A final word on the implications for sustainability. It is tempting and common to think of sustainable design as that which promotes efficiency: producing 'the same' object or service but with fewer resources. Or that it is about configuring objects so as to support durability, re-use or recycling. However, there is a much broader and much more significant sense in which all designers, regardless of their commitments and green credentials, contribute in some small way to the ongoing reproduction of a vast array of social practices that depend on arguably unsustainable flows of energy. By implication promoting sustainability is not about designing objects: rather it depends on asking more fundamental questions - what are these objects for, of what practices are they a part, and can these systems of practice be somehow 'steered'? That would be the place to start.

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Designing for the Life Sciences: The Epistemology of Elite Life Science Real Estate

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Abstract: In this article trends in the design of iconic elite life science buildings is discussed. Four main elite life science buildings of the new century are considered. The buildings reflect things going on in and around elite contemporary life science today, including changing ideas about the relation between the public and science, and about the relation of science to the market. Reading trends in the design of science buildings is a way to follow the evolving epistemology of the life sciences and changing demands of science policy.

Keywords: Design; architecture; STS; Life Sciences; buildings.

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1. Introduction

In the current era, it is common for elite life science buildings to be designed by top architects, and to win prizes and acclaim for their design. These imposing buildings concretize the valuation and values of the life sciences. Their layouts are literal interpretations of evolving ideas about how best to do science: who should have what kind of access to whom and to what, what activities should happen where, and what relations there should be between what goes on inside the building and its various publics. In some ways, this is nothing new. The architecture and design of elite scientific buildings has always reflected contemporary ideas about how science is best done and known, who pays for it, and what purposes it serves. The Ancient Library of Alexandria, built in the 3rd century BC, was reputedly designed to gather the world's written knowledge, to dis-

play and aid the exercise of power by rulers, and to attract the greatest scholars of the day and thereby promote more research and knowledge.

These same elements of gathering and housing data; service to power (whether rulers or other paymasters) and publics; and attracting the best scholars and facilitating the best research continue in various combinations to characterize the design of elite scientific buildings. The specific forms this takes, however, mirror evolving epistemic and social aspects of knowledge production. In this paper I consider an iconic elite life science building from the beginning of the revolution in molecular biology, the 1962 Salk Laboratory in San Diego. I then look at four elite 21st century life science buildings: Singapore's 2004 Biopolis Phase One, UC San Francisco's 2010 Dolby Regeneration Medicine Building, Cambridge, UK's 2011 Sainsbury Laboratory, and London's 2015 Francis Crick Institute[1]. Certain themes of the Salk's design, such as the emphasis on design itself, and the provision of basic lab bench needs as part of a flexible but inbuilt infrastructure have continued to characterize these buildings. Newer design elements, such as the explicit incorporation of a translational arc from "bench to bedside", and the incorporation of data management into the infrastructure, are evident. So, too, are changing ideas about innovation in the life sciences and its uses, dangers, and relations to its publics.

2. Science and Technology Studies and Design

Since its inception, Science and Technology Studies (STS)[2] has emphasized the places where science is carried out as part of its commitment to showing what is social and what is situated about knowledge that functions rhetorically as natural and un-situated (see Thompson 2005, 31-53; Shapin 2010). STS has also always paid attention to material culture and to the empirical, technology-mediated and spatialized ways in which epistemological judgments are possible (Latour 1999, 24-79; Lynch 1985; Prentice 2013; Suchman 2007; Thompson 2005, 79-116). Geopolitical spaces, from citizen science to regions and nations to circuits of knowledge, facts, materiel, and scientific personnel, have been elucidated as part of the sine qua non of modern science (Haraway 1984; Jasanoff 2004; Livingstone 2003; Mukerji 2010; Nelson 2011; Thompson 2013, 68-149). And the actual sites where science is carried out, from the field site to the lab, and from the Early Modern to the Contemporary era, have

[1] My choice of buildings is idiosyncratic, and reflects paths that my own research has taken. Although these buildings cannot be said to be representative of new life science research buildings in general, I suspect that the characteristics to which I draw attention are not only evident in these particular buildings.

[2] I use STS to refer to cognate work from the history, sociology, anthropology, and philosophy of science, as well as from STS "proper" (STS as a discipline).

long been thematized in STS, as microcosms of the self-contained case-study method, and as materially relevant to the science produced (Galison 1997; Latour and Woolgar 1986; Rudwick 2014; Thompson 2013). This paper draws on all these strands of STS.

Michel de Montaigne's C16th Tower has come to symbolise the tension between the ways one's environment can structure and nurture one's work, and the ways in which it stifles or corrupts the imagination and the intellect. Today, amidst the boom in elite science real estate, this tension is still evident. The start-up stereotype eschews the real estate of established science, and is populated, in the US imaginary, with under-socialized and vitamin D-deficient young predominantly affluent White males in basements and garages. The freedom from the trappings of professionalized science is equated with creativity and innovation. In fact, the necessary equipment, regulation, and data are all big science today, and only a very well connected Silicon Valley garage would be fit for purpose. Even within establishment science, individual scientists and specific breakthroughs are still the things that are venerated and credited with genius in a system of positive feedback by which the leaders pull away from the rest. This individualism and star system continues to flourish even though the sciences are in many ways ever more collective and interdependent. To design a building for contemporary life science, it needs to be seen as allowing for, or actively fostering, individual creativity. The new elite life science real estate has incorporated elements of these enduring ideas about the nature of innovation and of genius into its novel design[3].

3. The Life Sciences

The life sciences stand on the brink of being able to re-engineer molecular life in purposive ways. In this lies the potential to manufacture a new generation of bioweapons, and a corresponding need to make many branches of the life sciences secret as part of national and international security apparatuses. At the same time, never has the scope and depth of public implication in the life sciences from agricultural biotech to biomedicine been so great: our lives, our food, and our governance are part of a biotech mode of (re)production (Thompson 2005, Ch. 8). Life science real estate displays this tension between a heightened need to be accountable to and involve the public, and security needs that re-impose *cordons sanitaires* and limits to transparency and public access.

Life science today also characteristically proceeds according to new combinations of public and private funding, captured in the bench to

[3] The pedigree of these ideas, and their tension with how science is actually done, can be traced in the work of Steven Shapin (1991). See also Livingstone (2003).

bedside promise of translational biomedicine. The public is asked to support open-ended basic science, while private capital is tasked with its translational uptake, in an aspirational cycle of innovation and trickle down wealth creation. This rise of what could be called the research-industrial complex, in a parallel to the military-industrial complex of the C20th, imposes its own tensions. The extent of public non-military research funding carries with it demands for accountability and participatory science, and for visible, equitably distributed public goods flowing from research. The private sector money, on the other hand, brings its own legal and business rationales for keeping knowledge proprietary. This tension manifests at every level of the life sciences today from crises of reproducibility, to the open-access publishing movement, and unprecedented pressure for academic scientists to publish in high impact journals and engage in technology transfer and corporate spin-off. The buildings I consider below demonstrate their mixed public-private funding, and in some cases, their interior design attempts to address these tensions and remedy the problems of the heavily capitalized private versus public faces of contemporary life science.

4. The Salk Institute

The Salk institute was built in 1962 and designed by architect Louis Kahn, in collaboration with Jonas Salk, famous for developing the polio vaccine. It is one of the world's most iconic science buildings: starkly masculinist and framed by the frontier landscape of Southern California's Pacific Coast. The basic design has two rows of rectangular parallel laboratories running parallel to the coastline over which it is perched, on either side of a travertine marble courtyard. The courtyard is dissected by a straight line of water running, infinity-pool style, toward the cliff edge, and continuous to the eye with the Pacific Ocean. At sunset, the courtyard frames the setting sun. On the inside courtyard side of the laboratories are hemi-chevron shaped offices, blending wood with the warm cement mix of the labs. There are separate towers at the East end of utilities, and three of the six floors of the laboratory portion is given over to heating, ventilating, gas, electricity, and other support systems by then essential to bench science. See image 1 for the vista, and image 2 for the offices, seen from the ocean side. In 1992, the Salk received a 25-year award from the American Institute for Architects.

The labs themselves have no internal walls and have lighting units that can be moved, as well as the easily accessible, flexible support systems made possible by the service floors. These features were designed to support maximum collaborative potential, as well as to be easy to maintain and to leave open for the future exactly what configuration of working would best serve the science being conducted in the building. The Salk

remains one of the most productive and perhaps the single most illustrious life science facility in the world, in terms of its current researchers and many Nobel and other prize winning alumni. This speaks to the continuing attractiveness to researchers and funders, and scientific efficacy and longevity of the design.

Image 1 – The iconic view of the Salk Institute (reproduced from: http://pic.pimg.tw/leecocoa/1327583338-3916316003.jpg).

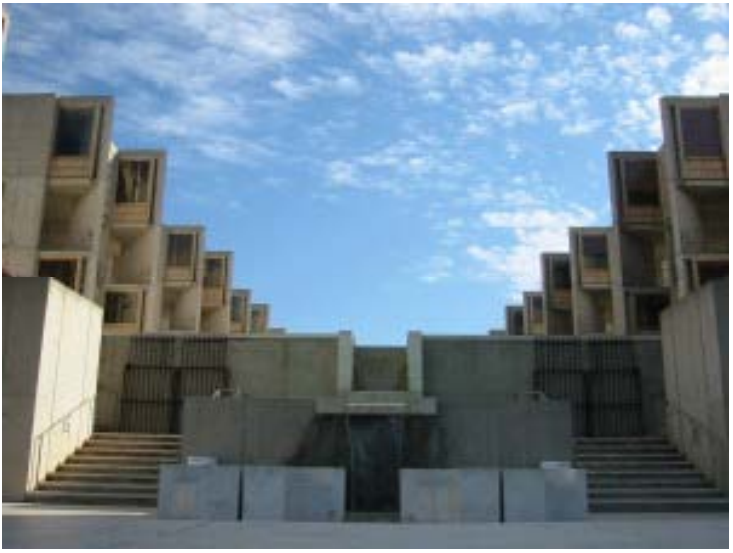

Image 2 – The hemi-chevron offices of the Salk Institute, seen from the ocean side (photo by Jim Harper/Wikimedia Commons).

The principle of building collaboration into the laboratory design so as to promote scientific discovery and innovation has continued in newer elite life science buildings. Nonetheless, the version of collaboration the Salk embodies is not the same as that more commonly seen today. The Salk is an austerely beautiful building, a scientific retreat of the most aestheticized modernist kind, frequently described as monastic. It is characterized by its symmetry and precision, and its interior spaces remains the sole preserve of scientists and researchers themselves. The collaboration is among scientists. The public is not part of its design, although the Salk was from the start a monument to science in the service of the human race, having been designed at the dawn of the molecular biology revolution, in the duel context of eradicating the greatest diseases of mankind and the Cold War. It has played a highly significant role in the life sciences from plant biology to neuroscience ever since. More recent life science buildings design the pros and cons of collaboration differently, incorporating a participatory relation to the public, rather than serving in a salvational relation to a greater humanity from which it is separate.

4. Fast forward to the 21st Century

By the twenty-first century, the Cold War, if not nuclear (dis)armament, was behind us, and the life and biomedical sciences had grown and capitalized dramatically. We worried about global warming, not nuclear winter. Our concerns with empirical science were more likely to stem from big data's lack of intelligence or justice, than from the gap between non-falsifiability and truth. Epistemological crises of science as an institution, such as failures of reproducibility, and their apparent causes in excesses of market and competitiveness, all threatened the life sciences' special relation with democracy. Could it be that the life sciences were contributing to a world caught up in increasing inequality rather than serving as the place from which to "speak truth to power"? The new iconic life science buildings displayed the concerns of the era, from spaces designed to mitigate excessive competitiveness to those designed to acknowledge a public who talks back. Like the Salk in its time, these concerns were literally part of the design of these labs, showing in another instantiation the claim made by Science and Technology Studies that science is co-produced with the social order of its time and place.

The new building design, then, reflected how people were thinking about science in the early twenty-first century, from innovation to ethics to participation to sustainability to interdisciplinarity to markets and security. Although all these elements are evident in all of the buildings I discuss below, for the sake of clarity and brevity, I am focusing on only certain particularly striking aspects of each building. I take the buildings in the order in which they were opened. For Singapore's 2004 Biopolis, I emphasize flow between the public and private sectors and between dis-

ciplines and nations; for UC San Francisco's 2010 Dolby Regeneration Medicine Building, I emphasize innovation and sustainability as rationales for public funding and private profit; for Cambridge, UK's 2011 Sainsbury Laboratory, I emphasize good science and the new monasticism against threats to reproducibility and excellence in science; and for London's 2015 Francis Crick Institute, I emphasize the invitation in and containment and management of publics.

5. Singapore's 2004 Biopolis Phase One

Singapore's Biopolis Phase One is a seven-building biomedical research compound that was built in 2003-4. Like the Salk, it was designed by a world famous architect, but one very much of the turn of the new century rather than the mid -20th century, the Iraqi-British architect, Zara Hadid. Hadid was the first Muslim and first woman to win the Pritzker Architecture Prize, in 2004, and she has also won the Stirling Prize. Her buildings are known for their flamboyant curves, and their futurism, conjuring up artificial natures rather than being at one with, or sustainable within, a threatened nature. Hadid's dual heritage betokening her global citizenship, and her familiarity with designing for new wealth-attracting global cities, made her a good choice for Biopolis. The names of the seven buildings of Biopolis, Chromos, Helios, Genome, Proteos, Centros, Matrix, and Nanos, made no secret of their life-science ambition to repurpose nature and re-master life itself, and Hadid's buildings reflected that. The buildings *are* the landscape, rather than built into the landscape.

Biopolis has something in common with such places as Silicon Valley's Googleplex in that it is governed by a view of innovation that is near totalizing. Many aspects of life are encompassed within the complex itself; you can eat, drink, get your hair cut, attend arts programs and drop off your kids and your dry cleaning. There are also nearby residential facilities for scientists and their families to live. The ethos – at least when I toured it – was not at all the Peter Pan-like one that I experienced at Googleplex, but rather, professional and urbane, and translational. Biopolis emerged as a microcosm for the city-state of Singapore trying to position itself in the knowledge economy as a global and regional hub for international life science.

The seven Biopolis Phase One buildings themselves are connected via sky bridges, again emphasizing the literal links between areas of specialization. Some of the buildings contain privately funded laboratories, and others are publicly funded; some of the research is basic, but it is imaged in connection to translational research. The built environment links them as a single manufactured landscape of research. Some of the labs are set up so as to facilitate collaboration among scientists coming from different national science traditions, having different kinds of experimental condi-

tions built into the infrastructure, and thereby facilitating attracting the best and the brightest ex-patriate scientists as well as Singapore's next generation of knowledge workers[4]. All in all, Biopolis Phase One designed into being a world of life science research that was flexible, internationally co-operative, and intrinsically translational, or "bench to bedside". The brain drain to Biopolis, and subsequent disillusioned exit of, several internationally recognized life scientists spoke to the tensions inherent in this model between basic, creative university science and science too explicitly in the service of the economy.

Image 3 – The landscape of Biopolis Phase One and its Sky Bridges (reproduced from: http://upload.wikimedia.org/wikipedia/commons/4/43/Biopolis-Singapore-20080712.jpg).

6. UC San Francisco's 2010 Dolby Regeneration Medicine Building

I turn next to the Ray and Dagmar Dolby Regeneration Medicine Building at UCSF, which houses the Eli and Edythe Broad Center of Re-

[4] In *Good Science* (Thompson 2013), I described Biopolis as "internationalist" in its layout, labs, and epistemology, while being very much a product of Singapore, with its city-state merging of private capital and government agencies, literally connected by sky bridges.

generation Medicine and Stem Cell Research. This building was designed by the New York firm, Rafael Vinoly Architects, and was paid for by a combination of private funds and taxpayer money awarded for stem cell facilities by the California Institute for Regenerative Medicine. It won an American Institute of Architects Design Award in 2011, among other recognition, and is widely regarded as a beautiful building.

The Dolby Regeneration Medicine Building is credited with four striking properties. First, it was built very quickly. Second, it is seen as an engineering feat, having been built on a 60% slope, curving horizontally along the Parnassus Heights hillside. Adding to the engineering prowess, the Nabih Youssef Association of engineers gave it remarkable seismic properties. The building was constructed on a steel framework with isolation bearings that reputedly would be able to move over two feet sideways and even vertically by an inch or two in the event of an earthquake. Everything about the building is innovative.

Third, the building was designed to receive Energy and Environmental Design for New Construction (LEED-NC) Gold level certification. Unusually for laboratories, it maximizes natural light, and it was built using many kinds of energy conservation methods. The building itself is also blended in with the environment, and aims to minimize its contribution to greenhouse emissions not just through energy conservation, but also through using the roofs of its various levels to grow native grasses. The Salk was designed in such a way that it aggrandizes its natural setting and vice versa. The Dolby is also an impressive building that fits its natural setting and affords splendid views, but it is more about energy and environmental sustainability and not disrupting its habitat than it is about grandeur and monumentality of nature inside and outside the lab.

