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DARMSTADT

Another Parting of the Ways:
Intersubjectivity and the Objectivity of Science

Alfred Nordmann

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ABSTRACT

Michael Friedman defines the scientific enterprise as an ongoing project with a dynamics of reason that persists through scientific revolutions: The coherence and continuity of science owes to a communicative rationality that is operative at all times. It assures us of our shared objective world by transforming subjective points of view into intersubjectively binding agreements. Though it takes a very broad approach epistemologically, this conception of science may yet be too narrow in respect to notions of objectivity. It excludes a prominent mode of knowledge production that might be called technoscientific. This exclusion becomes particularly evident in Friedman's discussion of Heidegger as a critic of Cassirer and Carnap and as a critic of objectivity as "universal validity" of scientific propositions. If one tends to Heidegger's own account of objectivity, one encounters a non-propositional notion of truth. Science is seen as a technology that brings forth phenomena and processes. Accordingly, even where modern physics appears to be concerned primarily with the formulation of theories and the testing of hypotheses, it uses mathematical and representational techniques to conceive and create the modern world. And more powerfully than intersubjective agreement, technologies assure us of the unity and objectivity of our simultaneously social as well as natural world. – There may be good reasons to hold fast to the close affiliation of communicative rationality, science, and enlightenment. However, to the extent that it turns a blind eye to technoscientific knowledge production and the technological character of science, a philosophy of technoscience needs to develop an alternative perspective on questions of objectivity, explanation, inference, or validation.

I. Background: History of Science and the Dynamics of Reason

In a 1957-essay on the "Aim of Science," Karl Popper considers what he calls the problem of depth in the discontinuous development of science. According to Popper, in the succession of theories, the new and more satisfactory ones explain the success of earlier theories while correcting them. His examples for this are taken from the history of physics, especially from Newton's theory explaining and correcting those of Galileo and Kepler, and from Einstein's theory explaining and correcting classical mechanics. The successor theory is "deeper" not because it entails the successor theory and thereby explains its success – for in that case, it would not be offering a genuine correction. Instead, though its conceptual structure differs markedly from the precursor theories, the new structure is deeper because it provides the means for grasping how the old structure worked and what it was doing. This increase of reflective depth establishes an asymmetry between successor and precursors theories – it is the reason why one can see the older theories only retrospectively as limiting cases of the new ones, and inversely, the new ones never as generalizations of the old ones (Popper, 1979, pp. 197-203).

Several years before Thomas Kuhn's *Structure of Scientific Revolutions*, Popper thus offered a notion of continuity in the face of discontinuity. The search for ever more satisfactory theories is not just straightforwardly a gain in explanatory power but allows for retrospective evaluations of what came before: Along with its explanation of phenomena it provides an implicit account of the advancement of knowledge and of what makes the current theory superior to those that came before.

At first sight Popper's proposal appears very much like Michael Friedman's in *The Dynamics of Reason*. Friedman also suggests that a reconstruction of the conceptual development of successive scientific theories can show how previous theories are limiting cases of current scientific understanding (Friedman, 2001, p. 63). Popper and Friedman thus agree that the discontinuities, ruptures, or paradigm shifts within the theoretical development of the sciences do not disrupt the overall dynamics of reason that characterize the scientific enterprise: Scientific revolutions do not detract from the overall pursuit of satisfactory explanations as the aim of science. Hans Blumenberg speaks here of a "movement of knowledge" that persists without rupture through scientific revolutions and their paradigm-shifts (Blumenberg, 1976, p. 16).[1]

[1] Blumenberg characterizes paradigm shifts as "a surrender of basic assumptions and the introduction of new elementary suppositions, which get rid of a desperate situation but do not necessarily rupture the identity of the movement of knowledge that had culminated in that situation" – "der Prozeß der Erkenntnis selbst [erzwingt] die Preisgabe seiner Voraussetzungen und die Einführung neuer elementarer Annahmen, die den ausweglosen Zustand zwar beheben, nicht aber die Identität der in ihm aufgelaufenen Gesamtbewegung zu zerbrechen zwingen" (Blumenberg, 1976, p. 16).

It was the intervention of Thomas Kuhn, of course, that separates Karl Popper and Michael Friedman. Kuhn's work dramatizes the difficulty of maintaining the unity and continuity of the scientific enterprise when it is conceived as the search for more and more satisfying explanations of an enduring substrate of natural phenomena. Indeed, Kuhn makes it impossible to speak of "science" in the singular by suggesting that there are as many special sciences as there are paradigms that enable normal-scientific research activities. In light of Kuhn's challenge, Popper's proposal appears a bit simple-minded, indeed circular. On his account, the increasing depth of successive theories results automatically from methodological requirements that are met by all sciences at all times and that vouchsafe a unified conception of science, namely the requirements of falsifiability, simplicity and empirical content: "The 'depth' of a scientific theory seems to be most closely related to its simplicity and so to the wealth of its contents" (1997, p. 197). The circularity arises because, on the one hand, it is a sufficient condition for greater depth that successor theories correct and explain their precursors, while on the other hand, "explanation" is defined as providing greater depth: "the properties described by an explanatory theory must be, in some sense or other, deeper than those to be explained" – where deeper properties are the more general structural or relational properties which are the subject of more easily falsifiable statements (1997, 197, 203).

