THE GENESIS AND ONTOLOGY OF TECHNOSCIENTIFIC OBJECTS

1. GENERAL INFORMATION

1.1. Participants

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1.2 Duration

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1.3 Abstract

This is a project aimed at developing a philosophy of technoscience through a focus on its objects. The ontology of the technosciences differs from the ontology of modern science. Aside from its philosophical interest, this difference deserves attention because these objects challenge received ways of thinking about the natural and the artificial, science and engineering, substance and potentiality.

The proposed collaboration investigates research objects that did not come into being as pure phenomena, but that became objects of study because of their technological potential or their dependency on technological systems. These objects originate within a specific epistemological context revolving around technical control, and they reconfigure the disciplinary map of knowledge. They include objects that come to the attention of various disciplines (*stem-cells, arctic ice*), objects that do not exist as of yet but are to emerge from a convergence of research efforts (*lab-on-a-chip*, *targeted drug delivery systems*), objects established in one research context that are of interest to others (*flagellar motors, marine shells, micro-algae*), objects that are engineered to provide a common referent for a variety of approaches (*onco-mouse, carbon nanotube, artificial water catchment*). In brief, we propose to analyze technoscientific objects that are neither natural phenomena nor technical devices, and that enjoy considerable prominence in contemporary research.

Without claiming that these kinds of objects are new, the joint project seeks to identify and investigate ideal-typical exemplars in order to develop philosophical tools for an adequate understanding of these objects. The project aims at preparing with the contribution of international collaborators a collective volume that should be a reference work for promoting the

philosophy of technoscience and for a systematic understanding of a type of objects that commands considerable attention in our contemporary world.

2 OBJECTIVES AND WORK PROGRAM

2.1 Distinctive aims

Smart materials, ambient intelligence, stem-cells and synthetic bacteria for ecological remediation are shaping the world we are going to live in. To scrutinize and understand candidate exemplars of these new kinds of objects is a precondition for understanding, controlling and regulating the objects that will populate the world of the future generations. Accordingly, the proposed research aims to

- develop philosophical tools for an adequate understanding of the objects that are created and investigated by current research,
- prepare exemplary cases that can inform philosophical discourse and teaching,
- bring together an international group of philosophers of science and technology to provide detailed examinations of a broad variety of technoscientific objects.

Starting with a programmatic essay, this research process will culminate in a book-length collection of *Biographies of Technoscientific Objects*. It will contribute to the development of a more precise notion of technoscience and an appreciation of its philosophical significance.

2.2 Definitions

The following definitions of 'object,' 'biography' and 'technoscience' mark points of departure that aid the process of identification and selection for the purposes of this project.

- Objects:

The project is centered on objects rather than on the subject of technoscientific knowledege because this appears as the best place to identify the specificity of technoscience. By 'object' we mean material things studied in technoscientific research. They are able to perform in different scientific and technological environments, they are used in transdisciplinary networks, and as innovative products they spread out very easily across the laboratory. Although some of them are extremly tiny and nearly immaterial, they can safely be referred to as things. They are not the basic constituents of matter but *minima materia* as the "smallest bits of matter *that retain their functional properties*" and that can serve as technological building blocks (Fuller 2008, p. 20). The material things of technoscience are meant to be familiar, quotidian objects, whether they are now existing (buckminster fullerenes, stem-cells) or envisioned (therapeutic viruses, artificial retinas). Their quotidian character is underscored by considerable efforts to ensure that ordinary people can somehow picture or imagine them even where for example the smallness of a nanoscale object eludes the imagination.

- Biographies

The title of the proposed collaboration pays homage to two books which set the stage for the projects' methodology: Ludwik Fleck's *Genesis and Development of a Scientific Fact* meets Lorraine Daston's *Biographies of Scientific Objects*. The link between these two works provides the minimal definition of 'biography' as coming into being (and passing away). This minimalistic definition of 'biography' does not prejudice the analysis of ontology. We do not want to convey an essentialist approach presupposing a substance or character that would be preserved through a lifetime of events. Rather we assume that the nature of technosceintific objects remains undertermined and can be continuously reconfigured in the life-time of the object under consideration. In addition we do not presuppose that there is a single biography for each object. In accord with the notion of (transdisciplinary) "boundary objects" (Star and Griesemer 1989) that are claimed simultaneously from diverse disciplinary perspectives and institutional interests, we should admit the possibility that certain objects have multiple biographies that intersect at certain times or in regard to specific functions. For an appropriately minimalistic definition we therefore follow Daston in saying that 'biographies' are defined by moments of birth and death (Daston 2000, p. 5). Technoscientific objects come into being and they can pass away. And by attending to the way they come into being, we can learn quite a bit about what they are, ontologically speaking. For example, arctic ice has been "just sitting there" for millions of years, but it came into being as a technoscientific object that tells us about climate change, about geophysics and biodiversity, about the distribution of particles in the atmosphere, about the history of technology, the history of the earth, and their interaction.