Finally, the Dolby Regeneration Medicine Building, like Biopolis, was explicitly designed to foster connections between the public and the private sector. Its collaborative design was different than that of Biopolis (or the Salk), however. Biopolis was designed to connect different subdisciplines to serve the growth of an international economy. The Dolby Regeneration Medicine Building, on the other hand, was built to connect sub-disciplines so as to facilitate and stage an interplay of ideas, the sharing of new techniques, and the growth of knowledge. This in turn was to speed the translational trajectory from basic research funded by the public all the way to clinical therapies, via commercialization and clinical trials. The economic benefit was implied in the translational design but it was secondary. Cures from stem cell research and regenerative medicine were the primary goal of the building's design[5].

At the Salk, the offices were off to one side. In the Dolby Regeneration Medicine Building, the offices and meeting and lounge spaces were

[5] In *Good Science* (Thompson 2013) I characterized this as "pro-curial" science, concerned with cures, and with the procurement and curation of life tissues and data.

placed in the areas that were directly between different labs. Getting to and from one's lab required interaction with personnel from other labs. In this way, walking, talking and thinking, were designed to be spontaneous and interactional. Research funded by public and by private sources would come into serendipitous contact in this interactive flow of minds and bodies through the building's layout. The building bears a literal signature of this collaboration in the 140-foot long, 90 foot above-ground, glass enclosed steel bridge which serves as the building's main entrance. In this entryway, the eponymous private donors are named and matched by a commemoration of the tax-payer and the innovative voter initiative, California's Proposition 71, that also provided funding.

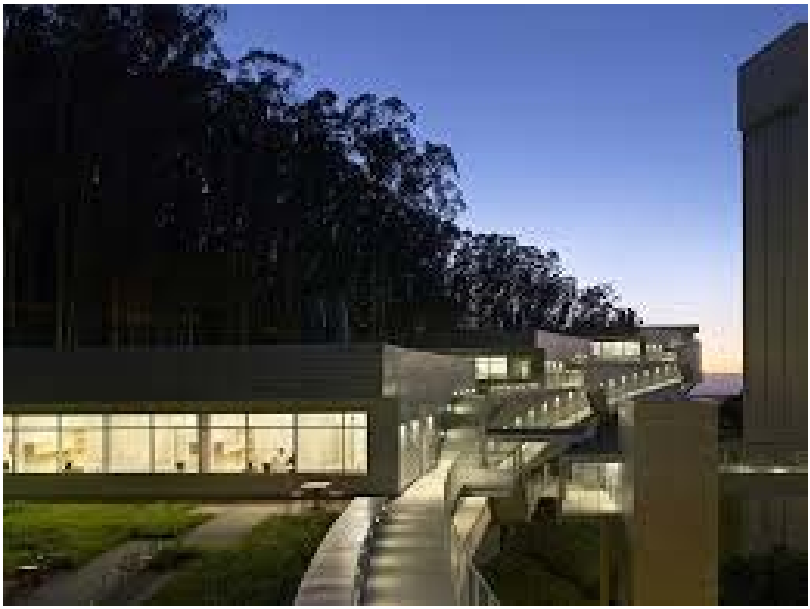

Image 4 – The Dolby Regeneration Medicine Building's curving hilltop design. (reproduced from: http://buildipedia.com/aec-pros/featured-architecture/ucsf-institute-regenerative-medicine).

7. Cambridge, UK's 2011 Sainsbury Laboratory

Cambridge University's 2011 Sainsbury laboratory was funded by David Sainsbury's Gatsby foundation, and designed by the architects Stanton Williams. In 2012, the building won the Royal Institute of British Architects Stirling prize, a prestigious architecture prize awarded for the building that contributed the most to British architecture in the last year.

The Sainsbury laboratory is a plant biology facility, and was designed with containment facilities for known pathogens. In other ways, though, it was designed with a high degree of openness and flow from the outside to the inside and among its inside spaces. Those working in the biomedical branches of the life sciences work in buildings designed for the unique challenges of animal research and human subjects (and in the case of stem cell research, embryos). As I discuss below, openness in biomedicine building design is constrained by the containment of animal rights activism and by privacy and property and propriety claims of human subjects. Openness means something different when human and animal subjects are not at stake. Those working in plant genetics encounter a not always supportive public, especially around the GMO question, but in general they can afford to be less concerned with dealing with the public actually or metaphorically inside their research premises than those working in biomedicine. Openness as a design feature functions differently. It still fosters research creativity and productivity by encouraging researchers to interact and share information and findings through working in shared spaces with few walls. Instead of a means of collating and containing the public, however, openness provides visibility and accountability. This is turn can encourage a research culture designed to avoid the pitfalls and temptations of hyper-competitive closed science.

The Sainsbury laboratory is situated in Cambridge University's Botanic Gardens, and is strongly connected to the botanic gardens, not just through its core mission of working to discover the mechanisms of growth regulation of plants, but also in its design. Although the laboratory is concerned with plant genetics and development at least in part so as to address the grand social challenges of food security and climate change mitigation, the building was built to emphasize the ethos of fundamental science, including the herbarium and covered growing area and the flexible lab benches and non-hierarchical layout of the lab. The pressures that might be associated with highly commercialized fields were counted in elements of the design. Only the laboratory's director has a proper office, and all other researchers of all ranks must do their meeting and working in shared spaces that overlook the garden and are contiguous with the lab space itself. Like the Dolby building, this building's design made interaction inevitable. The arrangement of space highlighted intellectual contribution rather than rank.

The Sainsbury laboratory building was built with a serene and calming combination of stone, cement, and wood, and was explicitly conceived of as monastic by the architects. This is a new monasticism since the Salk, however. The space is not public, but the public is able to enter the auditorium and the café and herbarium and the botanic gardens in which the building is set. The monasticism comes not so much from being a separate citadel from the world in which humanity is at risk, as in the Salk, but from the designed rigor required to pursue scientific excellence and truth in the face of politicized and capitalized applications for the science

at hand. The space both ensures that the work is relevant to the pressing global challenges of the day (food and climate), while steering a path that avoids the excesses of competitiveness, temptation to fame, and proprietory or secret behavior that might be expected to attend elite science at Cambridge, as well as science of value to the agricultural biotech private sector and the politically contested areas of climate change and GM crops. The pressures that threaten to corrupt science and scientists, hierarchy and competitiveness and secrecy, are designed to be as minimal as possible in the building. The new monasticism stands for good science in both the ethical and intellectually significant senses of the expression. Where Salk was aesthetic, the Sainsbury laboratory, for all its beauty, embodies a certain intellectual and organizational asceticism.

Image 5 – The Sainsbury Laboratory, Cambridge, UK, in its new monastic serenity (reproduced from: http://www.stantonwilliams.com/data/projects/372/img2.jpg).

8. London's 2015 Francis Crick Institute

The Francis Crick Institute for Medical Research and Innovation, in London, UK, is slated for completion in 2015. I toured it while it was still a building site, and was able to see the extraordinary engineering and design that went into the basic services housed in its basement. From gas and air, ventilation and cooling, clean and contained human and animal and pathogen handling facilities, and on-site data storage and back up, the Crick was the largest scale building and the most comprehensively serviced of the buildings. The Salk's innovation of having service systems built into the design and infrastructure of science buildings so as to promote sustainable unpredictable research and collaborations is alive and

well in all these 21st century buildings. A growing need for quality control, biosafety, and big data storage and management have all intensified the needs these needs for built in service infrastructure. The fact that the biological is beginning to yield new kinds of fundamental knowledge that can bridge the data-human-animal divides is mirrored in the facilities that need to be designed to permit this fungibility.

The Crick is a massive edifice, not remotely monastic, but instead positioned in the heart of the King's Cross development area of London, and explicitly engaged with its more and less local publics. The once-religious motives are not gone, for the basic design of the building is a giant cross. But it is an active and secular congregation that is beckoned. There is a team involved in public participation, and the public relations surrounding the building emphasize the public good to which the science inside is to be directed. Unlike the other buildings discussed in this paper, the public is to be invited into the belly of the beast, having access to much of an enormous ground floor atrium. In the emphasis on public engagement and the way the atrium has been designed, the Crick evokes a 21st century hands-on science museum more than a conventional laboratory space. There is a café, and a cinema pod in which demonstrations and films will be shown. Exhibits will be geared toward topics that are of interest and good to the public living in the areas that surround the building.

Image 6 – The public part of the soaring central atrium of the Francis Crick Institute (reproduced from: http://www.hok.com/uploads/2012/03/23/francis-crick-st05.jpg).

It has become a commonplace of science today to pay some heed to public engagement and participation in science, rather than simply seeking to educate the public. The Crick manifests this. It also manifests starkly the limits to public engagement in science, corralling the public in the central atrium, rather than in areas where the core science of the building is happening. The active research part of the building – the sides, top, and back of the building – are secured from public entry, so as to protect scientists from potentially dangerous animal rights activists (so I was told), and from others who might unwittingly or not disrupt the business of doing cutting edge science. Public participation, then, is more hands on than the earlier idiom of the public understanding of science, and no doubt, having the public in the building will serve to remind scientists of the centrality of the public good to their mission as scientists. Nonetheless, it is a far cry from the citizen science or crowd-sourced experimental space many of us have imagined might be the next design phase of 21st century life science.

9. Concluding Thoughts on the New Design

The iconic new buildings for the life sciences are like the Salk in that they continue to be award-winning not just as architecture, but as architecture in the service of research. They continue to design "the basics" into the infrastructure, but their design shows that the basics have expanded to include animal and data storage, and cooling and freezing capacity, and clean and efficient interfaces between human, animal, and data. Changing or blurring boundaries between human, non-human animal, and data are emblematic of the biomedical contemporary life sciences and are embodied in the design of these buildings. In layout the new buildings are: a) bench to bedside, including public and private funding in a single research trajectory, and affirming the link between basic and translational research; b) in touch with their environments, and even award-winningly green; c) participatory, but with strict limits; and d) designed for "good science" that would promote translation and spurs to innovation without falling prey to the excesses of "publish or perish," or the corrupting influences of the market. Reading elite science buildings is a way to follow the evolving epistemology of the life sciences and changing demands of science policy.

Applied to these elite science buildings, the STS claim of the co-production of science and society requires some further discussion. I have argued that the buildings reflect several rather different kinds of things going on in and around elite contemporary life science. For example, the buildings reflect changing ideas about the relation between the public and science, or about the relation of science to the market, which seem on the face of it to be science policy issues. The buildings also display a new

relation to the cityscape or to the environment in the age of global warming that seems to be taken from wider culture. In addition, the buildings display current interpretations of certain ideals of science, such as openness, good science, and the fostering of creativity through interaction, which might or might not reflect much about how science actually proceeds. The question arises, then, as to whether these phenomena have anything to do with scientific knowledge itself, or whether they just concern the cultural context of science[6]. As I tried to indicate above, the cultural context and the science itself cannot in fact be that cleanly separated, even though the entanglements between these things are different for each issue. So, although the buildings reflect changing (and in some cases, persistent) ideas about science to be found in the wider culture, they also reflect, and in turn help produce, changing scientific knowledge. For example, translational biomedical science aimed at finding cures needs to produce knowledge that survives translation from an animal model to humans, from proof of concept to scaleability, and this requires developing instrumentation, regulation, characterization, and different and tougher standards of reproducibility, among other things directly part of the science itself.

Contemporary science buildings' relations to the environment reflect the rhetorical role of science as evidence-based reason in naming and in mitigating global warming. The buildings, by mitigating climate change, impart that reason to what goes on within them. But elements of climate friendly design such as open plan and natural light are part of encouraging an interactive and transparent approach to science that guards it from becoming corrupted by excessive money and competition, and that ensures that creativity is constantly catalysed. This is true whether the openness literally renders everything visible and whether spontaneous open plan interactions actually cause more creativity, or whether those ideas function rhetorically as an ideal; in either case, the knowledge is produced and judged according to those standards. Likewise, the role of the public in the buildings' designs, whether as an absent guarantor of good science, or as present and participating in parts of the building, makes the scientific knowledge itself something that must be accountable to the public in certain ways. The public can talk back to science, appropriate it for its own ends, demand regulation, refuse a standard of proof, and many other things that affect what constitutes scientific knowledge and who is qualified to make that determination. In conclusion, then, the design of new elite life science real estate tells us about changing ideals of science, about contemporary issues in science and society, and even about some changing aspects of scientific knowledge itself.

[6] I am grateful to Paolo Volonté for correspondence on this matter.

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"On the Internet, We Are All Pirates, and That's Good"

Interview with Jean-Marc Manach

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Abstract: This interview with Jean-Marc Manach – investigative reporter, specialist of surveillance and privacy protection on the Internet, and a well-known French "hacker-journalist" – explores the issues of cyberconflict and cybersurveillance, focusing on the broad phenomenon of "piracy". In doing so, the interview outlines the different definitions, framings and reconfigurations of those practices, enacted by network users, which have been labeled as "pirate" by different economic and political actors of the Internet value chain. Following Manach's reflections, the interview provides a few benchmarks towards a critical perspective on "piracy" as an ensemble of situated practices which places us, perhaps for the best of our society, in the condition of being "all pirates" of today's digital networks – engaged in the construction and sharing of cyberknowledge.

Keywords: Internet; privacy; hijacking; cybersurveillance; piracy.

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Introduction

In the wake of Edward Snowden's revelations about the pervasive surveillance practices enacted by the United States National Security Agency – practices the legality of which is discussed within the American legal system itself – issues of cyberconflict and cybersurveillance have never been so much a matter of "current news". Information and communication technologies, Internet first and foremost, are increasingly leveraged to achieve economic or military objectives – from the theft of critical data to the hijacking of industrial systems. The generalized rise of digi-

tal espionage, tracking and surveillance is unveiled not only by the recent Snowden revelations, or by WikiLeaks' activities, but also by the construction and the organization of an increasingly widespread and lucrative market of surveillance technologies and equipment.

This context also brings about novel ways for the practices gathered under the label of 'piracy'. On the one hand, Internet users and citizens seek to respond to pervasive surveillance via a number of 'bricolage' practices that build, develop, hijack or pirate technical artifacts to secure their Internet connections and prevent third parties to access their data (Musiani, 2011). On the other hand, the development of surveillance and decrypting techniques is a powerful leverage in the development of computing in a "common good" perspective, as history reminds us (Musiani and Schafer, 2011). To understand 'piracy' as a phenomenon – its definitions, framing, reconfigurations – it is important to understand the extent to which practices that have been labeled as 'pirate' by different actors of the Internet value chain, economic and political, are *de facto* largely present and popular amongst users: a phenomenon which places us, perhaps for the best of our society of sharing and knowledge, in the condition of being "all pirates". We have discussed surveillance and its hijackings, digital bricolage and piracy, with "hacker-journalist" Jean-Marc Manach, on November 26, 2013.

Jean-Marc is an investigative reporter, specialist of surveillance and privacy protection on the Internet. For reasons that he details during our conversation, he defines himself as a "journo-hacker". Jean-Marc is mostly known for his blog on Le Monde website, called "Bug Brother", and for his past and present contributions on popular French information websites such as, for example, InternetActu and OWNI. Among his investigations, of particular note is the one that involves Amesys, the French firm which – we learn about it in 2011 – has sold to the Kadhafi regime the surveillance technologies that allowed him to place his opponents under strict surveillance. Jean-Marc is a founding member of the Big Brother Awards France, an award ceremony organized by Privacy International and destined to governments and firms that "do the most to threaten privacy". He has served on the board of *Nos oignons* ["Our onions"], association promoting the development of the digital network Tor in order to "guarantee information, expression and communication liberties". He teaches several courses in journalism schools, on themes of information security and protection of sources. His most recent project (since September 2013) is a WebTV programme on the website *Arrêt sur images*, where interviewees are reached via the Skype programme. His website is jean-marc.manach.net.

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FM: Let's start with a piece of most recent news. The Pogoplug firm announced yesterday the release of Safeplug, a "49-dollar box" aimed at securing Internet connections of users via a "plug-and-play" Tor. What does your experience within "Nos oignons" tell you about the likely future of this experience? Can the Safeplug box work from a technical standpoint, and be largely adopted by users?

JMM: Technically, it's something that has been done by hackers for a long time now. In this particular case, we arrive at the commercialization of a product, the stage after the prototype. I have a hard time in figuring out precisely the economic potential of this process – if a company can make a profit with this. What is sure, however, is that in the middle of the Snowden affair, this is happening at a very specific moment. One of the problems with the Snowden affair, is that most people will tell one of two things: either "we knew already", or "there is nothing we can do about it". The first point is certainly not true: there is plenty that this affair has indeed revealed or made public; and as for the second, of course not – there is plenty one can do, and could have done even before the Snowden revelations. These, however, have led people to build or experiment with things, both at the micro level and by organizing DIY "laboratories" to secure their Internet connections and prevent third parties (the NSA in the first place) to access their data and wiretap communications massively. At the same time, there are the 'giants', Twitter and Microsoft, turning to HTTPS... This little gadget, Safeplug, is part of a global movement, an effort to secure the Internet again. What is interesting with this box is that it is meant to be placed between the computer and the router – thus, whatever the protocol used, all the traffic is meant to go through Tor – not just Web traffic.