In light of Popper's and then Kuhn's challenge to the continuous and cumulative growth of scientific knowledge, Friedman approaches the task of reconstructing an overarching dynamics of reason in a far more subtle manner. Friedman builds on a criticism of Kuhn's attempt to salvage science as a rational and progressive process and this criticism equally applies to Popper. And yet, Friedman's far more subtle approach is also haunted by circularity. His proposal of a progressive conceptual development through the succession of theories also results automatically from his conception of the aims of science. This circularity is not vicious, but it insulates Friedman's account of science, narrowing it in respect to alternative notions of objectivity and in respect to a mode of knowledge-production that might be termed technoscientific. This will be shown in the following pages, beginning with the manner in which Friedman's *Dynamics of Reason* involves a circular conception of science as developing progressively and therefore exhibiting a dynamic progression of reason.

Friedman introduces his view of the dynamics of reason as an improvement upon Thomas Kuhn's own attempt to show how an overarching movement of knowledge might persist even through scientific revolutions (Kuhn 1993, pp. 338-339). Without invoking a notion of depth, Kuhn suggests that paradigm-shifts lead to simpler accounts with greater scope. By way of criticism, Friedman points out that any such operational criterion must fall short if we are to take Kuhn's paradigm shifts seriously:

> In the first place, there are powerful reasons from Kuhn's own historiography for doubting whether any such puzzle-solving criteria are really permanent across revolutionary scientific change. […] In the second place, even if we admit that there are constant or permanent criteria or values definitive of scientific success, it remains entirely obscure how there can be an 'uncommitted' or paradigm-independent standpoint for rationally assessing the satisfaction of such criteria. […] Finally, and in the third place […] it is surely uncontroversial that the scientific enterprise as a whole has in fact become an ever more efficient instrument for puzzle-solving in this sense – for maximizing quantitative access, precision, simplicity, and so on in adjusting theoretical predictions to phenomenological results of measurement. What is controversial, rather, is the further idea that the scientific enterprise thereby counts as a privileged model or exemplar of rational knowledge […] (Friedman, 2001, pp. 51-53)

If a clash of paradigms involves different conceptions of science and different standards for the evaluation of theories, these differences cannot be negotiated by a purely instrumental view of science in terms of falsifiability, empirical content, or simplicity. Instead, one needs to mobilize an idea of rationality that goes beyond "instrumental reason" by reflecting upon the very conditions under which the scientific movement of knowledge can proceed in light of competing frameworks of rational practice. In a rather different way than Popper, then, Friedman appeals to depth – here it consists in the philosophical examination of the common ground upon which one might maintain a unified notion of science.

> The inadequacy of Kuhn's response rests, in the end, on a failure clearly to distinguish between two very different aspects of human rationality. Following terminology introduced by Jürgen Habermas, I will call the first instrumental rationality and the second, communicative rationality:[2] "[…] This concept of communicative rationality carries connotations that ultimately trace back to the central experience of the non-coercively uniting, consensus creating power of argumentative speech, in which different participants overcome their initially subjective points of view, and, thanks to the commonality of reasonably motivated convictions, assure themselves simultaneously of the unity of the objective world and the intersubjectivity of their context of life." (Friedman, 2001, pp. 53-54, quoting Habermas, 1984, p. 10) [3]

In order to reconstruct the scientific enterprise as a unified and coherent project with a dynamics of reason that persists through scientific revolutions, one therefore needs to reconstruct the efforts of communicative rationality to continuously assure us of our shared objective world by transforming subjective points of view into an intersubjectively binding agreement. This is underscored by Habermas in a passage strongly reminiscent of Peirce:

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[2] It is this point that can also be applied to Popper's proposal.

[3] Friedman provided his own translation.

> The world gains objectivity only through counting as one and the same world for a community of speaking and acting subjects. The abstract concept of the world is a necessary condition if communicatively acting subjects are to reach understanding among themselves about what takes place in the world or is to be effected in it. Through this communicative practice they assure themselves at the same time of their common life-relations, and an intersubjectively shared lifeworld. (Habermas, 1984, p. 12; regarding Peirce compare Nordmann 2009)

Mary Domski and Michael Dickson have taken up Friedman's proposal by turning it into a manifesto for the integration of philosophy and history of science (Domski and Dickson 2010, see ch. III of Friedman 2001). What Popper calls "depth" cannot be had without realizing that the scientific enterprise is always also a philosophical enterprise, and vice versa. To reconstruct the discontinuous progression from one conceptual framework to another requires a history of concepts and how they are taken up by communicative rationality in various constructions of a shared world. This is a history of how concepts serve to schematize, take up, and process empirical data and how they enable particular ways of doing science. Such a history of concepts is also a history of the ways in which concepts set limits of knowledge and a history of the dynamics by which new conceptual frameworks enable new experiences. Philosophical reflection or communicative rationality focuses on precisely this transcendental or enabling character of concepts, and it is a philosophical history of concepts, therefore, that can elucidate from within our present space of conceptual possibilities how some earlier theoretical frameworks can be seen as a limiting case of our current best understanding.

It is readily apparent that Friedman's deeper notion of depth is also haunted by circularity in respect to a preconceived aim of science. It is the aim of science "to assure ourselves of the unity of the objective world and the intersubjectivity of our context of life," and it is therefore that the underlying continuity of science will be found in the philosophical reconstructions of just those conceptual means by which assurance of the objective world and of intersubjective contexts of life are attained: A philosophical history of the development of concepts is found to be fitting to science conceived as a philosophical endeavor.[4] The Dynamics of Reason therefore succeeds at providing a vantage-point from which to reconstruct the history of science while preserving the identity of its movement of knowledge – Friedman's dynamics unites the various ways of pursuing a single project, namely that of assuring ourselves of the world by means of concepts. Accordingly, the

[4] Of course, to assure ourselves of the unity of the objective world does not require a unified theory of everything. The piecemeal work of science helps provide this assurance simply by establishing the regularity, constancy, or lawfulness of certain portions of the world. By the same token, however, when science arrives at two fundamental theories that resist unification, this is viewed as a problem, perhaps scandal – a momentous piece of unfinished business! Also, the natural sciences assure us of the intersubjectivity of our context of life primarily by way of being a model community in which intersubjective agreement is legitimate and binding.

unifying vantage point is epistemology or the history and theory of knowledge.[5] This is not a vicious circle. If this is what science is – and why not define it most broadly along those lines? – the philosophical reconstruction of the history of concepts as enablers of scientific experience may well make for the most cogent integration of philosophy and history of science.