- Technoscience

Technoscience is not a "new paradigm" resulting from a "revolution." We allow that there is nothing new about technoscience and that for instance 17th and 18th century chemical research was technoscientific *avant le lettre* (Klein 2005). Adapting the language of Ludwik Fleck, one can say that technoscience is a style of thought characterized by transdisciplinary engagements with a shared (envisioned) object that holds the key to the solution of a technical, medical, or societal problem (for instance the artificial retina for the cure of a certain form of blindness developed by biologists, chemists, cognitive and information scientists). This style of thought brings about the reconfiguration of both scientific communities and the order of things, that is, the acquisition and demonstration of basic capabilities for the realization of technical possibility. These include capabilities of visualization, modelling, manipulation, construction, and simulation. Characteristic for the technoscientific style of thought is that this acquisition and demonstration of basic capabilities does not rely on the distinction between representing and intervening, between the natural and the artificial, between organism and device: It does not usually matter for technoscientific research whether one can separate out what is a mere representation of natural processes and what is due to the technical intervention by the researchers themselves. Owing to this indifference, technoscience confounds traditional ontological categories and calls for an ontology of technoscientific objects.

2.3 Guiding hypotheses

In the first stage of the proposed work, the partners need to present, defend, and render amenable to criticism the ***guiding hypotheses or background assumptions*** that motivate this project.

- *Value-laden objects*

Technoscientific objects come into being, not by way of constitution within a categorical or conceptual scheme as apparently value-free objects but through a process of valuation (Echeverria 2003). The case of arctic ice or that of blood from the umbilical cord makes this point: These have been objects and perhaps objects of scientific interest before an assignment of value turned them into technoscientific objects, and now they challenge the traditional contrasts of pure and impure, morally neutral and socially invested.

- *Functional objects*

A second guiding hypothesis is that this assignment of value is not just an addition whereby there is now one more reason why a familiar object is interesting. Instead, by becoming an object of technoscientific interest, the object becomes something new or something else such that it raises questions regarding its ontology: Technoscientific objects are defined not by what they are but by what they do, and accordingly their structure, properties, and structure-property dependencies fade into the background, while their potential functionalities take center stage and what they might usefully become through engineering. Arie Rip therefore speaks of technology as "prospective ontology." Like new-born children and other "hopeful monstrosities" he argues, technology holds the promise of what might be and how things might be (Rip 2009). According to our guiding hypothesis, however, these objects-of-promise have a way of being of their own and this demands an investigation not just of prospective ontology.

- *Familiar objects*

When one asks what objects are in terms of the structure that produces their appearance, the response often produces a divorce between everyday experience and scientific experience. The famous epistemic rupture between science and lay knowledge, emphasized particularly by Gaston Bachelard (1938) may no longer be applicable. Our third guiding hypothesis suggests that technoscientific objects are meant to be quotidian. Their potential functionality is, by definition, a technical performance that relates to imagined human purposes. And thus, even those technoscientific objects that elude perception are rendered familiar, if only by describing how and what they might perform. (It is the reason why discussion of the reality of unobservables or the special ontological status of quantum objects cannot inform a philosophical ontology of technoscientific objects.)

These three background assumptions frame the specific research questions without being immune to criticism. This framing also indicates what the proposed project is not:
- It is not a critical evaluation of technoscientific projects.
- It is not an inquiry into knowledge production and its social dynamics.
- It is not a general theory of technoscience.

Instead, the project takes itself to be exploratory and heuristic. The framing allows for the construction and study of ideal-typical cases in order to develop a more fine-grained philosophical vocabulary for understanding the kinds of objects that engage much current research. The aim is to direct the attention of philosophers of science and technology to features of technoscientific objects and to the dependency of these features on research practice and human purposes.

2.4 Research Questions

The guiding hypotheses circumscribe the framework within which more ***specific research questions*** about the ontology and epistemology of technoscientific objects can be formulated. Together with our international collaborators, we will explore these research questions and reflect back on our background assumptions.