FM: The release of Safeplug is but the latest occasion to reflect upon an issue that has been at the core of my research (Musiani, 2013) – and that of several STS scholars of communication technologies (Aigrain, 2011) – for the past few years: the shaping of decentralized alternatives to the most popular Internet services of today, as a possible way to improve the protection of privacy and the security of one's online identity. What do you think of this "technology-based" approach to security and privacy, and its effectiveness vis-à-vis other strategies, such as written law or user education?

JMM: One of the main geopolitical influences that the United States have exerted on the Internet has been, and still is, the worldwide propagation of the idea that law cannot be trusted. The U. S. is a country that does not trust its institutions: so, for example, it is a lot simpler to obtain information that concerns institutions, most notably thanks to documents such as the Freedom of Information Act. It is a very powerful instrument, which may even allow to declassify NSA documents. A fortiori, with the

Snowden revelations, we have seen how the NSA is indeed violating American law. In France, this defiance vis-à-vis the State may be there, but it is not embedded in the system; however, an increasing number of people, thanks to the Internet, are starting to be careful.

The solution is often thought to be a technical one, given that addressing the issue from a legal standpoint always takes more time. The privacy-by-design (PbD) approach[1] is technical, cultural and financial at once. People have been fighting for a long time towards this objective, but the interest of many firms is still lacking. Here again, thanks to the Snowden revelations, several States and companies will increase their security budgets, and this may, in turn, increase the large-scale adoption of PbD. Snowden has explained that the fundamental reason behind his revelations is that we are experiencing a turn in our conception of human rights. He thinks that, had he further delayed, it would have been too late to know if it is the Matrix that controls mankind or vice-versa, if there is accountability, transparency, responsibility. Maybe it is already too late, by the way. But in any case, we are in the middle of a turn.

This also applies, in my view, to education. A two-year-old child will know how to use an iPhone, while a fifty-year-old adult will need to read the instructions booklet. Well, the reason behind the success of the iPhone, is that there are no instructions to be able to use it. We are in a situation where teachers know less than students, because they were not born with the tools; in addition to this, the former were born in a situation where the act of teaching involves someone who speaks and someone else who listens – not a logic of co-participation and sharing, to which the Internet has accustomed us. Denmark is, to my knowledge, the only country which authorizes students to have Internet access open during their exams: Danes asked themselves why the day of their exam would have to be... the only day of their lives with no Internet access – they understood that the most important thing is not to memorize passively, but to know how to look for, and find, the most useful information at just the right time. I am quite skeptical that we will be able to fully incorporate this vision in our educational system, to set as our main objective the improvement of common knowledge. There are some 'islands'... for example François Taddéi and his Center for Interdisciplinary Research[2]. But overall, I do remain skeptical, especially when I am a witness to the 'strategies' of legislators. A few years ago, to educate children about questions relat-

[1] The PbD idea is developed by the Privacy and Information Commissioner of Ontario (Canada), Ann Cavoukian, in the mid-to-late 90s. It proposes that, as the legal framework is deemed insufficient to ensure the protection of privacy, the latter be introduced directly into the design and the implementation of computing systems and networks (as well as in the elaboration of responsible design and use).

[2] François Taddéi, engineer and biologist, promotes innovation and interdisciplinarity in education and research, especially thanks to the activities of the Centre for Interdisciplinary research (CRI, www.cri-paris.org), which he directs.

ed to copyright violations, they were sending people in schools to tell students not to do this or that – with a similar approach for social networks: don't share too much, it's dangerous! Which is, of course, the best way to make sure they do just that. To discuss dangers and opportunities of sharing at once looks like a more constructive approach to me.

A final point, in terms of education, needs to be made on the difference between the fact of making computing technology available, and making available the infrastructure that actually empowers people to use it. It is of little avail to equip entire schools with laptops if you don't equip them with power outlets and high-speed connections, as well. We need to move beyond our relationship to computers as gadgets if we wish for education to become an actual tool *vis-à-vis* issues of security, surveillance, privacy.

FM: Let us go back in time for a while. You are famous for your investigative reporting work on the themes of online surveillance and privacy, but you said on the occasion of our first contact that you have become a journalist 'by chance'. Indeed, your 'journo-hacker' trajectory (as you define it yourself), is hardly reflecting that of the average journalist. In 2001, you publish a book on French experimental cinema of the Seventies. Your two book-length works, *Big Brother Awards* (Garnier et al., 2008) and *La vie privée, un problème de vieux cons?* (Manach, 2010) [Privacy: an issue for old fools?] on surveillance and privacy respectively, come out in 2008 and 2010. What has led you to become interested in these two themes?

JMM: Indeed. In my early days, I didn't wish to be a journalist: I wished to become part of the film industry. During my days as a university student, I discover experimental cinema and documentaries, and I become passionate about it. I start creating fairly peculiar movies: film festivals didn't want any part of them, because they were too much of a documentary, and documentary festivals didn't want any part of them because they were too much of an experimental movie. So I started to write, just a little bit, because I wished to "defend" my movies. The French *Cinémathèque* was at that moment elaborating a catalog, on the occasion of a big retrospective on experimental cinema, and I suggested to include a chapter on a historical episode that had never been told: the deliberate decision that had been made of not providing any funding to experimental cinema. This article was excluded from the volume, for very opaque reasons of lack of space. I was disheartened by the fact that in a creative milieu such as cinema, thirty years later after the facts I was talking about, it was still possible to censor some things.

At the same time, I was discovering Internet – by chance, I was at the time writing for a journal which had a high-speed Internet connection, which was still very rare; Internet connections were mostly done with 56Kbit/s modems. I was starting to fool around with Web pages, mainly

my personal one. That's where and when it happened: in 1999-2000, I obtain a high-speed access, I start to become interested in the Internet, and that's when the report by Duncan Campbell comes out, talking about the communications surveillance and espionage ECHELON system (Campbell, 1998). My encounter with the Internet happened at the time when I also found out that the entirety of networks was under surveillance. I started to become interested in this from a journalist's viewpoint: to protect my sources. Journalists didn't have any set of instructions to manage this: by turning to the world of hackers, I realized that instead, they did – they knew how to protect their private life, they knew how to use security software. I started to read, then to translate and publish documents of instructions and best practices. That's how I became interested in these topics.

FM: The documentary *Une contre-histoire de l'Internet* [A Counter-History of the Internet], directed by Sylvain Bergère and co-written by you, emphasizes developers and/or activists, and shows the extent to which they have made the Internet what it is today. What was the genesis of this project? What is the advantage of this approach to account for the history – the histories – of the Internet?

JMM: A vast majority of people who retrace the history of the Internet explain that the network was conceived on demand of the U. S. Army to resist a nuclear attack. Well, Internet was conceived just as much by LSD-addicted hippies! This history had never been told before, and documentaries about the Internet were often of the anxiety-inducing type, assimilating Internet users to pirates, hackers to criminals... I wanted to show that it is also thanks to the hackers that we have the Internet. It has, indeed, been funded initially by the American army, but such is the case of Tor, as well – the obfuscation network on which we bestow all kinds of vices today. There is so much stuff we owe hackers – in a broad sense: the promoters of sharing, of the openness of source code, of free software, of an interest in transparency and a keen preoccupation with privacy...

FM: This also entails a re-definition, in the eyes of the public, of what a hacker actually is...

JMM: Very much so. Especially in France, indeed, where the hacker figure has been 'demonized' for so long. In fact, it is the DST [Direction for the surveillance of French territory] that put together the first team of hackers, in the early Nineties, and when this became known, nobody wished to be defined as such any longer. In 2001, I was attending the first French symposium on network security, and half of the attendees were wearing a uniform: the conference was taking place in the very premises of the *Ecole militaire*! We had to wait for 2007 in order to have the first hacker festival of France and the 'coming-outs' of people defining them-

selves as hackers. Last year, France hosted almost a dozen network security-related conferences, gathering internationally-renowned hackers – an unthinkable thing just a few years ago. The 'demonization' of the hacker also helps accounting for several things we have discussed earlier on, the approach of the educational system to digital matters. It also explains why we have been targeted, as TV viewers roughly at the same time, with a portrait of the Internet as a nest of paedophiles and nazis – so ludicrous. But this happens a lot more in France than in other countries, and I think it is linked to the top-down manner in which our State is organized. They have several faults in the United States, but there, if you try to build a company and fail, your chances increase to obtain funding to try and build another: in France, if you have failed, you're busted. That's what the hacker culture is about, as well: to integrate failure into development.

FM: In regards to "dominant histories" and the formatting of discourses that derives from them: we often have the impression, thanks to the way it is treated in the press, that the history of Internet surveillance revolves around the United States. Is it indeed the case, or at least, it it the case to that large an extent? Does this history hide discourses and practices – State-driven, company-driven, or a mix of both – of which we should be more aware?

JMM: We cannot understand the development of computing and networking without understanding that it also derives from the efforts undertaken in order to break secret codes during World War II. The Enigma programme, which had led to the development of Alan Turing's first prototype of computer, is an example of this. The development of the telecommunications industry has paralleled the development of the surveillance of telecommunications. A humongous amount of money has been destined to this development during the Cold War, as well. Internet is the "comet's tail" of all these episodes. Today, the market of telecommunication espionage and surveillance is estimated at 5 billions of dollars per year. These espionage systems were once exclusive purview of intelligence agencies of the biggest countries, like the United States, China, Russia, France. Not anymore. A number of small- and medium-sized companies are proposing services in this field.

FM: Is it the Amesys affair you are talking about? As a reminder, Amesys is the French company that – as we learned in 2011 thanks to your investigative work and that of the Wall Street Journal – sold to the Kadhafi regime the surveillance technologies that allowed him to put his opponents under surveillance, and to monitor the entirety of Internet communications alongside mobile and satellite networks in Libya.

JMM: Absolutely. Today, any dictator, just as any American county sheriff, can buy in a very simple manner any kind of telecommunications

interception devices. People, libraries, institutions, countries: there is a true military and industrial complex that is put into place, including several private contractors – Snowden was one of them. It is a business that was not at all existing at this level before 2001. So, to come back to your question, we speak too much of the U. S. and the NSA, but it is because, paradoxically, it is a country that has a culture of distrust towards institutions, where phenomena such as whistleblowers and the right to declassify secret documents do exist. It is not the case in Russia, or in China.... nor in France or in the United Kingdom, whose governments do, however, violate law in the exact same manner or at least, are heavily suspected to do so. It is, indeed, a paradox: the U. S. are a great democracy, with plenty of people fighting for their individual rights, and that's what allows us to have these documents; elsewhere, we do not have this opportunity, and lacking documents, we do not really know what is the extent of surveillance in our country. One of the lessons showed by Snowden in this instance is perhaps that, in this sense at least, the United States are a better democracy than France is.

FM: The privatization of Internet governance, the important role played by industry, voluntarily or forcibly, in the regulation of content and freedom of expression has been central an issue in my research for quite some time. Beyond Amesys, is this a theme you cross paths with in your work, and how?

JMM: Since the early 2000s, we have spoken about self-regulation, both of civil society and private actors. An interesting example, in France, is the now-defunct Forum des droits de l'Internet [FDI, Forum for Internet Rights], where, precisely, representatives of ministries were gathered with civil society and company executives. This has allowed to avoid some mistakes, and it also prevented several laws from being debated exclusively by politicians that, oftentimes, do not understand neither the functioning nor the capabilities of the technologies they wish to 'regulate'. Since then, the FDI was closed, and the Hadopi[3] law created...

FM: The multistakeholder model is also that of the Internet Governance Forum. The central idea of this arrangement is precisely that we "just" engage in dialogue there, but this dialogue...

JMM: ...allows to avoid a number of missteps! Well, the FDI has helped to a lot more than that, but as one of our invitees for the docu-

[3] The Hadopi acronym stands for *Haute Autorité pour la Diffusion des œuvres et la Protection des droits d'auteur sur Internet* and indicates an agency, created in 2009 thanks to the so-called "Creation and the Internet" law, which is mainly known to have been the first one to administer the "graduated response" or "three strikes" procedure as a means of copyright enforcement.

mentary was saying, "those who talk do not throw bombs at each other". Talking allows to avoid an excessively schematic and grotesque vision of the Other – the contrary of what happened when our former President declared that he wanted to "civilize the Internet", for example. How can one think that this point of view, not dissimilar to that of colonizers, can be applied to the Internet? The extent of this impossibility is highlighted by the (limited and not relevant) practical effects of the Hadopi law: a 150-euros fine, and it was not even the fault of the individual, but of his ex-wife who had used the connection unbeknownst to him. What mattered was that the Internet subscription was in his name.

FM: This is, indeed, one of the points argued by the engineers auditioned during the discussions of the Hadopi law project: it is not possible, for users, to have the technical and material certainty that they have indeed secured their Internet connection...

JMM: Yes, I had said that too: your law project isn't going to be sustainable because you cannot ask somebody to have the technical competencies to really secure his or her Internet connection. Specialized, big companies, with important financial means, do not manage to do this. The answer I obtained was: as we live in a capitalist economy, we will create a market, and companies will find a solution. Four years later, in this economy of markets, there is no security solution that has been labeled as valid by the Hadopi authority. It looks like things are a little more complex than an ultra-liberal, capitalist vision of the Internet.

FM: After WikiLeaks, notably, the profession of investigative reporter and that of whistleblower seem to have entered a new era (Brevini et al., 2013). Have they indeed, in your opinion? I am thinking in particular about an issue that is common to journalism and scientific research – that of the investigator's relationship to her sources. How do you tackle this question in your work?

JMM: After 1999-2000, I have started writing "instructions" to secure sources, as I have briefly mentioned. I didn't need to use them that much; however, a certain amount of information, and even scoops, that I was able to obtain, I obtained them because I knew how to protect my sources: they trusted me and they knew how to contact me in a confidential and secure manner. WikiLeaks has changed the situation in two respects. First: it has revived investigative reporting, on paper mostly. Before, newspaper owners were telling us that thanks to the Internet, where everything is free, there is less and less money for newspapers. Julian Assange and WikiLeaks arrive, propose to have access to important documents, and here come the Guardian, the New York Times, mobilizing dozens of journalists for months to work with WikiLeaks and complete the investigation. Because of the Internet, investigative reporting no long-

er worked; thanks to the Internet, it has been revived again. Secondly, we have seen the rise of data journalism. Indeed, that's what happened to me: I became a journalist because I started to analyze data thanks to end-user computing capabilities, even before the label "domestic computing" existed. Here again, we witness the renaissance of investigative reporting, of whistleblowers, and I am hoping that there will be an increasing number of the latter, because our democracies are in thorough need of them.

At some point in our documentary, Assange recalls the expression of a NSA whistleblower who was explaining that we are at a "turning point", a key moment – all we need is to turn the ignition key. And if we do, we balance into a totalitarian society, because all technologies, the entire system, is in place. If Snowden hadn't done what he did, we can easily figure that in two, five, ten years, some entity would have been in the position of monitoring absolutely everything. What looked like a Hollywood legend, when "Enemy of the State" came out in theaters, is becoming more and more of a reality: today, we all have a small tracking device in our pockets – the smartphone. Traceable by intelligence agencies, traceable by the police, traceable by companies because we allowed them to do so ourselves. The dream of the Stasi, in fact! This is the importance of what Assange and Snowden have done. The former may be confined to an embassy building in London, but before that, he has fostered a global debate, and has had several important geopolitical effects, notably the Arab Spring; both of them have revolutionized journalistic practices – journalists are re-acquiring the 'fourth power' that was theirs, i.e. asking others to be accountable. The ethics of Assange and Snowden is in fact the hacker philosophy, that which was conceptualized in the early 80s in the United States: the act of hacking is an act of mobilizing for the privacy of citizens, for the transparency of institutions, for citizens' ability to control institutions rather than being controlled and manipulated by them – make it so that institutions are at our service, not the other way around (Auray, 1997; Himanen, 2001; Jesiek, 2003). This programme is at the heart of WikiLeaks, and of what it prompts journalists to do.

FM: Has anything changed in the ethics of journalism, faced with this plethora of data and sources?

JMM: I don't know if it has changed anything for journalism ethics as a whole. Myself, I have had some issues when I had to manipulate, during my collaboration with WikiLeaks, Syrian mail. I was indeed not that different from the NSA: it was, after all, millions of emails from Syrian citizens. But I haven't found much – apart from the jokes Bashar el-Assad was sending to his assistant...

Otherwise, recently, I have changed my Twitter status and I present myself as "hacker-journalist": just a few years ago, I could not have done this. Now, it is possible to qualify oneself as a hacker and nonetheless argue that you are doing good things. I still get, quite often, the question

"but then, you're a hacker, it means that you can pirate mailboxes?" – while I have done nothing illegal apart from what other investigative reporters have done: being in possession of some information I am not supposed to have. But it is my job. I follow the hacker ethos, actually, I am not quite sure of what they are being taught in journalism schools as far as ethics is concerned. Maybe, with Big Data, with yet more information at our disposal, journalism will be confronted to yet more novel ethical challenges.

What is interesting is that this situation gives more power to developers and hackers. So, there is a debate, as well, to figure out whether a hacker who goes to work for intelligence agencies lands on the "dark side of the force". Working for the NSA, is it good or is it bad? It's complicated. A priori, if one is American, it is perfectly legitimate for him to create an intelligence service that will collect information with the purpose of protecting Americans. But does this make it legitimate to spy indiscriminately on everyone?