However, as soon as one grants this to Friedman, Domski and Dickson, a whole new set of questions opens up: What if there were research activities that do not aim to further intellectual understanding, to correctly represent the phenomena, to enable new experience through conceptual innovation and theory development, or to assure us of the unity of the objective world? And what if this, apparently "non-scientific" research was so predominant that the ongoing "scientific" practices of representation and explanation appeared side-lined? And what, finally, if this other kind of research also offered a vantage point from which to view the history of the sciences as a whole and marked only by incidental discontinuities?

II. Philosophy of Technology meets History of Science

These questions will strike most philosophers of science as odd, perhaps sacrilegious. In a sense, what they allude to cannot be, since science and the philosophy of science are defined and circularly confined by the assumption of a persistent movement of knowledge that seeks to offer assurance of the objective world or mind-independent reality. Only against the background of this assumption, after all, did Kuhn's claims of discontinuity become a matter of such great urgency and of needing to recover a unifying perspective. If our predicament as human beings is that of orienting ourselves and of requiring intersubjective assurance that we share a theoretical understanding of the world, this desire for orientation will be fueled and not abandoned in the face of falsifications, revolutions, or paradigm-shifts. Inversely, if there were a kind of research that does not seek to provide concepts and representations for the purposes of orientation, and that does not aim for intersubjective agreement on explanatory propositions, this could and would not be science at all.

From the perspective of the philosophy of technology, however, it is not at all obvious that we need such a scientific enterprise to assure us of the objectivity of a shared world. Accordingly, it is not obvious that this is what the scientific enterprise is all about. Of course, if we imagine a brute and unmediated encounter between the human mind and a bewildering array of sense data, there is an undeniable need for orientation, representation, and an assurance of agreement between mind and world. Historically speaking, this conception of our intellectual predicament posits a subject

[5] One might ask here how close Friedman's project is to "historical epistemology" as conceived by Gaston Bachelard, Michel Foucault, or Ian Hacking.

that stands naked just beyond the gates of paradise and has yet to embark on the arduous intellectual journey of developing theoretical knowledge and scientific understanding.

However, several thousand years into the scientific enterprise, the claim appears odd that people depend on science or philosophy or both "to assure themselves simultaneously of the unity of the objective world and the intersubjectivity of their context of life." Technologies provide this assurance along with rules and regulations, building codes and industrial norms, protocols and routines and, in general, the need to adapt to the technical modalities that make our world work: A technologically unified objective world demands conformity to it. Of course, a great deal of scientific and technical knowledge has gone into this physical construction of our intersubjective context of life, and some of this knowledge may have been generated primarily in order to make sense of an otherwise incongruous world of appearances. But where philosophers of science consider the unending quest to ascertain agreement between mind and world, between theory and reality, philosophers of technology question the very idea that there are two distinct ontological realms – thought and physical reality – that somehow require to be bridged. For them, philosophy begins with human involvement in the world and thus with a practical coordination among humans and their environments – coordinations that most often are not preceded by accurate theoretical representations.[6] Accordingly, philosophers of technology seek to understand how human experience is conditioned by technology and by the technologically organized lifeworld or context of life.[7]

These projects by philosophers of science and of technology are not mutually exclusive but they do qualify and relativize each other. Their contrast draws attention not only to so-called technoscientific research that seeks predominantly to acquire and demonstrate control of phenomena, but also to the fact that for many contemporary scientists their assurance of a shared objective world derives from their apparatus rather than from external validation through hypothesis-testing.

This is not the place to make the case for "technoscience" as a category complementary to "science" (compare Nordmann 2010). A thumbnail sketch must do: Theoretical physics or evolutionary biology serve as ideal examples of science as defined by Habermas or Friedman. Here, a scientific community comes together in a deliberative manner, proposes hypotheses and seeks to

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[6] Confronted with an early version of the present critique at a December 2006 workshop "The Philosophy of Michael Friedman" in Copenhagen, Michael Friedman chose to accept the advice to take technology more seriously – by providing a brilliant improvised analysis of the calendar as a technology (see Friedman 2010). It is telling, of course, that he would choose a technology that is essentially representational and whose working depends on the accuracy of the representation that is validated in much the same way as are scientific theories.

[7] There are many philosophers and philosophies of technology just as there many philosophies of science. But it is fairly safe to say that philosophers of technology generally hold this view – just as it is fairly safe to say that philosophers of science are generally concerned about the relation of theory and reality as a, perhaps the central concern of the sciences.

validate them by developing appropriate evidence. Pharmacy, the engineering sciences, or nanotechnology are idealized exemplars of technoscience. Here, the laboratory is a site for the development of capabilities to master complexity. Theory is drawn upon and developed just to the extent that it helps stabilize these capabilities in vivo, in vitro, in silico, and, in conceptu. It is an open question for the philosophy of (techno)science whether objectivity consists in intersubjective agreement on theoretical propositions or whether it somehow derives from the technological infrastructure that supports the new capability (compare e.g. Chang 2004).

