Introduction

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Introduction
The genesis and ontology of technoscientific objects

This book seeks to contribute towards the philosophy of technoscience and a better understanding of its significance. It proposes to do so by following objects that occupy a place of prominence in contemporary science and technology. Objects of advanced research such as smart materials, brain-machine interfaces, stem cells, and artificial organisms tend to capture the popular imagination. They are attractive not necessarily for what they are but for what they promise. A carbon nanotube is just a tiny bit of soot, but – rather like in the Cinderella fairy tale – we think it can do miraculous things if only we can fit it with a glass slipper. The 'dead matter' of classical physics becomes 'smart material' in the hands of materials scientists and other nanotechnology researchers, DNA molecules become a wonderful 'molecular machine' in the hands of bioengineers. Where does the seductive power of such things come from? Do they fit the mould of innovation that would change the world? And to what extent does technoscientific research redefine our relationship to things in the world?

Attractive and Mundane Objects

While the epistemology and ethics of science are focused mainly on the subjects of knowledge, we propose to shift attention from the subjects to the objects of knowledge. This volume displays a collection of diverse objects: polar ice cores, the oceanic garbage patch, graphene as the latest incarnation of carbon, video game networks, cardboard, GMO seeds, 'social' robots, stem cells, 'natural' wetlands, frictionless surfaces, nuclear waste, fuel cells, heroin, and a giant heap of 'sand' that simulates the genesis of an ecosystem. Taken together, these objects map a large part of the bizarre landscape of the technoscientific world. Many of them are frequently discussed in newspaper columns. Unlike scientific objects constructed in the closed world of laboratories that need to be popularized, technoscientific objects have a propensity to attract public attention. They prove to be attractive in more than one sense.

First, they act as 'attractors' of young talent, experts, funds and lobbies from all over the world. As their design requires a coming together of various specialists from established disciplines such as mathematics, physics, chemistry, biology, and computer science, they prompt the creation of new fields of research, new journals, and new institutions boasting technical platforms and considerable financial investments. By bringing people together and being a magnet for resources, they re-organize research activities and orchestrate networks of both people and resources.

Second, as knowing and making become ever more entangled, researchers' attention shifts from the characterization of things to how they perform, from structures to functions, from properties to processes. Objects of scientific research are prepared intellectually and technically in such a way that they cease to be mundane things; they are purified of all kinds of interests and values. They are considered to be nothing but bearers of properties and are recorded as matters of fact or states of affairs. By contrast, objects of technoscientific research are attractive in a mundane and familiar way, an observation which challenges Bachelard's epistemology of a break from ordinary experience.[i] They can be as simple as cardboard or rubber or beer. But whether 'hi-tech' or 'lo-tech', they are always value laden.

For a familiar illustration of this point, consider the history of the gene. The gene was introduced as a hypothetical substrate of inheritable traits and thereby served an explanatory and theoretical purpose. Encapsulated in 'the book of life', it raised questions about human nature and about the structure of reality to which each of us owes our phenotypic appearance. The confirmation of genetic theories of inheritance went hand in hand with the experimental manifestation or 'realization' of the gene as, for example, the molecular structure of DNA and mechanisms of replication were elucidated. As it was the referent of concerns about racial purity, about defective and healthy bodies, and about the myth of biological destiny, the gene signified something immutable and inescapable – all we could do was trace ourselves back to it and acknowledge its supreme importance. Nowadays, by contrast, genes are malleable or plastic, and as research objects they are hypothesized not as real entities that have an explanatory function but as a potent material that affords many kinds of manipulation. Researchers take an interest in them as instruments, materials and tools. According to the rhetoric of the day, genes are at last being released from the straightjacket of (deterministic) evolution: they are no longer features of an exclusively natural history but have become part of cultural history too, in that they are used in medical therapies and devices or as an agro-technical object for the improvement of crops, farm animals and human beings. Once the gene had thus proved interesting for what it could do in the creation of new products and procedures, for new ways of acting in and relating to the world, it became what we call an attractive object of technoscientific research.