Hacker profiles are increasingly sought after, by governments and companies at once, especially in the aftermath of Snowden. There is no doubt that this confronts the hacker to his own ethics.

FM: As you know, this interview has [initially] taken place within the frame of a dossier exploring "piracy". How is the appellation "pirate" present in the questions that interest you? What practices are associated with it – practices constrained, mobilized, "recycled" and made theirs by governments, companies, by different means such as espionage or surveillance?

JMM: For a few years, I have been teaching a course at the University of Nanterre in a department which was educating legal scholars to Internet-related issues. My mission was to increase their awareness of their practices and their very perception of the Internet. The first question I asked students was the following: "Those of you who have never pirated software, ripped a DVD, downloaded a copyright-protected mp3, please raise your hand." There was but one who did – the law enforcement officer on his continuing education stint. Nobody else. And my turn again: "Welcome to the Internet. If you don't understand this, you will not understand those who are called the "pirates" of the networks: all of us are pirates of the networks." We all are pirates, and always have been.

In 2005, the French National Assembly voted the DADVSI law, with the aim of fighting against piracy – this law was punishing the fact of hijacking DRMs[4], the restraining devices preventing the copy of digital con-

[4] Digital Rights Management (DRM) devices have the objective of controlling or limiting uses of digital works, thanks to a system of encryption and conditional access. They can be applied to different types of material devices supporting the

tent. I thought this was ludicrous: I have been a Linux user for ages, thus, my machine cannot read DRMs for which you have to go through Microsoft or Apple, thus if I wish to read a DVD which I have bought in a legitimate manner, the only way I have to do it is to pirate it. This law was making a pirate out of me, while a priori, I am a free software user, and therefore part of that small minority of people who never "pirate" software.

Thus, today, we cannot understand the Internet, the economy of sharing and access to knowledge, if we do not realize this. The totality, or near-totality of people on the Internet have at some point found themselves or put themselves in the position of violating the law, which is, after all, an unprecedented phenomenon in the history of humanity. And also peculiar is the fact that, if something is forbidden on the Internet, it reappears generally somewhere else, in some other form, some other way. Of course, we can talk again about Hadopi, who thought that to have people secure their own computers all you need to do is to "create a market".

The word "pirate" is strong – it reminds of violence, crimes, blood... and illegality. And yet, to what extent was somebody like Gutenberg harassed by authorities of the time, when typography was first introduced? Did he experience the same problems? I think that the person who says the most interesting things about this is Eben Moglen[5]. According to him, people fighting against piracy are also fighting for ignorance, illiteracy, poverty, for the interdiction of search for alternative solutions and bottom-up problem-solving: for economic interdiction against economic empowerment (Moglen, 2010). As the Internet enables so many things, the Monsantos, the Vivendis and the Sarkozys of this world interpret it as a loss of the power they still cling to. But I do not see how it would still be possible to look backwards: it will not be possible to prevent people from getting informed and from sharing, even if it involves the "piracy" of a few files – which is, by the way, often a lot simpler than buying them.

Then there is the "sexy" side of the pirate, and I think hackers have often played upon this side, the playful and adolescent one. But ultimately, I think we can make this assessment: on the Internet, each and everyone of us is a pirate – and that's good.

FM: In your opinion, what should we expect as far as evolutions of

fruition of digital works, from DVDs to tablets, and they can limit access in a variety of ways, according to geography, software, or specific reading functions.

[5] Eben Moglen is a professor of law and history of law at Columbia University, New York. He is the founder and director of the Software Freedom Law Center, which defends, *pro bono*, several actors of the free software domain, including the Free Software Foundation. His argument is that free software may be understood as a fundamental right in todays's society, due to its heavy dependence on complex technical systems. He is cited as the inspirator of the decentralized social network, Diaspora*.

surveillance are concerned, in the next few years? As U.S. President Barack Obama stated recently, is information – the ability to appropriate it, aggregate it, control it, "making sense" of and with it – the main 21st-century weapon?

JMM: In the next few years, I think we can hope for a redefinition of the legal landscape, and of what intelligence agencies may or may not do. Only Americans can decide this, despite the "pressure" put by Europe and other actors. We can also expect a redefinition, within the IETF[6] and other instances of Internet governance, of security and privacy protection norms so that there may be more privacy by design (Cavoukian, 2010), maybe even more security by design. Not only thanks to what Snowden has done, but simply because an increasing quantity of things depends on our connection to the Internet, and the fact that it is properly secured. The SCADA and a number of industrial systems are now connected via the Internet and other networks, and this may raise very important questions, because if electricity, thus connection, is cut, it will also be possible to cut off the supply of water, or other critical infrastructures. We are witnessing a militarization of the Internet, not only via surveillance, but also thanks to the so-called "offensive cyber-war", the hijacking of systems for purposes of espionage, possibly destruction.

We have been talking about the risks of cyber-war for years – I think we're fully in it right now. Assange is secluded in London, Manning will stay in jail for thirty-five years, several hackers close to Anonymous will not do without years in prison, and let us not forget Aaron Swartz's suicide, while he was facing a politico-legal machine which he did not think he could fight. On the other hand, we have a Nobel Peace Prize as the American President whose administration has launched a true "witch hunt" against whistleblowers. But my conviction remains, however, that hackers have already won. Even if we are still a minority, still mostly demonized, we have won because the general direction of History can no longer be switched – and the hacker ethos is here as it has never been before.

Acknowledgments

This interview has first appeared in French on the journal "Tracés". The complete reference to the original text is the following: Francesca Musiani (2014) '*Sur In-*

[6] The Internet Engineering Task Force (IETF) is an international and informal group (without statutes or formal membership), in principle open to every individual, but mostly composed of computer scientists and engineers. This group participates in the production of many standards that shape the Internet today, by issuing specification documents called Requests for Comments (RfCs).

ternet, on est tous pirates, et ça c'est bien.' Entretien avec Jean-Marc Manach, in "Tracés. Revue de Sciences Humaines", 26, pp. 235-247 (http://traces.revues.org/5963).

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Metaphors and Problematizations
Notes for a Research Programme on New Materialism

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Abstract The "ontological turn" in social theory is a major intellectual wave of recent years. Focusing on feminist new materialism, the paper outlines elements for a research programme on this topic. It elaborates first on the conceptual exchange between scholarships in social theory and biophysical sciences, dwelling on the constitutive role of metaphors. Then it considers the role of a profound socio-cultural transition that has begun in the 1970s and reached a full-fledged expression at the turn of the millennium. This transition has triggered a "problematization" (in Foucault's sense) that, pivoting on the notion of indeterminacy, associates social theory, cutting-edge biophysical science and neoliberal rule.

Keywords: New materialism; ontological turn; neoliberalism; metaphors; indeterminacy.

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1. Introduction

Feminist new materialism is an intellectual movement belonging to the broader wave of the so-called "ontological turn" in social theory (e.g. Escobar 2007; Dolphijn and van der Tuin 2012). We can talk of a wave – emerging in the late 1990s to gain growing prominence in recent years – because a similar trend is detectable in a number of disciplines: geography, sociology, anthropology, philosophy, political theory, science and technology studies (STS), humanities and so on. In general terms, and drawing on Michael Burawoy's (2005) typology of social science labour, two coordinates help identify the ontological turn: first, an "academic" concern for the limits of post-modern approaches, with special reference to linguistic deconstruction and culturalist readings, in accounting for the biophysical world and human agency; second, a "public" concern for the

inadequacy of these approaches in triggering social change. In both respects the case is made for "bring[ing] the material back in" (Hekman 2010, 3), according to post-representational epistemologies and "flat" and relational ontologies. Scholars and approaches like Gilles Deleuze (e.g. 1994; Deleuze and Guattari 1987), Alfred North Whitehead (e.g. 1978), Bruno Latour and Actor-network theory (e.g. Latour 2005), and practice theory (e.g. Schatzki *et al.* 2001) feature prominently as inspirational sources, providing support to an attack on the reality/language and ontology/epistemology dualisms – with all the implied dichotomies (nature/culture, mind/body, subject/object, organic/inorganic, animate/inanimate, reality/representation, matter/information etc.) – in favour of accounts of the world as populated by fluid, contingent entities (networks, assemblages, hybrids and so on). According to this view, as Annemarie Mol and John Law (2006, 19) nicely put it: "knowing, the words of knowing, and texts do not describe a pre-existing world [but] are part of a practice of handling, intervening in, the world and thereby of enacting one of its versions – up to bringing it into being".

Feminist theory is at the forefront of this intellectual movement, and one of its distinctive traits is that it builds to a significant extent on scientific advancements. In the following, I address in two ways the pivotal role of science in these theoretical elaborations. First, I deal with the conceptual exchange between scholarships in social theory and biophysical sciences, dwelling on the constitutive role of metaphors. Second, I expand my outlook beyond scholarly dynamics to consider a broader milieu – namely, the profound socio-cultural transition begun in the 1970s and come to a full-fledged expression at the turn of the millennium.

This contribution has no aspiration to be more than a preliminary note for a research programme on the underpinnings and implications of a broad convergence on a particular way to account for the biophysical world and human agency. This programme should be akin to what Foucault called an "ontology of the present" (Foucault, 2007), that is, a study of the problematization of our time. With the term "problematization" Foucault refers to the conditions by which "certain things (behaviour, phenomena, processes) become a *problem*" (Foucault 2001, 171, emphasis in original) and certain answers to these problems become conceivable; conditions instigated by social, economic and political processes that "can exist and perform their action for a very long time before there is effective problematization by thought" (Foucault 1997, 117-118). Moreover, if one wishes to remain faithful to Foucault's genealogical method, analysing the problematization in which we live does not mean to argue, building on some transcendental vantage point, that something is good or bad, right or wrong, true or false, but rather to show, from within the immanence of the situation, "that practices are problematic, dangerous, fraught, and in need of additional attention" (Koopman 2013, 92).

2. Feminist New Materialism

Introducing a collection of essays devoted to feminist new materialists, Diana Coole and Samantha Frost remark that: "everywhere we look […] we are witnessing scattered but insistent demands for more materialist modes of analysis and for new ways of thinking about matter and processes of materialization" (Coole and Frost 2010, 3). These demands are urged first and foremost by current advancements in technoscience. "New physics and biology make it impossible to understand matter any longer in ways that were inspired by classical science" (Coole and Frost 2010, 5), overwhelming "the ability of cultural theorists to critically digest and engage them" (Kirby 2008, 7). Actually, in physics, life sciences, biomedicine and elsewhere, material phenomena are increasingly conceptualized in terms of porous boundaries. Distinctions between physical and biological, natural and technological systems, ontology and epistemology, blur. For example, epigenetics challenges the gene/environment and brain/body dichotomies (Papadopoulos 2011). The inorganic realm is increasingly depicted as having vitalistic connotations, while life is simultaneously infused with dematerialized characterizations – textuality, information, codification (Keller 2007; 2011). Also, mining and processing of huge amounts of data generate unforeseen insights where knowledge and production of reality, discovery (of interesting relationships within the data) and invention (of meaningful associations among data), can hardly be distinguished (Calvert and Fujimura 2011; Cambrosio *et al.* 2014). Accordingly, new materialists depict matter as anything but "inert, stable, concrete, unchangeable and resistant to socio-historical change" (Hird 2004, 224). Matter exhibits agency, inventive capacities, generative powers. It is "not a thing but a doing" (Barad 2003, 822); an incessant process of becoming. Texts and signs can also be reconfigured as "substantively or ontologically material. […] 'Life itself' is creative encryption" (Kirby 2008, 9); a continuous rewriting of itself. The ontological divide between machine and organism is also to be reformulated, according to the "penetration of computational processes not only into every aspect of biological, social, economic, and political realms but also into the construction of reality itself" (Hayles 2006, 161).

Karen Barad's "agential realism" is exemplary of this view. She regards phenomena as "the ontological inseparability of agentially intra-acting components. That is, phenomena are ontologically primitive relations – relations without preexisting relata" (Barad 2003, 815). Phenomena, in other words, are not representations of things but things as such. Entities are continually reconstituted through material-discursive "intra-actions", where neither the material nor the cultural aspect takes precedence. For example, the material set up of foetal imaging simultaneously supports and is influenced by a politics of individual autonomy and subjectivity. The foetus that the scientists can see as an object is also the foetus that law defines as an independent subject. Hence, "the foetus is not a

pre-existing object of investigation with inherent properties. Rather the foetus is a phenomenon that is constituted and reconstituted out of historically and culturally specific iterative intra-actions of material-discursive apparatuses of bodily production" (Barad 2007, 217).

All that, according to new materialists, poses ethical and political questions in front of which "the dominant constructivist orientation to social analysis is inadequate" (Coole and Frost 2010, 6). Social change cannot be based on "reconstructing subjectivities, discourses, ethics, and identities […] [because] the material realm is irreducible to culture or discourse and cultural artefacts are not arbitrary *vis-à-vis* nature" (Coole and Frost 2010 25, 27). If feminism has successfully challenged all sorts of appeals to the facticity and prescriptiveness of nature, the latter is not necessarily "a repository of conservative political investments" (Kirby 2008, 8). Once nature is seen as dynamic, active, and unpredictably open, it is no longer an obstacle but rather opens the way to "a liberating anti-humanism" (Colebrook 2008, 74), in light of which human agency results disempowered and defective, distributed and limited, hence also modest, careful, responsible and opposed to the dominative hubris (Bennett 2010). Oppression (of women and anyone or anything else) can be fought only if recognized as an actual reality that cannot be effectively addressed through discursive deconstructions and indeed often stems precisely from the unwarranted separation of matter and language. Therefore, the approach to critique inherited by the philosophical and sociological tradition, with its ultimately ineffective focus on argumentative "errors and points of contention" (Grosz 2005, 27), is to be replaced with affirmative standpoints that build on thingness and corporeality as sites of resistance, creativity and hope, ethically relevant in their being the result of choices that materialize particular states of reality.

Feminist new materialism is not isolated in making this case. As hinted, similar arguments are advanced in a number of fields, from post-development theory to geography, from sociology to STS. According to these arguments, the greater analytical strength of ontological approaches goes hand in hand with its capacity to support a new season of emancipatory politics. Arturo Escobar (2010), for example, talks of "ontological struggles" with reference to counter-hegemonic processes in Latin America, which build on indigenous ontologies where human and non-human entities are enacted together in mobilizations against dams, drilling, mining, deforestation, transgenic agriculture. Amin and Thrift (2005) similarly talk of flat ontologies as the basis of new emancipatory politics, focused on an "ecology of hope" and an immanent, affective and decentred account of the world. Latour's (2004a; 2004b) plea for a "new constitution", aimed at overcoming the nature/society and science/politics divide and at replacing a constructionist critique eventually "run out of steam", can also be enrolled in this intellectual movement.

To sum up, new materialists account for their commitment to "bringing the material back in" by pointing to both "academic" and "public"

elements of dissatisfaction about the way feminism, and the social sciences in general, have addressed the biophysical world and human agency. Science advancements, as we have seen, feature prominently in this context, as both a challenge and a source of inspiration.

3. From "As" to "Is": Metaphors and the Conceptual Exchange between Biophysical and Social Sciences

As widely known, it is not the first time that the biophysical sciences influence the social sciences and philosophy. Comte and Marx took the notions of organism and metabolism from biology. Ecological thinking has affected significantly the Chicago school of Burgess and Park, as well as a variety of socio-systemic approaches. As for Darwin, one needs not insist on the multifarious influence of the notions of adaptation and selection on social theorizing and inquiry. Biology is important in Deleuze's philosophy while Whitehead's one draws to a significant extent on his background in mathematics.

Similar examples could take books. What may be worth recalling is that influences work also in reverse. Ernst Haeckel, the "father" of ecology, borrowed heavily from social imaginary for his account of organisms. He equated cells to individual citizens in an organized social community, and described the animal body as a "monarchy of cells" compared to the "republic of cells" of the vegetal body. Darwin acknowledged the influence of Malthus on his reflections on the asymmetry between the dimension of the offspring generated and the number of adults that reach the reproductive age – hence the influence of environmental factors in limiting what otherwise would be an unlimited expansion of life. Similarly, he acknowledged his indebtedness to Herbert Spencer for the definition of the concept of "survival of the fittest". For Stephen Jay Gould (2002), in his formulation of the natural selection principle Darwin was also influenced by the invisible hand of Adam Smith (in his turn, according to Alexandre Koyré (1965), inspired by Newtonian physics).

As for today, a number of studies account for the conceptual cross-fertilization of the social and the biophysical sciences: from evolutionary biology (Keller 2002) to cybernetics (Hayles 1999); from nanosciences (Dupuy and Grinbaum 2004) to chemistry (Lehn 2004) and immunology (Tauber 1997). The latter possibly offers the most striking evidence of conceptual exchange. Immunology has borrowed heavily from military imaginary (attack, enemy, recognition, borders etc.) and from philosophical speculations about the self, while in its turn increasingly affecting the way in which security issues are accounted for in the social and political realm (Esposito 2011).