Indeed, it is worth considering to what extent also the most "theoretical" and explanatory sciences have been transformed by research technologies. For example, physical explanation frequently consists in the ability to model phenomena with the available theoretical tools even where the resulting explanatory model is intellectually intractable. The claim that something is an adequate or true explanation becomes absorbed in the broader claim that the phenomenon or process can be retrodicted or predicted by such a model (Johnson and Lenhard forthcoming). To be sure, on certain positivist conceptions of explanation, the identification of a true explanatory proposition was always thought to be an impossible task. However, this positivist claim was emphatically motivated by a critique of metaphysics and the desire to offer a radical alternative to scientific realism. In contrast, under technoscientific conditions, the difference between "what works" and "what is true" is systematically neglected because the reliable performance of technology is as good, if not better an index of truth than any inference from evidence that indicates an agreement of theory and reality. Thus, if a dreamed-up theory can be used to explain something, it is philosophically important to ask whether this is sufficient to make it a true explanation. But if a technical device like a computer can reliably simulate a phenomenon, its physical performance makes it superior to any dreamed-up theory and it is a moot point whether the simulation offers a true explanation or not. Indeed, this can be the case even where fictional entities or algorithms from dreamed-up theories are incorporated into the simulation (Batterman 2005, Winsberg 2006). To be sure, this notion of "internal technological validation" in the place of "external evidentiary validation" requires a philosophical reconstruction in its own right (Chang 2004, Tal 2010). The very question regarding these different kinds of validation cannot be posed, however, as long as science is understood as a project to secure intersubjective assurance of the objective world and as long as objective validity is thought to arise from agreement about the truth or empirical adequacy of propositions.[8]

[8] Note that this not to say that traditional philosophy of science is committed to realism but only that it revolves around the question of how to construe the relation of theory and reality – with the attendant disputes between various brands of realism, instrumentalism, constructivism.

III. Friedman's Heidegger – objectivity as intersubjectivity

In the Dynamics of Reason, Friedman develops his conception of science and of a philosophical reconstruction of the history of science as an answer to the questions raised by Thomas Kuhn's Structure of Scientific Revolutions. In Parting of the Ways he offers, albeit implicitly, another context for his account of the dynamics of reason. Here, the account represents a third way between Carnap's proposal and Heidegger's critique of this proposal. The need for such a third way appears at the beginning and at the end of Friedman's book where he speaks of the real point of disagreement between Carnap and Heidegger as lying "in the circumstance that Heidegger denies while Carnap affirms the centrality of logic and the exact sciences." Accordingly, if one fails to "make good on the idea of an underlying unity for the totality of symbolic forms"

> we are finally left (in the present space of intellectual possibilities, of course) with the fundamental philosophical dilemma presented by Carnap and Heidegger after all. We can either, with Carnap, hold fast to formal logic as the ideal of universal validity and confine ourselves, accordingly, to the philosophy of mathematical exact sciences, or we can, with Heidegger, cut ourselves from logic and "exact thinking" generally, with the result that we ultimately renounce the ideal of truly universal validity itself. (Friedman 2000, pp. 12, 156)[9]

It is perfectly plausible to assume that Friedman's philosophical history of the dynamics of reason can fill this gap and expand the presently available space of intellectual possibilities by displaying not only the unity of science over time but also the unity between the mathematically exact and the non-mathematical sciences, including the Geisteswissenschaften (humanities). However, by positioning this search for the unity of science between Carnap's proposal and Heidegger's critique, Friedman again encapsulates his conception of science within the sphere of communicative rationality and of objectivity as resulting from intersubjective agreement. This becomes strikingly apparent from his neglect to look beyond the renunciation of "universal validity" to Heidegger's alternative understanding of scientific objectivity or truth. Following Friedman into the forbidding territory of Heidegger's thought, one might encounter his treatment of modern mathematical science as applied technology along with his view that technology is productive of truth, including scientific truth.[10]

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[9] Friedman here refers to Cassirer's failed effort to show the unity of all symbolic forms. *Parting of the Ways* concludes, however, with the urgent recommendation that Cassirer's work and Cassirer's ambitions should be taken up by contemporary philosophers of science (Friedman 2000, 159).

[10] It is not at all necessary to refer to Heidegger for the purposes of a philosophy of technoscience, for non-propositional or non-representational accounts of objectivity or truth, or for appreciating the technological setting – materially and intellectually – of contemporary research. It is entirely due to Friedman's telling neglect of Heidegger's theory of research that he becomes so prominent in this paper.

Friedman's generally careful and sensitive reconstruction of Heidegger's "breathtakingly original exploration of the spiritual and philosophical predicament of the early twentieth century" fails to engage Heidegger's own project when he identifies as the "weakness in Heidegger's thinking" that he takes early 20th century revolutions in the foundations of mathematics and mathematical physics as devoid of genuine philosophical significance (Friedman 2000, p. 151). Indeed, Heidegger denies the philosophical centrality of logic and the exact sciences insofar as, for him, "logical forms of thought […] can have no philosophical explanatory value whatsoever" (Friedman 2000, p. 150). This is so, however, because logic and the exact sciences are philosophically central to Heidegger as explananda in his interpretation of Kant and in his critique of the modern age. Furthermore, in his explanation of these explananda the development of modern science plays a central role in two respects – regarding its grounding in the experience of handling things (Arbeitserfahrung) and its conception of being (Seinsentwurf) that juxtaposes subject and object in a particular way.[11]

In his 1935/36 lectures on the fundamental questions of metaphysics, Heidegger frames this explanatory project in a way that appears to be addressed to the philosophical approach of the Vienna Circle. Noting that it seems quite natural to treat the nature of the thing, of the proposition, and of truth as being interdependent, he wants to know how we came to view these as interdependent. The thing is conceived as a carrier of properties, the proposition as predication (e.g., of properties to a thing), and it is only propositions that can be true or false, depending on whether they correctly predicate properties to things – or depending on whether they offer a correct representation (both in the sense of Vorstellung and Darstellung). Heidegger wishes to question the origin of this representational conception of truth:

> We ask: is it a mere accident that the determination of the nature of the thing *and* the determination of the nature of the proposition *and* the determination of the nature of truth occur simultaneously, or are all of these connected among each other and perhaps necessarily so? And if this is so, *how* are they connected? (Heidegger 1984, p. 44, cf. 1967, p. 45)[12]

According to Heidegger, this question identifies the explanandum of Kant's as well as his own philosophy. Things appear in experience and in a propositional judgment in such a way that agreement on the proposition amounts to the determination of the thing. If one wants to understand

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[11] For his claim that modern science is grounded in a particular ***Arbeitserfahrung*** and ***Seinsentwurf***, see Heidegger 1984 and 1967, p. 66.