Third, technoscientific objects are also 'attractive' in that they imply a kind of 'Copernican revolution'. They shift the focus from subjects to objects and display the wide spectrum of interactions between these objects and their surroundings. In becoming technoscientific objects, such things embody new relationships, values, more and less intense concerns that change their modes of existence. As Aant Elzinga shows in his contribution to this volume, polar ice has switched from being an archive of natural history to becoming a messenger of the future enrolled in urgent calls for political action to mitigate climate change. Of course, arctic ice has been 'sitting there' for millions of years, but it came into being as a technoscientific object by being transplanted into new material setups and practices (from ice drilling, coring, and trenching to global climate modelling) as well as in new discursive settings – a fragile object that has become a witness to the fragility of the human condition.

Accordingly, these attractive objects are of interest well beyond the limits of research laboratories. It is an important feature of technoscientific research that it operates in the open field of society and the environment, where its objects propagate, colonize, and transform their social and natural surroundings by (re-)shaping them and by imposing their own temporal dynamics upon them. Whether genetically modified organisms, nuclear waste or stem cells – all of them alike shape the outer and inner environment of the human body, all of them exert an effect on the material and imaginative level, and all of them deeply penetrate mundane practices and habits in almost all spheres of society.

But what exactly is meant by technoscientific research and how can the outcomes of this research be adequately conceptualized? What is so special about technoscientific objects? And does it really make sense to distinguish between science and technoscience? Why do we need to compound the familiar notions of 'science' and 'technique' or 'technology'?

Why Technoscience?

Technoscience is a rather suspect term indeed. At first glance, it connotes power and money, politics and capitalism rather than particular objects. Taking a closer look at the development of this concept, it turns out that 'technoscience' has been subjected to three kinds of uses since

the 1980s. The Belgian philosopher Gilbert Hottois used the term 'techno-science' (written with a hyphen) as a provocative wake-up call to rouse philosophers from their dogmatic slumber.[ii] Hottois contended that most philosophers were concerned mainly with linguistic issues in science, delegating the study of reality to the techno-sciences and thereby condemning philosophy to a condition of what he called 'secondarity'. Hottois switched from the philosophy of language to the philosophy of 'technoscience', referring to a new epoch in which technology is at once the milieu, the driver and the final goal of research.[iii] Our use of 'technoscience' comes close to that of Hottois, but our approach is slightly different: while science and technology are still considered as distinct but interacting spheres from the perspective of science, they become indistinguishable from the perspective of technoscience. Indeed science appears as a mode of knowledge production in which technology is often used to create phenomena and to make representations such as models or diagrams. In the technoscientific mode of knowledge production, theories, models, and algorithms become tools by which to achieve predictive and technical control and to make things work.
Moreover, unlike historian Paul Forman, who situated technoscience in the transition from modernism to postmodernism,[iv] we do not claim that technoscience represents a historical break – that would require us first to posit an age of science and Enlightenment and then, from this vantage point only, an age of technoscience.[v] Rather than claim such a break, we argue that technoscience denotes a certain mode of existence of research objects, one which is now dominant, although it can certainly be found in past centuries as well. Examples are plentiful: mechanical arts, alchemy and pharmacy, pneumatic chemistry, agronomy, automated calculation, zootechnics …. The historical depth of technoscience shows clearly that the technoscientific relation to research objects is not new, albeit it is strikingly prevalent in contemporary culture.

A second – quite distinct – meaning of the term 'technoscience' has been disseminated by Bruno Latour, Donna Haraway and other scholars in the Science and Technology Studies (STS) movement and in feminist studies. For Latour, technoscience is nothing but 'science in the making', the true expression of the real, impure and mixed practices of the sciences as they are made.[vi] 'Technoscience' has become a polemic term used to debunk the myth of pure and autonomous science. It is also a heuristic tool for rendering visible the various mediations and hybrid alliances (instrumental, technical, rhetorical, political…) required to construct scientific facts. This is most often done by means of a process of 'purification', at the end of which the contributions of humans and non-humans can be sorted into two opposite categories: 'nature' on the one side and 'society' on the other. In the STS world, science has always been technoscience, and today's explicitly impure technosciences (nanotechnology or synthetic biology) are nothing more than the 'truth speaking' of science, a sign that we are beginning to stop believing that we have ever been 'modern'. Unlike the STS concept of technoscience, we do not think that all of science can be exposed as technoscience. Neither do we claim that we are going to unmask the true face of scientific activity or that the work of purification is a futile and meaningless pursuit. What we contend instead is that a technoscientific object is encountered whenever the scientific work of 'purification' proves impossible, undesirable or unnecessary.