In this framework, the role of metaphors can hardly be overestimated. In a seminal study, George Lakoff and Mark Johnson have shown that

metaphors are crucial to conceptualization and reasoning. We use inference patterns from one conceptual domain to reason about another domain. Even fundamental ideas, like time, causation, morality, the self, are "almost entirely structured by elaborate systems of conceptual metaphor" (Lakoff and Johnson 2003, 249). Metaphors help give coherence to experience. They allow us to understand one kind of thing in terms of another. Moreover, as Lakoff and Johnson note, new metaphors create new realities because thanks to them we start to comprehend our experience differently, acting and producing consequences accordingly. They stress also that the truth-value assigned to new metaphors depends on the extent to which our understanding of a metaphorical sentence fits our understanding of a situation. Of course, in the concepts we use to understand the situation other, already established, metaphors are at work.

This is important because it shows how metaphors open a space not only for cross-disciplinary migration but also for views and beliefs borrowed from the broader socio-cultural milieu. Sensemaking depends, at least in part, on metaphors that make sense. And they make sense because they fit into broader landscapes of meaning. Ludwik Fleck (1979) has notoriously insisted on this point. "Thought collectives" develop at the intersection of scientific and broader social circles, and "proto-ideas", that is general notions or images drawn from religion, philosophy or other sources, help structure new fields of research. Moreover, as Isabelle Stengers (1987) has remarked, notions initially borrowed as metaphors tend – in their nomadic journey through problem-fields – to morph into concepts provided with literal truth-content, around which theories are built that bear no memory of their origin[1]. Also, the way in which the story of the transfer is told depends on its eventual success or failure. In case of success, the story tends to be one of "propagation", as a spontaneous process. The reason for the successful adoption of a concept seems to be its intrinsic adequacy to phenomena; its intellectual productivity. In case of failure, the story tends to be one of "propaganda", that is of mistakes, ideological drifts, seduction of mere verbal analogies[2].

Some criticisms addressed to new materialism and the ontological turn point precisely to the transformation from "as" to "is" that concepts

[1] Also Lakoff and Johnson seem to incur in this drift when they argue, on the ground of evidence from brain imaging, that metaphorical mapping is realized physically as neural maps. As far as I know, the causal connection between concomitant physical processes in brains and psychic processes in mind has not been proven. To say but one of the many disturbing questions related to the issue: blood takes some seconds to flood a brain area, whereas thought is obviously much quicker, so what happens in the meantime? Hence, saying that "metaphor *is* a neural phenomenon" (Lakoff and Johnson 2003, 256, my emphasis) is a statement provided with metaphorical, rather than literal, truth-content.

[2] The example suggested by Stengers is 18th-century chemists' use of the Newtonian concept of interaction forces, which has been subsequently blamed, from the vantage point of quantum mechanics, as a case of intellectual laziness.

undergo in their metaphorical journey. For example, Nicholas Rose remarks that social theory's increasing borrowing from the biological leads to "a strange form of conceptual gerrymandering: […] biology is translated into ontology, ontology is transmuted into politics. […] Biological claims evade critical interrogation where they seem to give support to a pre-given philosophical ethopolitics" (Rose 2013, 11-12). Judith Butler makes a similar case in regard to Vicky Kirby's attribution of textuality to things and ontology to signs. Kirby says that, in so doing, she has in mind "the code-cracking and encryption capacities of bacteria as they decipher the chemistry of antibiotic data and reinvent themselves accordingly. Are these not language skills? Is this not a very interesting case of epistemology as ontology?" (Kirby 2008, 9). Butler, however, warns against taking explanatory models as inherent to the phenomena being explained: "I am sure that encryption can be used as a metaphor or model by which to understand biological processes, especially cell reproduction, but do we then make the move to render what is useful as an explanatory model into the ontology of biology itself? […] What of life exceeds the model? When does the discourse claim to become the very life it purports to explain?" (Butler, quoted in Kirby 2008, 10).

Of course it is the very notion of biology that, as notes Maureen McNeil, has a "slippery double valence, designat[ing] both the operations and features of the human body itself, and the study of its functioning" (McNeil 2010, 435-436). Yet the problem is not limited to biology. Another example comes from Trevor Pinch's review of Karen Barad's major work (Barad 2007), which builds on Niels Bohr's physics. For Pinch, "Barad, like Karl Popper, seems to assume the very grounds that much science studies has contested. How is it that scientists can agree that phenomena are the same or agree on what makes an experiment repeatable? Once it is realized that repeatable experiments themselves come from a culture of trust, a shared form of life and shared practices […], then the orientation is focused once more on humans. […] I find it deeply puzzling that Barad can call for a more situated account of science and at the same time fail to situate the very part of science she is talking about, while drawing in a realist mode upon experiments to support her position" (Pinch 2011, 439).

Similarly, in his review of N. Katherine Hayles's (1999) book on posthumanism and cybernetics, Dennis Weiss (2000, 10) remarks that: "while criticizing Wiener and Maturana for adhering too closely to the realist, objectivist discourse of the sciences, Hayles seems to fall victim to the same problem". Latest research in evolutionary psychology and biology allegedly provides incontrovertible evidence of the decentred, distributed, emergent character of the self against the untenable assumptions of a unified self that were central to Wiener's and, to some extent, Maturana and Varela's accounts – assumptions that, according to Hayles (1999, 5), are aligned with a liberal model of possessive individualism "entwined with projects of domination and oppression". The problem, then, is that

Hayles's "key distinction between the true awareness of the distributed self and the false unified self seems hard to maintain in light of the reflexive epistemology she adopts" (Weiss 2000, 11).

In all these examples, as we can see, objections point to the veridical status granted to scientific evidence. What is found problematic in the accounts of Kirby, Barad, Hayles and others is that on one side, as regards the approaches they criticize, scientific truth appears – borrowing Foucault – "a thing of this world, produced only by virtue of multiple forms of constraint" (Foucault 1980, 131), while on the other, as regards cutting-edge research, their critical detachment disappears and their outlook becomes more akin to an "analytic of truth": an account of how old concepts are replaced by new ones, as provided with greater closeness to truth. To give another example, Mark Hansen criticizes Deleuze for his reliance on an account of organisms that "is alien to the conceptual terrain of current biology" (Hansen 2000, 18). In other words, the usefulness of Deleuze's theory would be limited by its drawing on biological models that are no longer valid. Then one might ask why current biology should be granted greater ontological validity; why we should not treat it with the same caution, given that there is no reason to think that current views on matter and life will not be superseded by other ones, perhaps completely different.

4. Broadening the Outlook: Indeterminacy and the Socio-cultural Transition

According to the criticisms above, the dynamics of travel (of concepts) and forgetting (of their metaphorical aspects) puts new materialism and comparable positions in the ontological turn at odds with their own post-representational premises. Older accounts of the biophysical world and human agency are deemed incorrect, while new accounts of the ontologically fluid state of reality allegedly depict the world as it is.

To come to terms with this contradiction, I think one has to go beyond scholarly issues (the movement of the intellectual pendulum to and fro the culture/matter, or realism/constructivism, polarities; the background in biophysical disciplines of many scholars engaged in STS and neighbouring fields), to address the broader socio-cultural milieu, as a source of meaning that facilitates the convergence of different disciplinary perspectives and the transition of concepts from "as" to "is". This is no doubt a risky and tricky move, yet, I believe, a necessary one for a genealogy of the ontological turn.

A possible point of entry into this issue is the question of indeterminacy. As we have seen, in new materialist approaches ontological indeterminacy, ambivalence or contingency are not only stressed but take positive, emancipatory connotations: as enabling non-determination rather

than constraining non-determinability; as opportunity rather than problem. In tracing the genealogy of this outlook, then, we should distinguish between the growing *relevance* of indeterminacy, which is a story dating back at least to the beginning of 20th century, and the changing *outlook* on indeterminacy, which is a more recent trend. In physics, chemistry, biology, economics, computer science and elsewhere, growing acknowledgment of the import of indeterminacy has for long been complemented with strategies for coping with it, claiming capacities of handling in spite of incomplete characterizations of the state of affairs[3]. At some point, however, things have started to change. Today, indeterminacy no longer is a problem, but rather becomes a resource. Ecology, for example, has traditionally built on the idea that ecosystems tend to balance after perturbations. From the 1970s onwards, however, the thinking of Eugene Odum's generation, with its assumptions of order and predictability, has gradually been replaced by a new view, according to which there is no spontaneous tendency to equilibrium in nature: no progressive biomass stabilization; no diversification of species or movement towards greater cohesiveness in plant and animal communities. Change goes on forever, with no direction or tendency to stability; no cooperation, consistence and holistic organization but rather competition, patchiness, fragmentation, individualistic association. Disturbance or perturbation is argued to be not extrinsic but intrinsic to ecosystems. Hence contingency and disorder are not against life, but what life depends on. "Populations rise and populations fall, like stock market prices, auto sales, and hemlines. We live […] in a non-equilibrium world" (Worster 1990, 11).

Similarly, in chemistry and physics, attention has increasingly focused in the last decades on dissipative structures. Thermodynamically open systems, where the spontaneous formation of dissymmetry and bifurcations leads to unpredictable reorganizations of matter, have been conceptualized as the rule rather than the exception. Again, this is not regarded as a problem, but as a crucial "enabling" feature. For Ilya Prigogine, whose work has gained decisive momentum from the 1970s onwards, both Boltzmann and Darwin replaced the study of "individuals" (organisms or particles) with the study of populations, showing that slight variations over a long period of time produce evolution at a collective level. Yet, while Boltzmann described an evolution towards uniformity and equilibrium, Darwin accounted for the appearance of new species. "Significantly, these two theories had very different fortunes. Darwin's theory of evolution […] remains the basis for our understanding of life. […] Boltzmann's interpretation of irreversibility succumbed to its critics" (Prigogine 1997, 21).

Another example comes from cybernetics. According to Hayles (1999), the first wave of cybernetics (1945-1960), whose central figures

[3] Quantum mechanics and Keynes's account of subjective estimates as triggers of rational decisions are good examples coming from completely different fields.

are Norbert Wiener and John von Neumann, takes homeostasis as its crucial notion. The central problem, for machines as well as living organisms, is to ensure control over their operations and integrity in a chaotic environment. The second wave (1960-1980) builds on the concept of feedback, which introduces a loop between observer and observed systems, hence the notion of reflexivity on which Humberto Maturana and Francisco Varela develop their theory of autopoietic systems, physically open yet informationally closed. The third wave of cybernetics begins in the 1980s and stretches to the present. Hayles identifies it with artificial life. The crucial conceptual shift, here, is from self-organizing systems to emergent systems. The contingent, disordered character of a world where the natural and the artificial are increasingly indistinguishable becomes a vital resource rather than a troublesome feature that systems have to handle.

In short, a generalized turn from order to disorder – simultaneously descriptive and normative – seems to begin in the 1970s, gaining growing momentum in the following decades. It is then sensible to explore the link between this broad intellectual shift and the contemporaneous, equally encompassing social change. Bob Jessop (2002) has depicted the latter as a transition from "Keynesian welfare national states" to "Schumpeterian workfare postnational regimes[4]. Other scholars talk, more simply, of the shift from Fordism to post-Fordism and financial capitalism (Boltanski and Chiapello 2005), or of the advent and progressive strengthening of neoliberal rule (Harvey 2005). The association between the two transitions – the academic and the social, or socio-cultural – strengthens if one reflects that, if indeterminacy is the semantic thread of the former, insecurity is the semantic thread of the latter. People's exposition to the "risks" of the new world (dis)order engendered by post-Fordism or neoliberalism may differ according to the opportunities and protections related to the occupational link with the new economy, yet this (dis)order and the implied centrality of unpredictability and insecurity have increasingly become a shared framework of meaning, a taken for granted condition of life (Azmanova 2010).

The problem, of course, is how to read this association. Drawing upon an analysis of a corpus of literature in business management, Luc Boltanski and Eve Chiapello (2005) conclude that the post-Fordist reorganization of capitalism has crucially built on the integration of the "artistic cri-

[4] In Jessop's description, the first regime aims at full employment and economic planning, prioritises social policies over economic development, centres policy-making and implementation on the national scale, and grounds public choice on neo-corporatist models; the second regime aims at increased competitiveness of national and local economies, focuses on technological innovation, places economic development over social policies, centres policy-making and implementation at the supranational and local scale, and grounds public choice on public-private partnerships and stakeholder consultations and negotiations.

tique" that the social and intellectual movements of the 1960-70s had addressed to state-organized capitalism, translating the plea for freedom, autonomy and creativity into a case for flexibility, networking, communication and permanent education. Critics of neoliberalism talk of an elite hegemonic project (Harvey 2005), stressing how well identifiable academic circles, think tanks and international institutions have actively supported and policed the spread of neoliberal ideas (Mirowski and Plehwe 2009).

Singling out specific, influential sources of diffusion of ideas, however, does not correspond to explaining why such ideas are found interesting and convincing by wide and diversified audiences. The reason of the spread of the values of the new economy well beyond its actual borders (Sennett 2006) and of the enduring consensus over the fundamental beliefs of neoliberalism in spite of repeated *débacles* (Centeno and Cohen 2012), is probably to be sought at the level of fundamental ontological and deontological beliefs[5].

As a matter of fact, new materialist "affirmative" standpoints about contingency and indeterminacy resonate with the way in which science and the biophysical world are being "neoliberalized" – no doubt a disturbing alignment, if one considers the emancipatory implications generally associated with the ontological turn. "Neoliberalization" of science and nature is usually taken to mean, on one side, changes in the institutional set up and functioning of science – the start-up company, the scientist-entrepreneur, etc. (Lave *et al.* 2010) – and on the other the increasing management of natural resources and environmental issues through market-oriented arrangements (Castree 2008).

However, more profound features can be detected. As Antoinette Rouvroy remarks in her study on the relationship between genetics and neoliberalism: "the social/economic/technical/political structure of society and innovation [are] related to each other, as part of the same metabolism, interacting in a dialectical manner, each being performative for the others" (Rouvroy 2008, 6). Similarly, for Melinda Cooper "the history of neoliberal theories of economic growth and biotechnological visions of growth needs to be pursued simultaneously", namely the economic crisis of the 1970s has found a reply in a series of legislative and regulatory measures "designed to relocate economic production at the genetic, mi-

[5] Foucauldian scholarship has stressed the peculiar veridical mechanism of neoliberalism, as a political project that seeks to create a social reality that it maintains already exists. On one side institutional practices and rewards are developed in order to expand competitive entrepreneurship. On the other, neoliberal intellectuals claim to purport not an ideal, but a reality: human nature (Lemke 2003; Read 2009). As a consequence any failure of the market, any evidence opposed to the promised increase in freedom and efficiency simply marks the distance between a trans-historical reality and contingent flaws, constraints, oppositions and irrationalities (Pellizzoni and Ylönen 2012).

crobial, and cellular level, so that life becomes, literally, annexed within capitalist processes of accumulation" (Cooper 2008, 19).

Whatever the intentions of technoscience theorists and developers, the de-standardization of life operated by the life sciences, with their increasing focus on the extremes rather than the norm, is consistent with growing demands for flexibility and speed of change. "Even in the work of Prigogine and Stengers the new political economy of nature sounds suspiciously like the new political economy of neoliberalism" (Cooper 2008, 42).

One may disagree with possibly too trenchant arguments, yet neoliberalization appears in many ways to be intertwined with technoscientific change, as both a trigger and a consequence (Pellizzoni and Ylönen 2012). For a start, there is plenty of evidence that disequilibrium, unpredictability and indeterminacy are central to neoliberal rationality. Pat O'Malley (2004), among the others, is particularly effective in showing how for neoliberal theories and policies proper calculations of risk are the exception, while reasoned bets over unpredictable futures are the rule. Uncertainty is seen as premised on entrepreneurial creativity, which requires intuition, foresight, flexibility, experiential judgment, rules of thumb and so on. Turbulence and contingency, as produced by global trade, innovation-based competition and floating exchange rates do not mean threatening uncontrollability, but lack of limits, room for manoeuvre, opening up of possibilities.

The most immediate interface between neoliberal rationality and technoscience is represented by regulation. Biotechnology patents, for example, regard a living entity as an artefact if its basic functional parameters can be controlled (thus reproduced), establishing a correspondence between information and matter, so that rights in property over information can be subsumed into rights in property over the organisms incorporating such information, and vice versa (Carolan 2010). We are therefore facing ontologically ambiguous entities, oscillating between materiality and virtuality.

A further ontological ambiguity stems from the claim that patented artefacts are indistinguishable from nature for any practical purpose (including the need of specific regulation). Artefacts are thus simultaneously identical to and different (more usable, more valuable) than natural entities. Patents, in short, produce indefinite entities, simultaneously material and informational, ontological and epistemic in character, the economic value of which resides precisely in this ambivalent status (Pellizzoni 2011).

Carbon trading provides another example. The possibility of markets in permits to emit greenhouse gases (GHGs) or in credits earned by not emitting them rests on the operators' acceptance of a conversion rate between CO_2 and other GHGs: the "global warming potential" (GWP), as established by the International Panel on Climate Change (IPCC). Reducing one's CO_2 emission or buying credits sold by someone else who,

somewhere in the world, is reducing another GHG is assumed as (physically, thus also financially) equivalent (MacKenzie 2009). Therefore GWP is an abstraction, like money, since it works as an exchange rate. Yet, it is also something bound (not) to happen in the atmosphere, a(n allegedly) prevented physical thing or phenomenon. In short, GWP is an ontologically indeterminate entity, oscillating between reality and virtuality, matter and symbol, concreteness and epistemic construction. Weather derivatives (possibly the most evident example of how biophysical uncertainty can be transformed from trouble into asset) work precisely in the same way, being designed to hedge and trade securities contingent on unpredictable states of weather, either catastrophic or not.