[12] One might object here that the passage makes Friedman's point: If he had paid proper attention to the development of quantum mechanics, Heidegger should have qualified his seemingly simplistic reference to things having properties in the understanding of scientific truth. However, Heidegger's references to the life-sciences and to modern technology suggest an answer to this objection (1984, pp. 39f. and 50, cf. 1967, pp. 40f. and 51f.): We try to extend this conception of propositional truth as agreement with facts about things even to domains where it does not fit. And this is borne out not only by (ongoing) philosophical disputes about the interpretation of quantum mechanics, but also, for example, by the influence on the philosophy of Carnap and the Vienna Circle of Wittgenstein's ***Tractatus*** and the idea that the meaning of a proposition consists in its truth-conditions.

this construction, the seemingly natural connection between "universal validity" and intersubjective agreement needs to be questioned, as well. It is primarily this first step that is reconstructed in Friedman's Parting of the Ways which considers the 1929 discussions of Heidegger and Cassirer in Davos and focuses especially on Rudolf Carnap's presence in the audience. For Heidegger's critique of "universal validity" Carnap provides the most formidable target in that he reconstructs science as a system of propositions – a reconstruction that conforms precisely to Heidegger's claim that modern science seeks to secure in thought and thus render certain as intersubjectively valid the appearance of things. Accordingly, Friedman arrives at the uncomfortable alternative between Heidegger's outright rejection of objectivity as universal validity and Carnap's all too narrow logicist articulation of this kind of objectivity.

The starkness of this alternative became particularly apparent when, a few years after the Davos discussions, Carnap wrote an essay on "overcoming metaphysics" – a goal he shared with Heidegger who later wrote an essay with the same title. But it is the full title of Carnap's essay that sets them apart: "The Overcoming of Metaphysics by the Logical Analysis of Language" (Carnap 1959). In this essay, Carnap takes as his target an expression of Heidegger's and demonstrates that it does not stand up to logical analysis. Heidegger responded to this in a passage quoted by Friedman. In it, he designates Carnap as one who does not overcome metaphysics at all but simply furthers a particular metaphysical program, namely the one that so neatly identifies agreement on the truth of propositional predications with the determination of things by their properties. This scheme of mutual determinations helps to "secure thought" by shifting attention from the things to the thoughts about the things and whether in a system of propositions these thoughts can draw agreement and take on the character of, ideally, logical certainty. Truth, in Heidegger's idiom, is thus diverted into certainty:

> Here [i.e., with Carnap] the last consequences of a mode of thinking which began with Descartes are brought to a conclusion: a mode of thinking according to which truth is no longer disclosedness of what is and thus accommodation and grounding of Dasein [being-there] in the disclosing being, but truth is rather diverted into certainty – to the mere securing of thought, and in fact the securing of mathematical thought against all that is not thinkable by it. The conception of truth as the securing of thought led to the definitive profaning [Entgötterung] of the world. The supposed "philosophical" tendency of mathematical-physical positivism wishes to supply the grounding of this position. It is no accident that this kind of "philosophy" wishes to supply the foundation of modern physics, in which all relations to nature are in fact destroyed. (Heidegger 1983, pp. 227f. as quoted in Friedman 2000, p. 22)[13]

[13] It is frequently a question of translation whether Heidegger sounds more or less reasonable. In this case, for example, "desacralization" might be more palatable than "profaning." Also, we will see in the next section what Heidegger means when he claims that in modern physics all relations to nature are in fact destroyed. Even a charitable reading of this passage cannot ignore, however, that it resonates with a dark current of German thought that flows at least from romanticism to the attacks on "Jewish physics."

Heidegger's polemic against Carnap and the Vienna Circle juxtaposes two conceptions of truth – "disclosedness of what is" and "securing thought by giving it certainty." There is no explication here of what is meant by "disclosing what is," but apparently this is not a matter of disclosing something in thought or in a representation but in reality. Whether or not one finds it plausible even to speak of "truth" here, Heidegger's essays about technology help illuminate this peculiar employment of the term. Technology discloses what is by bringing forth what has not existed before (Heidegger 2000, pp 5-36). To the extent that scientific research reveals hitherto unobserved processes, phenomena, or effects, it proceeds technologically. Moreover, its experimental method, mathematical formalism and other representational techniques render nature as a whole subject to the technological exploitation of laws and regularities. In a sense, then, modern science is applied technology in that it presupposes a technological attitude. Along these lines, modern science discloses what it is when it is understood as applied technology. But this is not, according to Heidegger, how modern science understands itself or how it is understood by Carnap and the philosophy of science of his day. On their account, science secures thought and renders it certain [sichern] by putting it in the form of propositions that can be validated intersubjectively, either by finding it in agreement with what is actually given or by showing that it is entailed by certain other propositions, or both. The certainty of the truth results from the binding character of propositions to which everyone must subscribe who adopts a representational conception of truth and for whom the nature of things, the nature of propositions, and the nature of truth form an interdependent unity (cf. Heidegger 1962, §33 and Friedman 2000, pp. 56f.).