Finally, the phrase 'technoscience' is widely used to denounce the corrosion of the scientific ethos and the contamination of scientific research by economic interests, the pressure of funding applications, and the consumerist society. This has also been noticed by Hottois, who criticized that 'technoscience' is used rather vaguely alongside fashionable terms like technocracy, capitalism, neoliberalism, globalization, and so on.[vii] What is more, technoscience carries a dubious 'postmodernist' flavour that celebrates the alleged surrender of the grand narratives of modernity.[viii] All these connotations may be one reason why the scientists and engineers who are the actors of technoscience never adopted the term. In not doing so, however, they deny its positive and heuristic power to reconceive not only science and technology but also the role of scientific research in society.

This book is not interested in arguing *pro* or *contra* technoscience. It does not even take the dichotomy between science and technoscience as given. Far from assuming that science and technoscience are two distinct entities with stable, transhistorical identities, we consider them as 'ideal types' forged against specific historical and cultural backgrounds. They are supported by more or less explicit grand narratives of progress that guide research policy. The ideal type of technoscience is associated with notions like 'responsible research and innovation' or 'sustainable development' which are thought to orient the future direction of research and development.[ix] It encourages a mode of research that is open to the world, which takes on board all kinds of societal, environmental and economic concerns. Research institutions or individual researchers who have been socialized in a very traditional way are now engaged in a diverse range of academic and entrepreneurial pursuits. The activities of understanding and making, knowing and producing are becoming indistinguishable from one another. In this context of the hybridization of science and technology, epistemic values (such as truth, simplicity, etc.) are displaced by non-epistemic values such as social robustness and environmental and economic sustainability.[x]

Consequently, technoscientific research can be neither appropriately characterized using the oddly established terms of 'applied' and 'pure' science nor considered as being research conducted in a trans- or interdisciplinary context. Technoscientific research explicitly involves problem solving in many different societal domains, including personalized medicine, climate change and alternative energy, and it does so by mobilizing everyday practices as well, such as game playing or consuming. Two examples are discussed in this book, the 'Sony PlayStation', presented by Colin Milburn, and social robots, discussed by Christopher Kelty. At the same time, consumers are confronted with GM products on the grocery shelves while biomedical research opens up a market in human enhancement, in sports, cosmetics, and medicine, for instance. Accordingly, technoscientific objects are heavily invested with a variety of interests. Far from being neutral, they are to serve societal interests such as durability, human empowerment, beauty, user-friendliness, efficiency, or solidarity. To some extent, the research conducted in nanotechnology or biotechnology, or in information technology or cognitive science, takes society as its laboratory.[xi]

Technoscientific objects are either already deeply rooted in the daily routines of societies or else they are at least virtually present by virtue of embodying a blueprint of future everyday life. Above all, they raise great expectations – and fears. By the same token, to behold them is to participate in their power, potential, and promise. Some of them, such as stem cells (presented by Lucie Laplane) and fuel cells (presented by Pierre Teissier), bear the promise of a cure for cancer, or of the hydrogen economy, and open up a world of unbounded possibilities. Other objects, by contrast, such as nuclear waste (Sophie Poirot-Delpech) and oceanic plastic garbage (Jennifer Gabrys), are fascinating because they confront us with vexing issues that have no immediate solutions. All of them point to the future. They become matters of interest or matters of concern; they fascinate and engage because of the futures embedded in them.

The furniture of the technoscientific world

Like the curiosities of an early modern *Wunderkammer*, the collection of technoscientific objects displayed in this volume blurs the boundaries between the natural and the artificial as well as, in some cases, between the living and non-living and between subject and object.

They are often presented as hybrids, and everyone seems to agree on their hybrid nature. In this respect, the archetypical technoscientific research object is still the oncomouse as introduced and discussed by Donna Haraway.[xii] This genetically engineered laboratory animal is at once a living thing and an artificial organism and, as such, is a hybrid of technology and nature. However, 'hybrids' wouldn't exist if it were not for our belief that some things are clearly natural, others artificial, and hybrids an entanglement of the two.