Regulation has been and still represents a crucial avenue to the interpenetration of neoliberal rationality and technoscience imagination and application. The dominant socio-cultural milieu, however, permeates technoscience beside and beyond regulation. One example comes from geoengineering, and namely from the still largely prospective and as yet unregulated field of "solar radiation management" (SRM) (Royal Society 2009; Macnaghten and Szerszynski 2013). Techniques aimed at reducing the net incoming solar radiation by deflecting sunlight or by increasing the reflectivity of the atmosphere, of clouds or the Earth's surface seem apparently to belong, whatever their technical novelty, to the traditional family of techno-fixes.

There is, however, a major difference. Given the constitutively indeterminate, open-ended character of the system on which SRM aims to intervene, talking of control, even in probabilistic terms, seems inappropriate. To "control" means to keep the behaviour of a system within predefined parameters. Here we could, at best, talk of capacity to react and adapt – on the spot, moment by moment – to the constant swerves of the system. Even in ideal conditions of technical capacity the idea is, once more, of "riding" uncertainty rather than "managing" or "coping with" it.

5. Conclusion

In this contribution I provided some preliminary remarks for an inquiry into new materialism and, more broadly, the ontological turn in social theory. We have seen that cutting-edge technoscience plays a central role in grounding and legitimizing an account of the biophysical world and human agency that takes distance from both traditional realism and cultural constructivism. We have seen that the conceptual exchange between social theory and different biophysical science fields, in itself hardly a novelty, is characterized by a marked tendency to shift from "as" to "is", downplaying the conventional aspect of scientific accounts and the metaphorical character of their transfer to different domains. We have also seen that explaining this in terms of intellectual disputes and theoretical oscillations between realism and constructivism tells only part of the

story. The other is likely to be found in a deeper, broader socio-cultural change. A number of indicators suggest that this change begins to gain salience in the 1970s and corresponds, both in terms of chronology and of the rationality at work, with the profound social and cultural restructuring engendered by the transition to post-Fordist, financial capitalism and the advent, spread and strengthening of neoliberal rule.

The precise way in which the link between this socio-cultural transition and the intellectual shifts occurred in specific areas of inquiry in the biophysical and social sciences have to be accounted for is a difficult question, on which only empirical studies may shed light. Whatever the outcome, the main suggestion of these notes is that analyses of the specific influences and conceptual transfers between scholarships – be they mediated through academic curricula, department organizations, funding schemas, integration of intellectual traditions[6] or other mechanisms – should not neglect another sort of inquiry, focused on more fundamental movements in ontological and deontological beliefs.

From this viewpoint I think that a relevant indication is offered by the importance given by new materialists to the sheer power that current technoscience is able to express: "the extraordinary challenges and perceived success of so much scientific and technological research" (Kirby 2008, 7). It is the meaning of this "success" – its underpinnings, necessity and implications – that should be interrogated, beginning with its connections with the "operational paradigm" – the paradigm by which being and doing, existence and its actual effects, are inseparably connected – which Giorgio Agamben (2013) places at the grounds of Western modernity.

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[6] For example, the impact of French post-structuralism on the intellectual life in the US is well documented by Cusset (2008).

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Mario Biagioli and Jessica Riskin (eds.)

Nature Engaged. Science in Practice from the Renaissance to the Present
New York: Palgrave Macmillan, 2012, pp. 301

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This collection of essays edited by Mario Biagioli and Jessica Riskin includes the contributions of some of today's major historians of early modern and modern science. These authors have at least two things in common: they all acknowledge that their work has been influenced by the historical approach developed by the American historian of science John Heilbron, to whom the book is dedicated, and they all adopt a pragmatic view of the history of science. As Riskin claims in her introduction to the book, historical pragmatism has emerged as a third way out of the opposition between two radical conceptions of science: a "rationalist" or "realist" view against a "relativist" or "constructivist" one. Here Riskin refers to the so-called "science wars" that involved many, but by no means all, practitioners of science studies at the end of the last century, after the emergence of cultural and social trends in the interpretation of science and scientific knowledge. These wars, which concerned issues such as the source of scientific credibility and trust, the truth value of knowledge claims and the alleged specificity of scientific activity, were a new development of a lasting confrontation between scientific and humanistic cultures, indicated as the "two cultures problem" after Charles P. Snow's famous essay of 1959.

Historical pragmatism aims at overcoming the opposition between irreconcilable ways of looking at science, either as a specific epistemic enterprise quite distinct from other forms of human culture, or as an activity with no peculiarities or differences with other kinds of social practices. For the contributors to this book, science is a mingled yarn, "no more separable into discrete parts (natural vs. social, objective vs. subjective) than the thread of life" (p. 3). Their approach is profoundly historical in terms of focusing on the contextual and contingent aspects of scientific knowledge, and it is pragmatic in terms of understanding the mutual engagement and permeation of scientific activity with society and culture at large. Hence the great variety of topics dealt with in the essays contained in the book.

The book is divided into four parts, which focus on different aspects of the mutual engagement of scientific activity with other dimensions of human life such as social conventions, legal affairs, historical practices, and worldly objects. Part I, titled "Conventions", includes a contribution by Ken Adler on the political and social aspects of the transition from 18th century cosmopolitism, realized by the idea and reality of a Republic of Letters, to 19th century scientific internationalism. The papers by Hasok Chang and Michael Gordin offer an original reconstruction of the history

of two scientific results – the establishment of the boiling point of water and the birth of the periodic table – showing not only their conventional character, but also the complex and contingent nature of their history. In his contribution, Dominique Pestre relates the development of information-processing practices in Britain during World War II to the specific needs of the military and their collaboration with academic scientists.

Part II is dedicated to "Laws" and its essays examine the mutual shaping of legal and scientific concepts and practices. Matthew Jones deals with the origins of modern patent law through the case of Leibniz's calculating machine, which played a major role in challenging traditional legal conventions related to scientific inventions. Mario Biagioli's paper retraces the legal roots and rhetorical value of Kepler's notion of eyewitnessing, as it emerged from his familiarity with inquisitorial law and was displayed in his astronomical observations. Focusing on a much more recent subject, Daniel Kevles examines the present regulation of property rights to genes, for which he makes a striking comparison with the history of a regulatory regime for railroads established in 19th century America. Remaining in the American context, Tal Golan deals with the mutual influence between epidemiology and law in courtrooms of the late 20th century.

Part III, titled "Histories", is less rich in number of contributions but not in interest for the reader. It includes a paper by Anthony Grafton, who focuses on how astronomy and history mingled in Mercator's work in the field of Renaissance chronology, and one by Paula Findlen, who reexamines the well-known history of Galileo's trial from an original angle, namely the correspondence between one of his disciples and a Jesuit mathematician about the biography of Galileo and the meaning of this tragic event.

Finally, Part IV is devoted to "Things" and the material culture of science. Jessica Riskin deals with the role and epistemic scope of automata in Descartes' mechanical philosophy, while Jim Bennett focuses on another type of early modern objects, the sundials, and describes how the design and construction of these instruments affected the knowledge and practice of cosmography. The last chapter of this part, and of the book, is written by Giuliano Pancaldi, who shows the complex and hybrid nature of William Thomson's work in electricity and magnetism through the reconstruction of the history of his mirror galvanometer.

Taken together, these essays reveal the variety of topics and interests cultivated by current historians of science who share a historical and pragmatic approach to the discipline. In this regard, *Nature Engaged* is primarily addressed to young practitioners of science history, as well as to a broader readership interested in science and technology, who can have a grasp of what doing history of science means after the example of scholars like John Heilbron and after what Hans-Jörg Rheinberger (in his book *On Historicizing Epistemology. An Essay*) has recently called a "practical turn" in the study of science and its history.

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Dominique Bourg, Pierre-Benoit Joly, Alain Kauffmann (eds.)

Du risque à la menace. Penser la catastrophe [From risk to threat. Thinking about the catastrophe]
Paris: Puf, 2013, pp. 252

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The book edited by Dominique Bourg, Pierre-Benoit Joly and Alain Kaufmann is a collection of articles presented at the Colloque of Cerisy, which took place in September 2011. After 35 years from the publication of Beck's *Risiko Gesellschaft*, the conference questions the appropriateness of the expression "risk society" to explain contemporary dynamics. The book is divided in four parts.

In the first one, historians contest Beck's main thesis of the existence of a break between the present and the past. According to them many characteristics, which have been attributed to the risk society, were already present at the beginning of the XIX century. In particular, they question the supposed virtues linked to the risk society. In the past, the acknowledgement of the dangerousness and of the potential damages in the development of techno-sciences has not led to a limitation of their expansion. This has rather brought to the development of measures of accompaniment. So, while according to Beck, the risk society would be more reflexive and conscious of the side effects of its production, the authors in the book claim that this avowal goes in the sense of a risk acceptance rather than risk criticism.

In the second, part, different contributions, mostly from philosophers, elaborate on the concepts to think about the actual society. The necessity to overcome the notion of risk and its connected idea of control and capacity of evaluation leads them to propose a substitution of it with the term "threat". Here we find the reason for the title of the book. The "society of threat" would better convey the idea that we live in a society made of potential damages which are out of our capacity of evaluation, prediction and control. In Beck's work, science plays a central role. Different contributions give account of the limits connected to the notion of risk and provide some elements to frame a new epistemological paradigm. The need of controlling incertitude has been increasingly left to mathematical models and cost and benefit analysis. As side effect, the excessive "mathematization" of society has led to the eviction of sense and to all interpretative work. Attention is then addressed to post-normal science (Funtowitz and Ravetz, 1990) which is based on a pluralism of perspectives, on a critical distance towards models and on a new attention to in-

terpretation. This brings to a reconfiguration of knowledge itself, whereby its ultimate goal would not be prediction but "care". Moreover, the notion of risk does not seem being adapted to cover so called "transcendental damages". The term risk entails in fact an individualist and monetary dimension. Thus damages connected, for instance, to the degradation of the biosphere could not be acknowledged under the category of risk. The proposal is to take the incertitude for serious and to adopt a cognitive approach, which recognizes the limits of human action. This should be based on a "logic of clues" (in French "*logique indiciaire*" that is based on "*indices*", clues), which is close to judicial enquiry or to police investigations. The logic "of clues" is linked to a situated type of knowledge and to a way of proceeding by analogy. This would allow overcoming the idea of the principle of precaution as cost and benefit analysis. The assumption of the incertitude by the principle of precaution entails a change in the way of thinking, which does not aspire to tell what is "true" but just what is "right". Moreover, with the development of the techno-scientific society, new legal questions arise. If new subjects (non-humans, animals, etc) long for rights, this goes beyond the traditional class framework, which has structured society and law. Lastly, the language of catastrophism – natural and social - seems well adapting to acknowledge the contextual framework.

The third part gives account of how social sciences have mobilized and have appropriated the concept of risk. Through a sort of *mea culpa*, French researchers admit of not having taken many risks in analyzing the "risk society". They have remained in much legitimated areas of research – such as controversies on risk, public debates, etc. - and have not adventured themselves in more uneasy domains: for example the analysis of the risk where it is produced or of risk perception. In the same line, few works have engaged in theorizing risk in connections with the new transformations of the State action. A parallel is then made between technical democracy proposed by STS, on one side, and the sub-politics proposed by Beck, on the other. If both approaches are interested in the new forms of democracy and to the development of participatory processes beyond the institutional ones, some differences in scales and temporalities are offered. Most importantly, while for STS, the affirmation of fora of hydrides is a result on its own, Beck rather tends to lay emphasis on the *apories* of power in the new circuits of sub-politics. The space dimension represents a category, which is embedded in the notion of risk. By taking into account some of the last Beck's works and the global spreading of some health diseases, authors propose a new grammar of spatiality of risk which overcomes the traditional cartography. The proposition is a "navigation" form of cartography permitting the connection of the different locations where the risk manifests itself. After space, time. If the sociology of risk is connected to predicable and calculable time, the pragmatic tradition lays emphasis on other notions of time which are meaningful in the acknowledgment of risk. The activity of prediction is not based just on

models but on different argumentations that people mobilize in their experience of time.

In the fourth part, studies give account of the fact that the technological risk has not replaced the social risk. In the analysis of the trajectory of tuberculosis, the phenomenon of resistance to antibiotics is not qualified as "iatrogene" by health institutions but it is connected to a misuse of the technology by users and to problematic social contexts. In another example, which compares two experiences of epidemiological crisis in XVIII century and at our time, the human conditions seem to be at the base of the epidemics, beyond any rational technical tool of risk management. Finally, climate change represents the greatest challenge to the notion of risk and to the research in social science. Its exceptional character consists in its planetary dimension, it irreversibility and its close link to governance questions.

Even though some of the argumentations mobilized in this text are not completely new and despite a certain difficulty in finding a *file rouge* among all the texts, the readers of Tecnoscienza may appreciate the polysemy of contributions stemming from different disciplinary approaches. Beyond all criticisms and attempt to overcome the notion of risk society, the expression introduced by Beck still represents one of the *grand récit* of our time and this book provides a further confirmation of it. At the same time, this contribution speaks for the difficulty of finding a new coherent *grand récit*, under the banner of "threat", "catastrophe" or something else.

* * *

Peter Keating and Alberto Cambrosio

Cancer on Trial. Oncology as a New Style of Practice

Chicago and London: The University of Chicago Press, 2012, pp. 456

Stefano Crabu *University of Padova*

What do prizes donated by General Motors, oncomice, molecules, patients, the acronym VAMP, statisticians and oncology have in common? Apparently very little. They are, however, some of the elements and objects that, throughout a complex and articulated convergence process, laid the foundations for the birth of the composite and diverse biomedical transnational movement for cancer research and treatment.

The history of this particular and heterogeneous convergence is the subject of the latest book by Alberto Cambrosio and Peter Keating, two of the most eclectic and prolific authors who have worked at the inter-

stice of history and social studies of science and technology. Without ever giving in to the illusion of producing a teleological narrative that subsumes, as in a "total history", the emergence and development of scientific research in oncology, the authors describe, in a detailed and meticulous way, the genealogy – in the sense conferred by Foucault (1963) – of a portion of contemporary biomedicine that has significantly contributed to innovate and transform biomedical practice *tout court*.

Through a narrative comprising 12 dense chapters divided into 3 different sections, the volume offers an interpretation of the practices, the economic, institutional, organisational, epistemological and technological dimensions, and the political implications of scientific research in support of cancer care and treatment. These are dimensions that give depth to the analysis of the pillar, now taken for granted, of contemporary oncology practice: cancer clinical trials, which the authors define in terms of a new "style of practice".

This latter concept is discussed in the introductory chapter of the text and is inspired by a well-known article published in 2007 in the *Bulletin of the History of Medicine* by the authors themselves (Keating, Cambrosio 2007). In this sense, the introductory consideration to the volume constitutes the theoretical framework of the empirical analysis that runs through a plot which is densely populated by human and animal actors, biological entities, technical objects and epistemological assumptions.

The authors, approaching the tradition of social studies on science and technology, take up the classic concept of *style of reasoning* in an innovative way. Proposed by Ian Hacking in the early '90s, the notion of *style of reasoning* (1992a; 1992b) indicates a particular configuration of institutions and organisations in relation to scientific practices and technologies aimed at investigating specific research questions, elaborating convincing answers, evaluating and disseminating the results to the scientific community, and regulating research activities. In reference to the thought of Hacking, however, Cambrosio and Keating suggest a semantic shift by proposing the term *style of practice*, in order to clear the notion of *style of reasoning* from its particular "cognitive" connotation. Furthermore, while Hacking's analytical perspective has a long-term historical reference, the volume proposed by Cambrosio and Keating seeks to explore the processes of innovation in the biomedical field through a few decades.

Each of the three sections making up the text explores in great detail the three historical moments identified by the authors, through which the methodology of conducting cancer clinical trials has emerged, developed and partially stabilised as the new style of practice in the biomedical disciplinary domain. Although the boundaries between the three main historical periods when this new style of practice was developed are relatively unclear, the authors identify peculiar elements of discontinuity that allow a precise and clear characterisation.

The first historical phase (chapters II-V), which evolved from the mid-

50s to the mid-60s of the last century, saw the emergence of chemotherapy as a potential third treatment course for the cure of cancer, in addition to surgery and radiotherapy. 1955 is perhaps to be considered as a landmark year for cancer research, which in previous decades was rather characterised by a "scientific Tower of Babel" where simple qualitative observations wouldn't go beyond medical anecdotes. In this first part of the text, the authors thoroughly analyse the emergence and development of chemotherapy practice, medical oncology and clinical experiments incorporated in *clinical trials*. This first phase is marked by what Cambrosio and Keating define as the experimental *turn* that led to the emergence of a new style of practice generated by chemotherapy, which would soon involve all aspects of cancer treatment and care (radiotherapy, chemotherapy and surgery).