In other words, the notion of truth as propositions secured in definite logical and evidentiary relations to other propositions is only that apparently perfectly "natural" representational conception which is the *explanandum* in Heidegger's philosophical project[14]: Given that truth might also be the business of poetry and art, technology and craft, and given that it might encompass many different ways of disclosing reality, how did it happen that the question of truth was narrowed down to questions of representation, of agreement among propositions and agreement of theory and reality? And thus, Heidegger begins to answer his question by describing Carnap's mode of thinking as the last consequence of a metaphysical tradition that began with Descartes and that he later associated with the epoch of representation, that is, the modern era of world-views in which one makes pictures of the world ("*Das Zeitalter des Weltbilds*," Heidegger 1977, pp. 75-115).

[14] Again (see note 8 above) this is not to impute to philosophy of science a particular construal of thought ought to be secured. From Heidegger's lofty point of view, deductivist and semantic conceptions, empiricist and naturalist approaches are simply fighting over the best way to achieve the same goal.

To be sure and as Friedman points out, by viewing the diversion of truth into representational certainty as a kind of metaphysical fall from grace, Heidegger appears to be paying a high prize. The notions of certainty or validity signify, after all, that finite humans are capable of producing transfinite knowledge. This amounts to the capacity of casting their knowledge into a form that dissociates it from the special finite and contingent conditions of its production. Paul Feyerabend referred to this as the "separability assumption" (Feyerabend 1999, pp. 131-146). And once one inquires about the forms in which such detached or dissociated knowledge can be universally valid or eternally true, one arrives at logic and mathematics.[15]

By considering these forms not as conditioning truth but as a distorting a more general and perhaps original notion of truth, Heidegger opens himself to Cassirer's question whether, quoting Friedman, "he really wants to renounce such objectivity and to maintain instead that all truth is relative to Dasein [the concrete finite human being)]" (Friedman 2000, p. 2f., see also pp. 139, 144, 156).[16] Indeed, in the record of the Davos disputation Cassirer poses the question in just these terms:

> Does Heidegger want to renounce this entire objectivity [Objektivität], without this form of absoluteness [Absolutheit] that Kant has represented in the ethical [sphere], the theoretical [sphere], and in the Critique of Judgement? Does he wish to withdraw entirely to the finite being, or, if not, where for him is the breakthrough to that sphere? (Cassirer in Heidegger 1991, p. 278, quoted by Friedman 2000, 139)

Here, Cassirer associates the term objectivity with the transfinite, the absolute, the eternally valid.[17] When Heidegger responds to Cassirer, he takes up the problem of "eternally valid truths" and acknowledges the central problem of "getting beyond finitude" – but he does not associate with these the notions of objectivity or the absolute. After rejecting as insufficient the proposed standard of validity for "eternally valid truth," he also recognizes the central problem of how to move beyond finitude. He views this problem as the concern of Kant's transcendental philosophy: Finite human beings can conceive of themselves and their world in such a way that their world exists forever and is schematized mathematically such that knowledge of this world might also hold forever. This is what ontology is for. It creates the conditions under which finite beings can view

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[15] To be sure, contemporary Science Studies approaches might identify the forms that produce detachable knowledge also in archives, institutions, networks. Arguably, though, these function only because there is inscribed in them a logic of preserving and transmitting truth.

[16] This is not to suggest that Cassirer's conception of truth is as thin as that of the Vienna Circle logical empiricist, or of Lotze and other targets of Heidegger's criticism.

[17] To be sure, Cassirer's own account of the sources of object is rooted in his conception of symbolic forms and provides richer notions than Carnap's "exact thinking." This is one reason, to be sure, why Friedman recommends a return to Cassirer.

themselves as part of a uniform lawful nature. If however ontology is the requirement for finite beings to project themselves into a world that yields to human law-giving, this renders ontology itself an "index of finitude" (1991, p. 280). According to Heidegger, then, Kant's transcendental reconstruction makes transparent just how humans can and do project themselves into a space of reasons or a kingdom of ends or a republic of letters in which truth can be discovered in the course of an eternal conversation (Nordmann 1995). But rather than provide a firm grounding, Kant is said to show that this projection into an eternal space of reasons is a "metaphysics of metaphysics." It is a reconstruction of how we deceive ourselves, perhaps must deceive ourselves about our way of being in the world.[18] And the ultimate deception, of course, is the notion that Cassirer refuses to surrender, namely that as finite beings humans are nevertheless capable of transfinite knowledge. And indeed, Heidegger might add, this deception can be maintained, but only by seeking refuge in logic and mathematics and in an ontology that renders the whole of nature susceptible to mathematical treatment.

While Heidegger's account may appear sketchier than those of Kant or Cassirer, he does provide a comprehensive sketch of how and why transfinite knowledge is produced – and this is an attempt simultaneously to understand why it appears so natural to us that we know of things and their properties once we agree intersubjectively on the propositional representations of these things. And thus, contrary to Cassirer's and Friedman's suspicion, Heidegger appears to have no difficulty understanding what validity and certainty are and how we might obtain "eternally valid propositions" once we adopt and push to its last consequence a metaphysical mode of thinking.[19] He does not consider this metaphysical mode of thinking an absolute foundation that grounds the possibility of eternal truth. Rather, he understands it as a powerful stratagem to deny, perhaps overcome or transcend human finitude. Along similar lines, he does not believe that "objectivity" has been recovered when one acknowledges the unknowability of the things themselves and offers as a substitute the representation of their appearances in the framework of mathematical logic.