However, it is characteristic of technoscientific objects that the question of their hybridity does not even arise. Instead of confounding nature and artifice, they are simply impure and not in need of purification. As mundane objects, they are as simple and straightforward as a wooden chair or an aspirin tablet – since it would not occur to anyone to ask whether and to what extent these things are natural or artificial, there is also no reason to consider them 'hybrids'. The great divides that served as the pillars of modern culture are not ones that structure the technoscientific world.

As things of the world (or, mundane things), technoscientific objects are so ordinary that we view them with ontological indifference. However, it is not for science to be ontologically indifferent when its business is described as identifying an immutable substrate of reality, as Peter Galison argues in this volume. Technoscientific research, by contrast, is mainly interested in making everyday things that are meant to require no special conditions for their existence, even though it goes to nanoscale extremes and has the audacity to create biological organisms. Technoscientific objects are as richly ordinary as Martin Heidegger's 'things'. Like the jug that he takes as his example,[xiii] they gather within themselves (*sammeln*) the ways and conditions of the world, they grant us (*schenken*) new ways of doing things in the world.

For all their straightforward simplicity, the mode of existence of such worldly things deserves our attention. As objects of technoscientific research they replace the paradigm of objects that are believed to be grounded in immutable facts of nature. Now, terms like 'furniture of the world' or 'mode of existence' evoke the philosophical field of ontology. Typically, it encompasses a type of categorical analysis that focuses on substance and accidents, on manifest and dispositional properties, on primary and secondary qualities, and the like. Technoscientific objects – and this is one of the main theses of this book – require distinctively different ontological categories to understand them as things of the world.

They need to be characterized by their performance rather than by their structure or composition. They undermine the traditional distinction between *substantia* (what it is) and *potentia* (what it can do or become). More precisely, their *potentia* relies on affordances rather than on dispositional properties. The concept of affordance plays a central role here, in that it points to a relationship and not primarily to the intrinsic properties of a structure. Affordances accord something to an organism in its environment that wouldn't otherwise be possible. What James Gibson, who first established the concept of affordance, sought to suggest with it is a particular perspective on the furniture of the world.[xiv] A vertical, flat, extended, and rigid surface such as a wall or a cliff face affords falling – it is fall-off-able – but might also become climb-up-able if we are attentive, and so on. Similarly, the design of technoscientific objects relies on what materials and natural phenomena can afford in certain circumstances or in relation to specific conditions. The design process does not consist in the application of general laws. Turning molecules into machines or using proteins built up through the evolution of life on earth as tools is all about seizing opportunities to provide abilities. The activity of design is organized so as to develop an ability in material entities to do something (switch a signal, store information) or to produce something (a toxin, a fuel, a material). The ultimate goal of research is to make things 'actionable' or to 'enable' certain actions – two key words in the language of contemporary nano and biotechnology.

Such terms encourage discourses about 'shaping the world' or 'redesigning life'. Common phrases such as 'materials by design' or 'smart technology' often suggest a Promethean view of designers projecting form and information on a passive matter. But the practices of technoscientific design do not fit this 'hylomorphic' conception of artefacts.[xv] Technoscientific designers are not dealing with matter in general. They use materials, working with their singular qualities, propensities, or with their surfaces, their interactions, and with the environment.[xvi]