While avoiding the banal empiricism that regards clinical research as a mechanism of linear implementation of "objective" laboratory results, the authors take into account two important experimental protocols (so-called VAMP and 6313 protocols) in order to show how, since the mid-50s, a new and completely unique style of research has emerged. This is based on a highly experimental design that lays its roots in biostatistics, careful selection of patients and treatment procedures, and unequivocal criteria of correlation between variables. In this sense, VAMP and 6313 protocols offer a privileged analytical perspective on the complex institutional and cooperative network that allowed the emergence and implementation of clinical trials. In the first section of the book, the authors emphasise the cooperative nature that marked the beginnings of clinical research in oncology. As a result, Cambrosio and Keating coined the term "epistemic organisations" in order to stress the importance of integrating experimental and clinical research and the organisational methods developed in support of the research itself. It is a fact that, despite the great interest among historians and sociologists in the subject of oncological trials, only few studies mentioned the key role of cooperation. Historians mainly based their work on archives and investigated institutions such as hospitals, professional associations or commercial enterprises that produced and filed such records. Furthermore, the distributed/fragmentary, flexible and provisional nature of the cooperative activity of cancer groups and the lack of records that testify its importance, led social sciences as a whole to overlook this specific method of carrying out scientific investigation. As a matter of fact, in the attempt of establishing a strong link between science and industry and self-verifying the sterile paradigm where "science discovers" and "industry applies", social sciences have traditionally seen chemotherapy and cancer research as the outcome of a well-defined industry research program. However, the first part of the volume shows how cooperative groups from both sides of the Atlantic were particularly differentiated and quite far from the organisation of industry research as it was conceived, for example, in the making of the atomic bomb.

The second section of the book (chapters VI-IX) is dedicated to the analysis of the development processes taking place from the mid-60s through the 80s that involved some of the most significant institutions arising from the birth and stabilisation of cooperative groups – such as ECOG (Eastern Cooperative Oncology Group) or EORTC (European Organisation for Research and Treatment of Cancer) – as protagonists of cancer research in the previous decades. This second historical stage is dominated by large-scale clinical trials having the objective of comparing the potential of new therapeutic regimens based on the combination of several pharmacological substances, and recursively problematising neoplastic diseases against which these regimens were designed. These trials shared the fractional efficacy of chemotherapeutic drugs to hinder the replication of cancer cells (the cell kill hypothesis) along with a number of assumptions about the growth and replication of cancer cells (cell kinetics).

Accordingly, the authors focus on how the design and experimental implementation of the clinical trials discussed in the first part of the volume have changed. Cambrosio and Keating describe the transition from a first phase, mainly characterised by clinical screening of anti-tumour substances being tested on a relatively small number of patients, towards clinical research on a very large scale. Although the clinical protocol analysed in this section (ECOG 0971) differs from the previous protocol (VAMP), it cannot be considered as a novelty in itself, since it took over and showed standard features of the new practice style that had already emerged in the previous phase. This new phase, whose importance is symbolically expressed by the ECOG 0971 protocol, is seen as part of a broader research strategy based on the alignment of a number of related institutions within a transnational network, including data centres and protocol review committees that helped streamline the work of cooperative groups. In addition to these innovations, there is the development of new strategies for statistical analysis (sequential statistics, centralised randomisation) in support of experimental design and analysis of data produced by cancer clinical trials. This contributed to the development of a complex distributed network involving a range of different professionals, such as doctors, data managers and biostatisticians, who gave the impulse to further strengthen the emerging evidence from clinical research with the aim of reshaping anticancer therapeutic practices. Keating and Cambrosio describe the development of a clinico-experimental network going beyond the rigid institutional and national borders and establishing a new biomedical space where oncologists and biological entities cooperate within the framework established by the new style of practice. The authors show how the methods of cooperation and partnership involving researchers from both sides of the Atlantic has become extremely complex and varied through the incorporation of an increasing number of stakeholders, including, for example, the pharmaceutical industry. This led to the emergence of new organisational processes subjected to the

production of scientific knowledge in oncology and constituting what has been called *oncopolitics*, described as the method for governing the processes of production and sharing of knowledge about cancer(s).

During the 80s, however, a sense of crisis pervaded the international community of oncologists. Some of them even argued that cancer research had come to a *plateau* and no trial could significantly increase the chances of curing and treating cancer. The end of the 80s, with the so-called molecular turn, marks the beginning of the third historical phase, which is dealt with in the last part of the volume (chapters X-XII). The authors show how the innovations in the field of molecular biology reinvigorated cancer research, transforming the epistemological assumptions and the management of experimental practices. In 1984 the first human oncogene was isolated and, at the same time, that complex and controversial process that would then lead to the sequencing of the entire human genome began (M'charek 2005). These are the elements peculiar of the third phase identified by the authors of the book, which is characterised by the hybridisation of different disciplines for the consolidation of oncogenic theory within the study, prevention and treatment of cancer. In particular, clinical research would no longer focus, as was the case in previous decades, on strategies for the prevention of cancer cells replication. The episteme passes from a cellular level to a sub-cellular one, in order to develop new therapeutic regimens capable of interfering with the biochemical processes that take place in sub-cellular interactions. Therefore, the hybridisation between cancer clinical trials and molecular biology gave rise to the idea that the ever-increasing gap between basic and clinical research could be further reduced. Under the aegis of what was defined as *translational research* in biomedical circles, a number of researches and new funding programs had reinstated the rhetoric of the so-called "unity between care and clinical research", expressed by the all-embracing concept of *biomedicine* (Clarke *et al.* 2010). Therefore, the consolidation of the oncogenetic theory opens the doors to new research strategies and new ways of treating cancer patients. Biomedical strategies regard *translational research* and *targeted therapies* as the two most interesting approaches so far available and encourage the redefinition of the new style of practice, in order to achieve a greater synergy between research laboratories and the clinical domain.

Overall, the work of Cambrosio and Keating is difficult to categorise with a specific disciplinary label. The book is mainly a work of history of science that also examines the processes of innovation in the biomedical field from a distinctively sociological perspective. Of particular interest for STS researchers is that both the historical and sociological perspectives are fully involved in the narrative and provide theoretical thickness to a work with a strong empirical structure, which is based not only on the traditional archive sources generally accessed by historians, but also on biomedical literature, interviews to leading names in the field, as well as an interesting and innovative bibliometric analysis of scientific produc-

tion. For this reason, this book shows a renewed methodological option that STS should take into careful consideration: the genealogical perspective.

While contemplating a genealogical approach and a particular sensitivity to the social dimensions of science and technology, this book also stresses the importance of complementing a processual and contingent analysis of the production and sharing of scientific knowledge (typical of ethnographies) with a diachronic dimension. This would allow to account in an articulated way for the historical dimension of how different genealogies of actants converge, diverge and rearrange, creating a technoscientific balance, as precarious as it may be.

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Tom Boellstorff, Bonnie Nardi, Celia Pearce and T.L. Taylor

Ethnography and Virtual Worlds: A Handbook of Method

Princeton and Oxford: Princeton University Press, 2012, pp. 237

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As the title clearly anticipates, the book offers, in the form of a methodological handbook, a sound reflection on the use of the ethnographic approach in/for virtual worlds research.

The handbook arrives in a time in which, on the one hand, ethnography-based research are increasingly spreading through and contaminating with fields other than the traditional ones of anthropology and sociology (such as new media and communication studies, ergonomics, design, HCI, CSCW). On the other hand, research on virtual worlds has continuously proliferated in the last decade and showed a growing affinity with qualitative research design and ethnography, in particular. The four authors' effort is praiseworthy and the result of their work a valuable one, precisely, because in times of methodological appropriation and disciplinary contamination, the re-assessment and the update of what it means to do ethnographic research in/on virtual worlds were sorely missing. Furthermore, the many years of experience that Boellstorff, Nardi, Pearce and Taylor share over the handbook topics shine throughout the book making it a sound and authoritative source.

Authors' commitment to a clear definition of "virtual world" as "object" and "field" of research is a remarkable aspect of the handbook, as well as it is their attempt to maintain clarity between what constitutes virtual world research and what not. Indeed, for instance, they clarify more than once, throughout the book, that games with multi-player capabilities, online communities and most networked environments that are usually studied nowadays are not virtual worlds. Virtual worlds "are *places* and have a sense of *worldness*. They are not just space representation, but they have object-rich environments with which is possible to interact. […] They are multi-users in nature. They exist as shared social environments with synchronous communication and interaction. […] They are *persistent* and continue to exist even when participants log off. […] virtual worlds allow participants to *embody* themselves, usually as avatars" (p. 7; original emphasis). Furthermore, in my opinion, the fulfillment of the handbook's main goal – "to provide ethnographers with a practical set of tools and approaches for conducting successful fieldwork in virtual worlds" (p. 1) – is successfully pursued through the handbook's sough-after design as a manuscript that (*i*) is concise and agile: to be held in one hand, in opposition to most handbooks; (*ii*) is compact and practical reference guide: not just to be studied, but to be carried and used while doing ethnography; and (*iii*) identifies with the greatest possible precision the key tenets of ethnographic research (p. 7-9).

In compliance with the principle of a lightweight and agile instrument, the handbook is composed of twelve, relatively brief, chapters each one addressing a key aspect of ethnographic research. The book is not divided into parts, but it is easy to identify the macro areas covered by the chapters.

The first two chapters ("Why this handbook; Three brief histories")

deal with the framing of ethnography as a method for researching virtual worlds. In this initial part, the authors provide an explanation of the rationale behind the handbook and a recount of the emerging research trends on virtual worlds and methods. Chapters three and four ("Ten myths about ethnography; Research design and preparation") justify the choice of method and its place in the research design. This part proceeds by explaining how the choice of an ethnographic approach can be grounded against the typical objections that researchers could face in this regard and how such choice can be seamlessly integrated into a sound research design.

If a core of the handbook shall be found then, in my opinion, it is in chapters five, six and seven ("Participant observation in virtual worlds"; "Interviews and virtual worlds research"; "Other data collection methods for virtual worlds research"), which tackle in depth the key ethnographic tenets of data gathering: participant observation, interviewing, and the use of virtual worlds specific data (e.g. screenshots, chatlogs, audio, virtual artifacts). The authors give incisive explanations about the meaning of *participating* in/for the fieldwork and about the establishment and upkeep of fulfilling relationships with the informants. More importantly, they clarify the differences and the similarities for (participant) observation and interviewing as conducted in virtual worlds research and physical worlds ones. The eighth and ninth chapter ("Ethics"; "Human subjects clearance and institutional review boards") enter into the details of research ethics, both in terms of principles and practical matters. Chapters ten and eleven ("Data Analysis"; "Writing up, presenting and publishing ethnographic research") deal with the challenge of analyzing and presenting the data within the frame of ethnographic research. In this part, they are particularly helpful the practical tips over the drafting of the research results through different ethnographic genres, as well as the considerations over the styles and the target venues for submitting research outputs. The last chapter ("Conclusion: arrivals and new departures") is a small, conclusive reflection on the rationale of the handbook's design and the authors' expectations over its usefulness and outreach. Finally, as an overall framework, the handbook also includes: an initial "Foreword" by George Marcus, a very rich "References" section and an "Index" one.

The critical remarks to address to the handbook are very few in my opinion. An issue worth mentioning is that, despite being a methodological book, it includes no examples of the practical application of the techniques that are introduces and explained in general terms. For instance, the sections "Taking extensive fieldnotes" (p. 82) or "Keeping data organized" (p. 85) discuss very well the tenets and principles of fieldnotes taking and of their coherent organization, but the book provides no fieldnote excerpt neither an organization scheme for the data as examples. Similarly, when explaining the use of chatlogs and screenshots as data, no examples of how to use, organize or subsequently analyze this kind of data are provided. Another, minor, issue I feel to highlight relates to the choice of

keeping the book light while covering a large spectrum of methodological topics which, of course, come at the detriment of the depth of analysis for each topic or sub-topic. As this is an explicit choice made by the authors it can be hardly criticized, also because it is well pursued. However, certain chapters really make the reader wish the authors had dwelled deeper into the matter. A clear example is in chapter five where the handbook touches on a sub-topic such as "Making Mistakes" (p. 79-82). From the practical point of view of doing ethnography this is a very interesting theme, but it is treated for no longer than a couple of pages. The same issue goes for chapter seven, where the use of different data types and gathering techniques that are specific to virtual worlds research are mentioned, but not fully treated. Truth be told, to cushion both of the issues mentioned here, the authors often provide an account of how they tackled the specific topic at hand in their own respective research works, which is a very interesting and pleasant way to establish affinity with the reader, or provide references to specific literature that allowing those who would be interested in, to dwell deeper into the topics.

About the style of the handbook, I certainly appreciated its narrative and fluid tone that manages to establish a direct and somewhat informal conversation with the target audience. Statements, key arguments and examples are clear and never convoluted. Furthermore, the use of virtual worlds' jargon and of theory-laden terminology is kept to the minimum, which makes the book easily accessible for researchers who are starting to approach either the methodology or the field of virtual worlds. A few words shall be spent also about the audience the book is addressed to. Indeed, I believe that, regardless of the fact that the authors' explicit intent was to provide a useful instrument for graduate students and early stage researchers who are not necessarily acquainted with the handbook's subject matters, "Ethnography and Virtual Worlds: A Handbook of Method" can be useful for more experienced ethnographers too. The main reason for this is that the handbook itself grew out from the authors' direct experiences and challenges with ethnographic research and it is the result of an ongoing conversation among the authors about such challenges. Therefore, despite being written in a simple, accessible and lightweight way, it certainly touches the key methodological issues that any researcher entering this field will have to face, regardless of his or her experience.

One final aspect I want to raise in this closing sentence may be of interest for some STS scholars. Indeed, I believe that through its design, its style, the scope of its arguments and the framing of its specific elements, the handbook manages to make looking as outdated the whole set of methodological and epistemological challenges that were raised by the study of the computer-mediated, the second self, the online and the virtual during the past two decades. These past great challenges appear here as "normal" and integrated elements that are common to any research journey, ethnographic or not, striving for discovering a world, virtual or not.

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Francisco Tirado and Daniel López (eds.)
Teoría del Actor-Red. Más allá de los Estudios de Ciencia y Tecnología [Actor-Network Theory. Beyond Science and Technology Studies]
Barcelona: Amentia Editorial, 2012, pp. 398

Claudio Ramos-Zincke *University Alberto Hurtado, Chile*

Over 30 years, actor-network theory (ANT) has evolved from a proposal for the study of science and technology to a theoretical approach about reality in general, questioning the basic notions of modernity, challenging sociology and other social sciences, and involving explicit ethical and political implications. Throughout this journey, ANT has sustained an intense dialogue and self-criticism. Today, it is an internationally recognized approach with institutional consolidations but nevertheless maintaining a spirit of inquiry and questioning. This book, product of a group of researchers from Spain and Latin American countries, is an expression of that spirit. It consists of twelve chapters, one introductory, sketching some highlights of the trajectory of ANT, and eleven containing research results or reflections based on ANT. They innovatively explore realities in which science and technology are involved, appealing to the conceptual and theoretical tools provided by the ANT, but revising them and relating them to other approaches and adding new conceptualizations.

The three chapters that follow the introduction are directly based on empirical investigations and are extremely interesting. In a long and substantial chapter, Jorge Castillo & Francisco Tirado analyze the new reality of cancer. Through the practices and technologies of the current biomedicine, especially of the genetic analysis, a cancer has been constituted that extends itself beyond human tissues, a cancer that even exists in healthy people. It is a presymptomatic cancer, constituted in a probabilistic way, and identified through the results of the oncological genetics. Now, cancer patients are also those who have risk of contracting it and that could be intervened in a preventive manner. In this way, the disease incorporates several superposed levels: an individual, bodily level; a family, genealogical level, and a population level at which statistical calculations are made. The cancer is, therefore, a phenomenon extended at those three levels or scales that are folded in the individual patient, involving a multitude of actors and practices of very diverse nature. In spite of that complexity, the network of medical operations enact, according to the authors, a well harmonized and non multiple disease. Castillo & Tirado also argue that the medical protocols play a central role in the coordination of the diagnostic processes, technological handling, treatment and monitoring. These protocols would be a central force harmonizing the disease,

avoiding a differentiated ontology, despite the existence of multiple scales. It would be possible to discuss if the integrative force that Castillo & Tirado attribute to the protocols is so powerful and effective as they assume, and if this is the main integrative factor, but their exposition is well argued. The authors conclude that this type of cancer represents a peculiar type of object that they call "potential object". It is the result of calculations in an extended field that are instantiated in a specific body. This would reflect a variety of objects and processes of enactment different from those habitually treated by the ANT.

In the next chapter, Blanca Callen studies another particular type of technological, scientific objects: computer programs built using free software (FS), whose constituent code is released and may be copied, distributed, used and modified by anyone, contrasting with the restrictive logic of commercial circulation. Unlike what is usually raised by the ANT, the effectiveness and success of these objects based on FS does not derive from their black boxing but precisely from the opposite: from its openness and transparency. The construction of socio-technical objects using FS proves, according to Callen, that the stabilization and proper functioning of an object do not necessarily require its closing and blackening. The sustainability and quality of these products based on FS are provided by the users' collaboration and appropriation of the products. This openness of the productive process rather than destabilize it, contributes to its improvement and reinforcement. These objects, instead of "immutable mobiles", in terms of Latour, are "mutable mobiles", fluid objects, whose advantages lie on such character. In a larger perspective, this proposition supports the benefits of using ample collaboration in the construction of facticity and can be read in the perspective of an ontological democratization.