- What about agency? One of the philosophically most provocative statement regarding technoscientific objects ascribes to them "non-human agency" which is treated on a par with "human agency" (Latour 1999, 2000). In order to assess this claim, changing conceptions of agency need to be considered alongside with the attributions of agency to objects.
- What about dispositions? Dispositional properties are a central theme in the ontology of scientific objects, in part because these allow a clear separation of two kinds of agency in the laboratory: the technical agency of the scientist triggers a situation in which the natural agency of the object produces a dispositional response to the technical stimulus. Technoscientific objects, in contrast, manifest behaviors that are attributable to an 'apparatus-world complex.' Gibson's notion of 'affordance' may thus turn out to be a central ontological category in the analysis of technoscientific objects (Gibson 1986, Harré 2003).
- What about individuality? In experimental science individual objects are usually considered as samples of a species or a class of objects. By contrast technoscience such as nanotechnology tend to focus on individual entities (molecules or gene sequences). The ambition to collect and store them in data banks technoscience appears to revive a Baconian "natural history" approach.
- What about resilience? Whereas scientific objects in experimental settings are viewed as resilient or “recalcitrant”, technoscientific objects appear plastic and flexible. They tend to be immaterial to the point of becoming mere potentialities, totipotent entities.
- What about conservation principles? The constitutive role of conservation principles for objects of scientific theory has been emphasized by philosophers of sciences – in

particular Emile Meyerson – and they play a crucial role in the advancement of objective knowledge. However as technoscientific objects are meant for performing tasks or demonstrating capabilities, the notion of conservation seems less relevant than the emphasis on the unbounded productivity of nature and technology.

- What about the laboratory? Laboratory experiments determine objects of research by addressing their various properties in isolation. Objects of research are examined under controlled conditions in closed spaces and the whole procedure must be reproducible. By contrast field experiments (and, in the limit, collective real-world experiments conducted in society as a laboratory) assume an indivisible complexity and singularity of objects.
- What about the attractiveness of objects? One feature of technoscience seems to be that researchers are attracted not primarily by theoretical or disciplinary problems but by their objects of research. An account of this attractiveness involves two dimensions: Shared objects or instruments serve as attractors because the technical promise of these objects renders them attractive. Rather than being constituted by a scientific community, the attraction to technoscientific objects constitutes a scientific community that includes a wide variety of researchers who work with these objects alongside those who study them working not with but about these objects are also included.
- What about their mode of existence? Do they come into being by the imposition of a form on a passive matter (hylemorphic model) or as the end result of a process of concretization including the associated environment into their functioning? In coupling the issue of genesis and ontology we invite to reconsider Gilbert Simondon's characterization of the mode of existence of technological objects in terms of their genesis and evolution rather than by the human intentions that presided over their design.
- What about media and society? Though ours is decidedly not a social science approach to technoscientific objects, a philosophical analysis can trace how media technologies or meta-narratives regarding the relation of science and society enter into the determination of technoscientific objects (including the role of representational versus substitutional, analogue versus digital media, of technological determinism and notions of social shaping).

And what about ontology? These and other specific research questions serve to determine what technoscientific objects are in respect to contrastive categories like pure and impure, morally neutral and socially invested, generic and individual, material and immaterial, dispositional and relational, evidentiary and self-vindicating, structural and functional, characteristically determinate and hedonistically totipotent, substantial and potential.

2.5 Objects and their biographers

In particular, one kind of technoscientific object has become quite famous. It is the so-called onco-mouse, which has been subject to close scrutiny by various scholars. This genetically modified mouse designed by Philip Leder and Timothy A. Stewart of Harvard University as a tool for conducting cancer research with patents filed in the 1980s has raised a general issue (Haraway 1997): what is the ontological status of such artificial organisms, fabricated for affording the researchers with cases of cancer? Where do they fit between technical making and manifestations of natural dispositions, and what conflicts of value do they thereby generate?

Comparatively speaking, a mouse that is genetically engineered to reliably develop a specific cancer is an easy case because it so obviously confounds the categorical distinctions between the natural and the artificial, the organic and the technical. These easy cases have the advantage of great clarity and a certain suggestive force, and therefore we do not exclude them from the project. Indeed, a discussion of the ontology of the onco-mouse will allow us to sharpen our conceptual tools in the first phase of the project. It is likely to figure prominently in our initial programmatic paper.

Overall, however, the proposed project aims to tackle also the harder cases, including simple and by all appearances quite ordinary inanimate material things such as molecular wires, carbon nanotubes, or a heap of sand (an artificial water catchment) with ecotechnological promise. The selection of objects should include i) familiar objects that have only recently become technoscientific objects, ii) instruments or research apparatus, iii) objects that are characterized by their promise of future performance, iv) contemporarily prominent objects from robotics, nanomedicine, restoration ecology, or information technologies, but also v) objects from the history of pharmacy, chemistry, medicine, biology or the agricultural sciences.