More importantly, when it comes to technoscientific objects genesis and ontology are intimately linked. Typically, such objects come into being as proofs of principle – they neither constitute evidence nor are they demonstrations. Rather they are exhibit(ion)s of a prototype that promise indefinite possibilities. They are designed to become, their mode of existence is simultaneously one of 'no longer' and 'not yet'. Genes are no longer an inexorable destiny, they can be redesigned, re-engineered, and re-assembled to create new forms of life in the future as well as to serve as materials that encode their own construction plan. Matter is no longer a rigid constraint, a pole of resistance or recalcitrance. It is plastic and malleable as soon as one takes materials or cells in their nascent state and works with them to generate a material or a tissue by design. Technoscientists are taking advantage of the intrinsic dynamic of material entities and their collective behaviors. In thus playing with the spontaneous dispositions of things – self-assembly, self-organization, or self-repair – they address nature as *natura naturans* rather than *natura naturata*. In their efforts to seize all opportunities, they co-operate with natural phenomena and use molecules, bacteria and viruses as partners. Nature is neither to be commanded nor obeyed; it is an ally of technoscientific adventures.
Such alliances determine the ambiguous modes of existence of technoscientific objects. They are designed with an eye to the future as a door opening onto a new set of possibilities. Whether material or merely virtual, whether wetware or software, they are perched between promise and reality. They are 'always within reach' (if only the proper technical conditions were realized) and at the same time 'always just slightly beyond reach'. As a consequence, they call for action, for more research, more investment, more regulations. Technoscientific objects, in contrast to well-defined scientific objects, are never stabilized; they are always 'work in progress'. They are endless processes and as such continuously require the mobilization of a variety of human and non-human resources to keep moving.

Finally, they are torn between the utopia of emancipation from matter and the affirmation of unrestricted potentials lying in material structures. On the one hand, objects such as frictionless surfaces or graphene undermine the notion of materiality as a constraint. They thereby revive the grand narratives about mankind being in control of nature, and the modern ideal of emancipation of mankind from the constraints of matter and the limits of life. On the other hand, the same objects may also be seen as the manifestation of the potentials hidden in matter or even as an enhancement of matter. As new material creatures they have a life of their own, which far exceeds that of their designers and users.[xvii] Technoscientific objects come to life, they show resilience and a certain obstinacy, they interfere with evolutionary processes. It is thus possible to characterize their temporal dynamics in terms of their life cycles, from cradle to grave. Plastics or microchips have their own times, which are hardly commensurable with the timescales of their ephemeral use.

Featuring technoscientific objects

Rather than including a general philosophical essay on the ontology of technoscientific objects, this volume contains *stories* about the genesis and life of a selection of such objects.

Narratives are a powerful tool that serves to throw a spotlight on objects as the central characters of a philosophy and history of technoscience focused on processes rather than on substances, on individual modes of existence rather than on essences, while paying attention to the various timescales implied in their existence. The narrative approach is an alternative way to address philosophical issues while mobilizing the traditions of philosophy and of science studies.

A first set of papers – grouped under the heading 'horizon of possibilities' – explores the ontological commitments present in technoscientific research process. Peter Galison's simulations, nano-objects and strings inspire a new map of knowledge that profoundly changes the identity of disciplines. Their 'ontological indifference' comes into stark contrast with the ontological anxiety expressed in twentieth-century debates that pit realists against anti-realists in theoretical physics.

However Lucie Laplane's analysis of cancer stem cells research suggests that ontological indifference is actually a problem for technoscience. Depending on the ontological status of stem cells, the therapeutic strategies will be conceived quite differently. She argues that ontology matters for very practical purposes.

The next two chapters explore the relations between technoscientific objects and modes of theorizing. Whether physical or simulated, the robots presented by Christopher Kelty are used as a kind of model organism that affords a way of accelerating the time-scales involved in biological evolution. These robots, which subvert the ontological divide between reality and copies, exemplify the productivity of technoscientific simulacra. Subverting the ontological divide between reality and copies proves to be a heuristic epistemic gesture.

The frictionless surfaces pursued by nanotechnologists and presented by Alfred Nordmann exemplify the quest for an ideal world that lies not *behind* the appearance, as in Platonism, but *beyond* the appearances as the vanishing point of engineering. In spite of a marked ontological indifference they hint at a possible new world, an ideal world emancipated from the constraints of matter – the dream world of perpetual machines that modern thermodynamics had repudiated.

To counterbalance the dreams of dematerialization, the fuel cell, to which Pierre Teissier gives a voice, instantiates the recalcitrance not only of nature but of technology as well. Fuel cells embody the promise of an eco-friendly hydrogen economy capable of overcoming the finitude of a world with limited and depleted resources. They show that not every object can be turned into affordances.

The objects displayed in the second set of papers – 'arenas of contestation' – raise the issue of the interplay between political and economic values and scientific norms. Jens Soentgen's *longue durée* history of a controversial chemical substance known as heroin exhibits the tensions between the scientific and the legal control of this drug, and calls attention to the struggle between gaining and losing control.