Tomás Sánchez Criado studies how the user of telecare services for seniors is constituted and maintained. His investigation is in continuity with the approach of the co-construction between users and technology, and incorporates Mol's notions of multiple reality and their articulations. The user is understood, therefore, as an effect of multiple material and semiotic processes; as an assemblage developed through diverse practices. These practices include a certain type of legal, bureaucratic work and the management carried out by the suppliers of the service regarding relatives and acquaintances who can inform about the user and help him. Along with this, Sánchez Criado seeks to address the psychosocial domain and subjective process involved, to which the ANT has not paid attention. He recognizes, thus, in that process of user enactment, a particular semiotic and material articulation allowing the constitution of a singular subjective dominion, habitualized, located and dynamic.

In the remaining chapters the authors present different reflections, more tentative, connecting approaches and making conceptual discussions around the ANT. In six of them, the main center of attention is the relation of ANT with politics, giving special value to Stenger's notion of

"Cosmopolitics", assumed by Latour, and to the derived proposal of "ontological democratization". Such notions propose a configuration that is not actual, involving a normative concern. This means, as Yann Bona and Salvador Rodriguez say, to take care of several different cosmos, without the universal rules and possibilities of convergence expected by a Kantian cosmopolitanism. This raises the need for mediation, for which role science has special conditions as a connecting "diplomacy". It is a political - diplomatic and scientific work with a prospect of future construction, which deviates from the direction assumed by the original ANT. Besides, part of this diplomatic work would be with the own "sociologists of the social" who have been questioned and fought relentlessly by Latour based on his "sociology of associations" approach. Such "internal" diplomacy would also be a new direction for the ANT, not easy to carry out. Paloma García expands on this diplomatic role of the social scientist who seeks to communicate different worlds or cosmopolitics among themselves. This is a scientist who seeks to connect worlds, from within and not from some external point of reference, promoting an ontological pluralism. However, according to García, Latour particularly addresses the interpretive descriptive work and not the intervention mechanisms that such diplomatic perspective requires; he does not elaborate proposals on how to enhance the ontological democracy that involves a complex relationship with various publics, in many cases conflicting among them. Latour's method, according to this author, it would not be sensible to a "heterogeneous public opinion", which would limit its practical impact. The transformative potential of this line of work would be limited by its lack of attention to the socio-technical mechanisms of agency involved in such diplomatic mission. In this matter, it would have been helpful that Garcia included further discussion and assessment of approaches such as Callon, Lascoumes & Barthe (2009) on Hybrid Forums and its practical applications, where it is taken care of such plurality, adressing specific mechanisms to be used.

In his text, Israel Rodríguez draws up the trajectory of the network concept in ANT and some of the criticism it has received. He highlights the increasingly prominent political orientation of ANT, with its ideas of des-ontologization and ontological politicization. He also shows a special concern for the spatialization of networks and the resulting complex configurations. In this regard, he explores connections with other concepts, such as Peter Sloterdijk's notion of "spheres", which could be understood as strong networks of relations that operate protectively. There are many and varied stabilizations, such as these spheres, resulting from the movement of the networks; one could conclude that the ANT's emphasis on the movement and circulation perhaps should be balanced with further study of the crystallizations that are being generated and that contribute to the ever-growing complexity of networks.

The text by Ignacio Farías provides a theoretical perspective useful to frame several lines of inquiry that arise from the book's chapters, for ex-

ample on potential objects or on the stabilization of complex configurations. His central question is how the complex social plurality is formed, how to reconcile the logic of networks with the existence of configurations that traditional sociology has identified as social subsystems, fields and value spheres: politics, economics, science, art, etc. In fact, the same Latour (2013), in his last book, arrives at similar distinctions, now understood as "modes of existence". Farías, based on Niklas Luhmann's theory, argues that ANT, with its emphasis on ongoing practices, leaves out the "virtual", which may serve as background for the actual. Social reality depends on communication, and each communication introduces a difference between what is indicated and a horizon of possibilities. Social meaning is inevitably a combination of presence and absence; it is based on differences and anticipations. Luhmann shows how different forms of semantic accumulation and communicative configuration, such as the economic, legal, political, artistic and scientific systems, have been constituted historically. These configurations, or networks of meaning, operate in a world of possibilities with respect to any specific practice. To the extent that, in each wave of practices, neither all those elements of meaning nor all those connections are actualized, Farías attributes to them the character of virtual. These virtual stocks of meaning have a procedure of selection, accumulation and maintenance, which is based on the constant local application of a general criterion or code. The recursivity in the application of such a code, around the reference problem, gives form, through historical evolution, to social differentiation. This is a theoretical perspective of exploration that is very suggestive. Along with its potentiality, however, it contains a number of aspects that require clarification or deepening. To begin with, the apparent dissociation between a practical-material-actual dimension and another semantic-virtual dimension would require to be specified, in order to avoid confusing it with the ontological separations and purifications that precisely Latour questions.

This book is aimed mainly at an academic audience already interested in the study of science and technology, and especially at an audience with some knowledge of ANT. This public can better appreciate the questions, comparisons and new conceptualizations. However, for those who have less knowledge on ANT, several chapters include illustrative syntheses and reviews about it that will facilitate them to approach this theory.

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Niki Vermeulen, Sakari Tamminen and Andrew Webster (eds.)

Bio-objects: Life in the Twenty-first Century
Farnham, Burlington: Ashgate, 2012, pp. 226

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Techno-scientific breakthroughs have generated a process of representation of, and intervention on, life at molecular scale. The ability to decompose and recompose, create and modify, stock and circulate living-objects has dramatically increased. This has stimulated many academics to write about an objectification of life, particularly evident in the case of DNA codification.

This book intends to contribute to this wide debate by providing the analysis of contemporary reconfigurations of life with "a useful conceptual device or heuristic" (p. 1), *bio-objects* (hence the title). The thirteen case studies presented in this book span a wide range of subjects, including patients, foetuses, embryos, gametes, stem cells, genes, transgenic animals, genetically modified plants, artificial silicon cells and water. As implied by this Borges-like list, the authors are not concerned with providing a complete catalogue of "life in 21st century", as implicated by their subtitle. Their aim, rather, is to introduce a new methodological approach, grounded on the dynamic processes of bio-objectification, which is understood is marked by a fundamental ambivalence. On the one hand, living-objects are controlled, processed, hybridized, collected and exchanged at a unprecedented rapid-pace. On the other, this reification process is not wholly new, complete or definitive, in that it draws upon the traditional processes of the domestication of life. While rendered highly malleable, these living-objects are not rendered inert, not even when codified in genetic sequences, or replaced by artificial *in silicio* models.

In a Foucaldian way, bio-objectification implies necessarily the creation of subjects. As highlighted by the oxymoronic relationship between *bios* and *thingness*, the similarity to a living-object raises issues about the moral status and the position of these new entities in a similar manner to animal/human, organic/inorganic, subject/object dichotomises. Sketched in a brief theoretical introduction, and then resumed and enriched in the empirical analysis that follows, this fascinating conceptual backbone basically follows the trajectories of these "out-of-place entities" through multiple levels of analysis. In particular, they address the interplay between the epistemic and the ontological dimensions of these entities, not only their moral status, but also the regulation of their substance in terms of traceability.

The 13 case studies are organised in three different sections. In the first section, "changing boundaries of human, nonhuman and society" are

analysed through the discursive and concrete shaping of bio-objects in relation to the attribution of life. Radically new forms of life, like transgenic mice, are represented through a contradictory process, in which both the comparison with ordinary forms of life, and the demarcation of their exceptional value, are aimed at silencing their sufferance (Tora Holmberg and Malin Ideland). Likewise, *pluripotency* of embryonic stem cells is depicted through an analogous strategic insistence on homogeneity and heterogeneity, as compared to adult stem cells (Lena Eriksson). Even more traditional subjects/objects are also included. Clinical research patients are translated in interdisciplinary data assemblage by algorithms (Conor M.W. Douglas), while water is excluded from the designation of life in that it acts as an external vector for successful attribution of life (Ragna Zeiss).

The second section illustrates the way in which governance practices affect, and are affected by, the configuration of these entities as a result of their position in the living hierarchy or their proximity with the life itself. In the United Kingdom, the reaction against transpecies or chimeric embryos, leading to their prohibition in 2008, has created a discursive and material process of purification. Paradoxically, the production of new epistemological and material embryos, different from "true hybrids", reinforces the boundary between human and animal (Nik Brown). In the case of prenatal screening and diagnostic test, technologies have participated in the construction of a new bio-object, the foetus, which in turn has shaped new moral responsibility regarding the normal/pathological divide (Nete Schwennesen). The crucial role that the relationship between genetically modified crops and traditional ones has played in the policy-making process is addressed (Janus Hansen). We also find the new responsibilities and care protocols implemented by the genetic analysis of susceptibility to pathologies (Aaro Tupasela).

In the third section, the "generative relations" of bio-objects are explored, particularly in the field of reproduction. In Germany and in Italy (studied respectively by Bettina Bock von Wülfingen and Ingrid Metzler), the discursive and regulative processes that separate the embryo from kinship and familial projects, which have justified the strict limitations on assisted reproductive technologies, are then put into question through a process of re-connection interpreted as a "fruit-of-love". Even when the paradigm of life-as-information is taken to its extremes, as in the case of an *in silicio* model of a cell, the generative capacity of life has an influence on the organisation of science (Niki Vermeulen). The last two studies concern the potential for genes to assemble biosocial solidarities, such as requests for non-discriminatory measures in insurance policies (Ina Van Hoyweghen), and the implications of the frozen gametes market in the significance and governance of suspended, cryopreserved life (Sakari Tamminen).

As stated in the introductory chapter, the concept of bio-object needs further development. However, it seems very promising particularly con-

cerning methods. The strongest contribution that this book offers the field is precisely the introduction of an effective tool for the study of this epochal change, conceived within a conceptual framework that is clearly inspired by Foucault. Here I am referring to the authors who developed aspects of the "molecularization/geneticization thesis" (in particular Rabinow, Rose and Novas), but also materialist analysts of biomedicine (such as Sunder Rajan and Cooper), or biopolitical philosophers (such as Agamben and Esposito). According to this perspective, the present must be read in the light of an epochal change displaying the intensification of control over life. This search for belief and power systems (*épistémé*) is useful for drawing connections between laws, epistemic apparatus, governance, economic circuits, social relations, representations, and so forth. Simultaneously, the willingness to find out the spirit of an epoch expresses a tendency towards the whole and the structure. A willingness that is complemented with a sensitivity, proper of Science and Technology Studies, toward objects, their agency, their ability to mediate, as well as their discursive and material trajectories. The conceptual framework of bio-objects is an analytical tool that is as malleable, flexible and generative as the forms of life (or non-life) that it aims at studying. Above all, it is capable of combining a detailed analysis of case studies with a broader perspective on the transformation of life within and beyond biomedical research.

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Sarah B. Franklin
Biological Relatives: IVF, Stem Cells and the Future of Kinship
Durham and London: Duke University Press, 2013, pp. 376

Giulia Zanini *University of Padova*

Thirty-five years after an In Vitro Fertilization (IVF) procedure has for the first time lead to the birth of a living human being and five millions test-tube babies later, ethnographic accounts witnessing how IVF has spread around the globe proliferate. In the meantime, a flourishing reproductive transnational industry has emerged and the use of human reproductive substance for regenerative medicine has become so much desirable and legitimate as it is profitable for global pharmaceutical and health services market.

Among this collection of works, Sarah Franklin's *Biological Relatives: IVF, Stem Cells and the Future of Kinship* surfaces to wisely refocus on the very scope of ethnographic accounts in theorizing socio-biotechnological dynamics and to make a point about the way in which the normalization

of IVF plays a role in the current reciprocal understanding of biology and technology.

The book has the urgent ambition to explore how we might think about reproductive substance as a technology, and technology as a reproductive substance; and the ways in which we might combine these approaches to make sense of the contemporary "age of biology". Franklin's approach resists and goes beyond the presumptive separation of domains characterising the theories of social embeddedness of IVF. To reverse such an approach, she elaborates a definition of technology that cuts through diverse disciplines and that emerges in its ambivalent and co-constitutive relationship with biology.

The author investigates the very meaning of "being after IVF" in its temporal, spatial, logic and qualitative terms. Without eluding the complexities of analysing IVF production and reproduction processes, Franklin rather scrutinizes contingent ambivalences, illustrating their cultural, political and technological powers. By exploring IVF socio-biotechnological life and legacy Franklin spans across a variety of contemporary pressing phenomena, including PGD, stem cells research, mithocondrial DNA, regenerative medicine, feminist reproductive politics, cybrid human-animal embryos, synthetic biology.

The introduction of a Marxist approach to highlight the very substantial value of the "hand-tool-embryo" allows Franklin to unfold and recompose one of the very mechanisms by which biology is technological and technology is biological and to illustrate how new kinds of kinships are crafted through such mechanisms.

By investigating the IVF-stem cells interface, presenting the reader with an extremely accurate ethnography of the stem cell derivation lab at Guy's Hospital in London and analysing some crucial moments of the history of embryology, Franklin wisely retraces the process through which IVF has set the cognitive and practical grounds for transforming human reproductive substances into a tool, establishing a new paradigm of biology as a technology which has gained increasing support in contemporary UK and which promises to be crucial to upcoming health industry.

Franklin successfully illustrates how IVF is a technology that exists and is thinkable and practicable through the work of other technological apparatuses, such as the technology of kinship and of sex. The author navigates across feminist literature on IVF to examine how IVF is simultaneously produced by and produces technologies of sex and gender; and how IVF is called to artificially create the facts of life that are thought to naturally ground sex and gender themselves. The resulting picture is one where technologies of sex and gender, more than biology, appear as driving the process of naturalization of reproduction.

Biology displays instead its relativity insofar as IVF is used to produce and reproduce biological relatives while the very content of biology is both taken as an *a priori* and reinvented by IVF. IVF owns a paradoxical mimetic character, which makes it both 'the same' and 'not quite the

same' as the process it has been created to imitate and substitute.

The ambivalences emerging from IVF understandings and applications are multiple and strategic. While they allow its perpetuation as a technology that reproduces gender and sexual norms, they also create biological relatives, and favour its affirmation as a creative technology that bring about unprecedented biotechnological relativities (i.e. the condition of being "a little bit pregnant").

From this perspective, kinship is also looked at as a technology which organises and facilitates human reproductive capacity as much as IVF is a technology of kin making. If the very concept of kinship is a technology designed to chart and discipline human reproductive substances and outcomes, the process by which these substances are "taken in hand" in the lab produces new kinship in a double way: it both introduces new kinds of biological relatives and new modes of being biologically related. The way in which Franklin uses the term "substance" in this book is a very productive one, which includes the specific reference to gametes and embryos as well as the more extensive one which recalls the outcome of "relationships between embodiment, sociality, identity, material objects, and technology" (p. 17). The technological creation of biological reproductive substances and the technological use of reproductive substances for different scopes (i.e. stem cells derivation) leads to a blurred and wider meaning of the concepts of biological relations and biological relatives. In this context, where reproductive substances are biotechnological products and their relationships with people, tools and scopes vary, potentialities exist for the emergence of new kinships.

The mechanisms that make the technology of kinship work in the field of IVF are spectacularized through the diffusion of the iconic image of the ICSI procedure, which represents "not only the logic of IVF, but the biological relativity implicit in making biological relatives. The relativity of the biological and the technical […] in which substance and tool engage in the complex intercourse of merging with a purpose" (p. 254).

Aware of the aesthetic value of diverse IVF-related images and visual forms, Franklin also dedicates very captivating pages to bioartistic interpretations of IVF ambivalences and presents a very detailed ethnographic account of the works by Gina Glover inhabiting the transition spaces of IVF clinical encounters at the Guy's Hospital in London and offering an aesthetic extract of the combined experience of IVF by different actors.

Franklin conceives her book as a mosaic, where a number of ethnographic encounters, historical inquiries, bioartistic displays and theoretical sources provide the instruments for the development of a thoughtful, composite and extensive analysis of the landscape of IVF.

The argument is not a circular one. Instead, Franklin's acute and detailed analysis unfolds and expands along a spiral path, which navigates across different domains of IVF history to explore the socio-biotechnological circumstances of its development and the development of the socio-biotechnologies that have emerged in its presence. Such a

distinct approach to the study of IVF as a lens through which the coproduction of biology and technology can be unpacked, owns the creative power of extending its hermeneutical validity beyond the boundaries of the past and present of IVF to the future of kinship.

The author retraces the multiple intersecting meanings of reproduction in its historical and eclectic manifestations and interrogates the dynamics of intellectual academic knowledge dissemination and reproduction. As much analytic and precise as evocative and inspiring, the skilful assemblages of ethnographic evidences with literary sources, the perceptive combination of Marxist, Foucauldian and Latourian conceptualisations with feminist approaches and the narrative juxtaposition of chapters that Franklin elaborates constitutes itself an original written reproductive formula which develops along complex and non-linear trajectories.

This book constitutes a reference for all those who approach the study of technology or kinship and is inescapable for those who adventure into the intersections between these two concepts.

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