Three examples may indicate that these objects attract not only the interest of researchers but are intellectually attractive also to philosophers and philosophically-minded historians of science. This intellectual attractiveness will allow us to interest external collaborators:

- Arctic Ice

Recently, the arctic ice has become one center of attention in climate research, which is in itself a profoundly multi- or interdisciplinary endeavor. It thus becomes an object of mathematical modeling, empirical data-mining of physico-chemical parameters, historical age determination or morphological studies of ice structures. Simultaneusly it becomes an object of public attention and awareness which involves, for example, its display in museum exhibits. Tellingly, this technoscientific objects is extremely fragile and vulnerable not only conceptually but also in its material aspects: coring, preservation, and preparation for analysis are highly complex operations. Despite its apparent remoteness and owing also to the required delicacy of handling the core sample, arctic ice serves as a measuring instrument for anthropogenic effects and signifies the fragility of conditions of life in the age of climate change. – This technoscientific object might attract the attention of an environmental historian who is studying Antarctica and other economically significant landscapes, but also that of a philosopher who looks at modeling and simulation techniques in climate science, and thirdly it may be found interesting how a sample of ice can come to represent the history and future of the earth as a whole.

- Stem Cells

Embryonic stem cells have the ability to differentiate into any type of cell. They are therefore considered as being totipotent which implies a powerful promise for the development of medical treatments for a wide range of conditions. However, there is increasing evidence that also adult stem cells have some plasticity and in addition are less likely to produce immunoreactions. Stem-cells are interwoven in a web of institutions and practices, in legal, social, epistemological, ethical discourses. – For the purposes of the proposed project, the notions of totipotency and plasticity are of special interest, but stem cells are also prime exemplars for an ontology of boundary objects that are claimed, for example, by medical researchers as well as ethicists.

- Frictionless Surface

The frictionless surface is an object pursued by researchers in the United States and Münster, Germany. For centuries, friction was considered as a necessary constraint on motion and one of the main reasons why a perpetuum mobile is an impossible dream. When in the Münster-experiments measurements of absolutely frictionless motion are obtained for some atoms on a surface but not for others, the source of error is sought with those that still exhibit friction: if only one could get rid of the atomic "grime", an impossible dream may come true, after all. – This technoscientific object is of particular interest because it has been experimentally realized but is not stable enough as yet to be counted among the things that make up the "furniture of the world." Furthermore, it raises questions regarding the interplay of theory, measurement, and experiment in science and technoscience, especially concerning the status of an experimentally produced object that stands in an evidentiary relation to theory on the one hand, acquired capability on the other. Finally, this object brings to the fore the relation of various levels of theory, of technical and physical possibility, of conservation and decay. Here, too, the selection of the collaborator who studies this object will direct the focus on its ontology.

2.1.6 Outputs, deliverables

The proposed collaborative project aims primarily to engage philosophers of science and technology more closely with technoscientific research. This is thought to be important, however, because researchers and their publics will benefit from a reflection of the "obscure objects of desire" that are matters of curiosity as much as of utility, which are neither isolated natural phenomena nor technical artefacts, and upon which just about everybody's hopes for innovation are pinned.

We will therefore address our peers first with a co-authored programmatic paper that sets the stage for the development and refinement of a philosophical vocabulary for technoscientific objects. It will inform initial discussions with twelve international peers who will contribute chapters to the final edited volume on *Biographies of Technoscientific Objects*.

Aside from the usual journal articles that will be published along the way, one of our two workshops and the final conference will extend our discussions to the technoscientific research community and a larger, not exclusively academic public. The workshop will be structured as a mutual learning experience where technoscientific researchers are invited to "talk back" to the draft biographies.

We plan for the final public conference to include a poster-exhibition of the technoscientific objects under scrutiny in the volume. We will therefore seek to secure as a venue for the conference an institution like the *Cité des Sciences* in Paris or the *Deutsches Museum* in Munich, or the *Humboldt-Forum* of the *Humboldt University* in Berlin. The aim is to make this an academic conference with a larger appeal.

2.1.7 Significance for public discourse

Synthetic biology, nanotechnologies, ambient intelligence or smart environments research, ecological restoration and geo-engineering projects are promising to address fundamental societal and environmental problems of sustainability, global warming, renewable energies, environmental remediation, ageing populations, or global equity. The high expectations placed in future technologies are attended by an apprehensive expectation of the ways in which they will transform our lives and, in particular, relations to ourselves, to nature, and to technology. These anxieties have found one prominent focus in proposed technologies for human enhancement that question human nature. Accordingly, the laboratories of scientists and engineers are the most likely place where one gets a first glimpse of the objects that may differently configure the natural and the artificial, human and technical agency. Here, one also may realize how tenuous and contingent technoscientific objects are as they are valued for their potential and promise, for what they may be able to do rather than what they are. Social scientists have therefore introduced the conception of "ontological politics" (e.g. Mol 1999, Andler et al. 2006, 2008) to characterize what is at stake in emerging technologies.

We expect that our biographical approach to technoscientific objects will draw the attention of scientists and engineers. As we share the conviction that it is useful to bring philosophers into scientific and engineering practices, we intend to include scientists in our workshops and to invite their feedback. This supports the general trend – to which the partners contributed already on various occasions – to incorporate philosophical reflection in engineering practice, broadly conceived (Ball 2009).