The story of the outage of Sony PlayStation®Network (PSN) told by Colin Milburn questions the distinction between experts and amateurs – hackers – as well as between the individual and the collective. The PSN is simultaneously a technical assemblage, an experimental platform and an affective space of pleasure and devotion for eighty million players. As a corporate mechanism that redistributes fun as well as capital, knowledge as well as risk, the PSN presents itself as a 'quasi-object' that brings into existence a new way of 'technogenic' life.

Writing the biography of a mysterious disease affecting a young boy, Simone van den Burgh explores the precarious instability of a disorder as it is negotiated between the patient's family, health professionals and medical technosciences. She moves from the patient's family to the physician's cabinet to emphasize the changing identity of the disorder and she argues that this shifting meaning deserves attention in translational medicine.

Kevin Elliot's story of swamps reconceptualized as wetlands draws attention to the combination of traditional 'scientific' values with 'social' values. Environmental science interferes with conservation and regulatory policy in the design of an object, which also blurs the boundary between naturally grown and artificially designed pieces of nature.
Hugh Lacey's genetically modified seeds illustrate the same elusive boundary between nature and artifice. While GM crops exemplify the potentials and the powers of technoscientific objects, they also emphasize the complex environments they require as well as the problematic character of their impacts on nature and society.
The chapters gathered in this group strongly suggest that technoscientific objects cannot be grasped through laboratory inquiry alone because they reconfigure the social fabric. This is particularly clear in the case of the mundane cardboard boxes presented by Cheryce von Xylander, which have been a key factor in reframing our ways of mass consumption in the twentieth century. She argues that cardboard as a material has deeply changed the function of paper in culture with the shift from a literacy of signs toward a literacy of things.

The objects assembled in the third batch of chapters – 'multiple temporalities' – raise the issue of the persistence of the ephemeral, an issue that might yet become a central concern for a philosophy of technoscience. Following the traces and footprints of carbon, Sacha Loeve and Bernadette Bensaude-Vincent explore the multiple modes of existence of this common object in a tentative 'ontography'. Carbon has displayed so many profiles over the course of the centuries that it seems to create various '*personae*' that move with a momentum of their own and weave amongst a wide spectrum of timescales and timescapes.
The story of ice-core drilling told by Aant Elzinga also displays a wide range of temporalities in the context of climate research. The compressed snowflakes and air bubbles of each individual ice core literally encase its temporal states. It needs to be disclosed by bringing the durable international standards international standards of measurement and data collection to its ephemeral physical condition.
Recounted in a different tone, Jennifer Gabrys's geo-mythological narrative about the Great Pacific Garbage Patch is also a story of inextricable entanglements of actors and timescales. Whereas the ice cores originally have a solid aggregate state, the garbage patch, a floating soup of small and medium sized debris, is fluid with no firm or permanent boundary. A crucial question raised here is how to discern and identify such a radically plastic object, how to monitor its becoming.
An even more intractable polychronic and technopolitical object is nuclear waste. Sophie Poirot-Delpech portrays a 'monster', a thing that is neither natural nor technological (a product of human industry and a source of artificial nuclei) since it has no function and no potential use. With its period of decay exceeding the limits of human experience and intellectual imagination, it raises anxieties about the future and doubts about recent technological choices. The ontology of nuclear waste radically questions the limits of technoscientific power to remake the world.
Astrid Schwarz's artificial heap sand is the drama of an emerging ecosystem featuring the malleability of nature. The artificial water catchment 'Chicken Creek' was designed in order to study the initial states of natural systems. It works both as a *real world simulation* in that it simulates the dynamic properties of the genesis of ecosystems and simultaneously as a real-world system that embodies them in real time. This research object gathers together theories, skills, and interests and, in doing so, affords the proof of concept of the relation between the epistemic and the ontological: theories and concepts *about* things are inevitably linked with a theory *of* things.