Notions of intersubjectivity and objectivity run through Friedman's *Parting of the Ways*, reflecting their difference in meaning.[20] In Friedman's quote from Cassirer (just above),

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[18] Charles Sanders Peirce and contemporary science studies, one might add here, are continuing this Kantian project, as conceived by Heidegger, when they pursue the question how we can contingently construct a world that is not a contingent and constructed world, how we construct a world that is made up of the eternal laws that apparently cause us to discover them (compare the discussion of Peirce in Friedman, 2001, and Nordmann, 2009).

[19] To be sure, Cassirer's suspicion is that Heidegger wishes to "renounce" this notion of eternal validity. This suspicion is justified only to the extent that Heidegger exposes the conceit of modern subjects to negate their finitude. By the same token, he also explains that for modern subjects in the Cartesian tradition the aspiration toward eternal validity cannot possibly be renounced.

[20] The following passage is of particular importance for Friedman's own proposal and his recommendation to look to Cassirer for a middle ground between Carnap and Heidegger: "whereas Carnap's ideal of truly universal intersubjective communicability is precisely that which is expressible in rigorous logical notation, Cassirer wants to extend it (also as a regulative ideal) to all the other symbolic forms as well" (Friedman 2000, p. 153).

"objectivity" refers to transfinite truth. The term "objectivity" is offered tentatively as a translation of Carnap's claim that philosophy's "*neue Sachlichkeit*" affords objective knowledge like any other science (Friedman 2000, p. 18). Also, the term refers to intersubjectivity (2000, pp. 56f., referring to Heidegger 1962, paragraph 33): Intersubjectivity is possible where there is no access to the object; it is a substitute notion that was advanced by a critical epistemology that finds itself cut off from the thing themselves and only knows things as they are given to subjectivity. And once, in contrast, Friedman uses "objectivity" to translate Heidegger's term *Gegenständlichkeit* – a term that designates a certain way of relating to the things, namely by way of opposing the subject and the object:

> The suspicion directed against "logic," whose conclusive degeneration may be seen in logistic [modern mathematical logic], arises from the knowledge of that thinking that finds its source in the truth of being, but not in the consideration of the objectivity [*Gegenständlichkeit*] of what is. Exact thinking is never the most rigorous thinking, if rigor receives its essence otherwise from the mode of strenousness with which knowledge always maintains the relation to what is essential in what is. Exact thinking ties itself down solely in calculation with what is and serves this [end] exclusively. (Heidegger 1996, p. 306, quoted in Friedman 2000, p. 13)

In this rather dense passage, the terms "calculation" and "exactitude" take the place of "validity" and "certainty." They pertain to propositions that refer to each other, including the propositions that describe what is. Such calculation stays on the plane of what is given to subjectivity, it involves only lateral movements as connections are forged among and between descriptive and theoretical statements, allowing them to become secured in a network of propositions. These calculations consider the "objectivity" [Gegenständlichkeit] of what appears to the observing and knowing subject. According to Heidegger, they do not consider the "truth of being" that is disclosed, for example, by technology or art, and they do not make the truly rigorous effort to maintain a relation to "what is essential in what is."

Formulations like these raise a skeptical question: Can such an invocation of the truth of being have any bearing for a philosophy of science that has come into its own by rejecting any such appeals? With this question we shift from thought and representation to making and building, from the subject-object dichotomy to the "worldliness" of things, from the self-understanding of modern science to technoscience, from Heidegger's book on *Kant and the Problem of Metaphysics* (1991) to his lectures on the fundamental questions of metaphysics that were published as *Question of the Thing: On Kant's Doctrine of Transcendental Principles* (1984) and his essay on "The Thing" (2000, pp. 165-187).

IV. The other Heidegger – technoscientific objectivity

When Heidegger complains about truth as mere intersubjective agreement and when he speaks instead of a "thinking that finds its source in the truth of being," this suggests that he rejects the idealism, conventionalism, or constructivism of Kant and the Neokantians and that he advances a more realist conception of truth.[21] However, this reading of Heidegger misses the point entirely, since the issue of realism vs. idealism or constructivism arises only when we debate whether there can be representations of a mind-independent reality. However, Heidegger is no realist in that he agrees with Kant regarding the non-representability of the things in themselves. Things must always be represented not as they are but only as they appear to us, that is, as objects of experience and objects of nature and thus in the framework of metaphysics (Heidegger 1984, pp. 130f.). Representations necessarily "leap over" the things and do not encounter them "in the truth of being." According to Heidegger, Kant himself reflected this predicament as opposed to the rather more naïve Neokantians of Heidegger's day (pp. 244-246). Not Kant himself, but only the Neokantians delude themselves that what they are engaged in is a theory of knowledge that is simultaneously a critique, if not rejection of metaphysics:

> 'Theory of knowledge' is the name for the increasingly constitutional incapacity of contemporary metaphysics to know its own nature and what it is grounded in. Any discussion of the ‚metaphysics of knowledge' is similarly misguided. In truth this is the metaphysics of the object (*Gegenstand*), that is, of being as object (*Gegenstand*), as object for a subject. (Heidegger 1983, p. 73)

When something is an object of knowledge for a subject, or when someone is the subject that represents an object, the opposition between subject and object relies on the metaphysical construction of the Cartesian modern subject. When Heidegger contemplates an encounter with the things "in the truth of being," he seeks to step outside this modern tradition. Paradigmatically, this encounter takes place not ONLY when things are brought forth in technology and art, but also in science when it is considered as "productive research" (*aufschließende Forschung*, Heidegger 1984, p. 67).[22] Indeed, Heidegger considered especially the most mathematized sciences like classical physics as technology. Though the best-known statements to this effect can be found in "The Question concerning Technology" (2000, pp. 5-36), the idea appears in earlier writings such as the

[21] Indeed, Friedman refers repeatedly to Heidegger's realism (e.g., 2000, pp. 53-55, 58-61).