In medias res

The papers gathered together in this volume were conceived and discussed in the context of the project *Biographies of Technoscientific Objects* funded by the German and French Research Councils (ANR-09-FASHS-036-01 / DFG NO 492/5-1). The 'GOTO project' (as it has come to be known[xviii]) has fostered a dialogue between the French and German philosophical thinkers who begin *in medias res*.
Whereas classical scientists step back and view the facts from a distance in order to construct an image of the world, technoscientific researchers behold their objects from the midst of things by participating in the natural, technical, and social processes that make these things salient in their world. These objects of research are prototypes for the furniture of a world populated by things that gather within themselves not only found and processed materials or products of human crafts, not only the values of an experimental society but also the knowledge and power acquired by humans in the history of science and technology.
This characterization resonates with Heidegger's view of things as they appear beyond modern metaphysics and modern science and beyond the Cartesian subject that pictures a world of objects. Heidegger's is one of many philosophical avenues, however, towards an understanding of technoscientific objects, their attractive and quotidian mode of existence and their particular ontology irrespective of the distinction between the natural and artificial.
Simondon's philosophy of technology with its notion of concrete objects offers another avenue. It also begins *in medias res*, as it strongly rejects the abstract notions of technical objects as the materialization of a design project or as means towards an end. Whether natural or artificial, objects become concrete when they display functions that integrate the environment where they operate and turn it into the object's 'associated milieu'. Simondon considers technical objects not as static things, definable by their here and now. He describes them in terms of individuation as a process, a sequence of stages that makes up an interesting story rather than a stable entity.
Finally, a qualified extension of Gaston Bachelard's conception of metachemistry[xix] replaces the Kantian question as to the preconditions for the possibility of true representations by attempting to identify the preconditions for the possibility of knowing through making. This allows us to consider the attractive objects of technoscience as objects of a peculiar kind of knowledge.[xx]
From the midst of things in the world, of concrete objects known through the making of them, objectivity is the agreement among objects and not the agreement of subjects. From the midst of things, limits of knowledge and limits of technical control are not discernible but can only be probed by running up against and perhaps transgressing them. They are therefore not absolute or even – in the Kantian, transcendental sense – constitutive, but appear only as erstwhile failures to surmount them. And from the midst of things, it is a challenge to gain critical distance on attractive objects and the peculiar social or economic values that make them so attractive. It means that grand historical narratives, ambitious social and political agendas are not in sight, but that there are many revealing stories to be told and philosophical issues addressed within the midst of things. As we come to terms with the specific relations between people and things in our contemporary world, we hope that this book will stimulate further revelations about the unsettling attractiveness of objects.

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[xiv] J. J. Gibson, *The Ecological Approach to Visual Perception* (Boston, MA: Houghton Mifflin, 1979).
[xv] Hylomorphism means 'something = matter + form'. For a critics of hylomorphic dualism in technology as well as in ontology, see G. Simondon, *Du mode d'existence des objets techniques*, 1958 (Paris: Aubier, 1989), translation in progress: https://www.academia.edu/4184556/Gilbert_Simondon_On_the_Mode_of_Existence_of_Technical_Objects.
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[xvi] B. Bensaude Vincent, *Eloge du mixte. Matériaux nouveaux et philosophie ancienne* (Paris : Hachette Littératures, 1998). 'The Concept of Materials in Historical Perspective', *NTM Zeitschrift für Geschichte der Wissenschaften, Technik und Medizin*, 19:1 (2011), pp. 107–23.
[xvii] It is not just a matter of re-scription or of co-construction of users and technology. See M. Akrich, 'The de-scription of technical objects', *in* W. Bijker and J. Law (eds.), *Shaping Technology/Building Society. Studies in Sociotechnical Change* (Cambridge, Ma.: MIT Press, 1992) pp. 205–24. N. Oudshoorn, T. Pinch, *How Users Matter. The Co-construction of Users and Technologies.* (Cambridge Mass.: The MIT Press, 2003).
[xviii] See our collaborative paper : "Matters of Interest: The Objects of Research in Science and Technoscience", *Journal for General Philosophy of Science*, 42:2 (2011), pp. 365-383.
[xix] G. Bachelard, *The Philosophy of No: A Philosophy of the Scientific Mind* (New York: Orion Press, 1968), on p. 45.
[xx] A. Nordmann, 'Metachemistry', in J-P. Llored (ed), *The Philosophy of Chemistry: Practices, Methodologies, and Concepts* (Newcastle: Cambridge Scholars 2013), pp. 725–43.