[22] It is worth noting that here and elsewhere Heidegger foregrounds the notion of research (*Forschung*) rather than science or inquiry.

lectures on *Kant and The Question of the Thing*. Physics is not a matter of hypotheses and theories but of producing our modern world :

> It is said that modern technology is incomparable to any previous one because it relies on the exact natural science of the modern age. But in the meantime one has recognized more clearly that the inverse holds, too: as an experimental science, physics of the modern age depends on technical apparatus and the progress of instrument-making.
>
> Physics of the modern age is experimental physics not because it uses apparatus to question nature, but the other way around: because physics, considered even as pure theory, coaxes nature to present itself as a predictively calculable system of forces, the experiment is called upon to find out whether and how nature answers as it has been asked to present itself. […] Since the essence of modern technology consists in [this way of challenging or framing], it must employ this exact natural science. And this produces the deceptive appearance that technology is applied science. (Heidegger 2000, pp. 15, 22-24)
>
> We cannot adopt a popular line of thought by saying: What is being said about [Eddington's] scientific table number 2, about spiral nebulae and the dying sun, are just the views and theories of physics. The response to this is: This physics is at the bottom of our gigantic power plants, airplanes, telephone and television, and all of technology which has transformed the earth and humans beings more than they are aware of. These are realities, not views that are held by some sort of researchers that are "detached" from life. (Heidegger 1984, p. 13)

Rather than reject science's claim to universal validity, Heidegger suggests that technology and, by implication, science have more to offer than true propositions – by bringing forth things, science and technology are productive of truth, if by "truth" one means that something has been disclosed or brought to the light of day (2000, pp. 14f.). And rather than disparage science as "mere technology," Heidegger views the modern world as resulting from modern science, or more precisely, as resulting from a transformation of technology that implicated science. Technology was transformed from a poetic "bringing forth" of things, dwellings, and gifts to a demanding expectation that "challenges" all of nature to yield calculable behaviors which suit human purposes. The analogous transformation of science consisted in the transition from Aristotelian to Galilean and especially Newtonian science. Heidegger reflects on this transformation in order to characterize the starting point of Kant's *Critique of Pure Reason* that begins with the fact of Newtonian and decidedly not of Aristotelian science. Condensing 40 pages into one sentence, one might summarize Heidegger's point as follows: After everything had its own nature for Aristotle, there is only one all-encompassing nature for Newton – and the shift from one conception of nature to the next changes what it is that technology and science bring forth. In the modern world, science discloses nature as a "calculable system of effective forces [*berechenbarer Wirkungszusammenhang von Kräften*]," that is, as a resource for the realization of human purposes (2000, p. 27, see also 22):

> Nature is no longer that which determines manner of motion and the location of a body by way of its inner power. Nature is now the axiomatically designed realm of a homogeneous spatio-temporal context of motion, such that bodies can be bodies only by being inserted and bound up [verspannt] within it. (Heidegger 1984, p. 93, see also 89)

According to Heidegger, Kant reflects the tension between the non-representability of the things in themselves and the ways in which bodies can be bodies in a Newtonian conception of nature. Kant's transcendental reconstruction of Newtonian science should not be mistaken for a grounding or foundation or justification of Newtonian science but as a reconstruction that brings to light its metaphysics – as such complementary to the previously noted interpretation, according to which Kant's theory of experience does not so much serve to ground the possibility of truth but to clarify how human finitude is overcome. Accordingly Heidegger takes Kant's critical reconstruction as a preparatory step for his explanation of this metaphysics, including its conception of nature, confrontation of subject and object, and construal of objectivity as intersubjectivity. Newtonian science now appears part of a specifically modern technology with its recruitment of the whole of nature as a resource: It uses mathematics on the one hand, laboratory apparatus on the other to transform the world into a set of lawful relations that deliver predictable behaviors in a calculable manner.

Despite first appearances, therefore, Heidegger's critique of modern science is not that it is applied technology. All science is technological in that it brings forth, discloses, or makes available things, processes, or phenomena. Instead, Heidegger is critical of modern science disclosing a modern world in which nature is a calculable system of forces and in which objectivity is the agreement on propositions that describe this system. He arrives at an alternative conception of objectivity by comparing the different worlds that are brought forth by Aristotelian and Newtonian science. And though it does not to need to refer to Heidegger's analysis at all, a philosophy of technoscience can draw on this alternative conception when it considers those research practices that are not subordinate to the search primarily of true theories, propositions, or representations. Only a sketch of this can be suggested here.

According to Rom Harré (2003), the experimental production of a thing, process or phenomenon is the affordance of an apparatus/world complex. Heidegger characterizes this in a very similar way as a way of concentrating or gathering together bits and pieces of the world such that, taken together, they grant something (Heidegger 2000, 165-187). Whether natural or manufactured, things are concentrations of materials and of agency that allow other things and processes to take place. They are mundane or worldly in that they, literally, incorporate the world in themselves – the social

and natural world are invested in them. Heidegger here adopts Aristotle four-fold notion of causality when he says that things assemble or gather together matter, form, purpose, and agency. Moreover, this assemblage affords something, just as a pitcher affords, grants, or permits the storage and pouring of liquids. In other words, the gathering together (versammeln) of the four causes brings forth or discloses a thing that affords something (schenken).[23] This formulation can be adapted to the case of technoscience: The gathering together in the laboratory of theoretical knowledge, instruments, skills, and human purposes affords a process or a thing which serves as immediate evidence for the successful acquisition of the capability to produce this thing or to exhibit what it can do (Nordmann 2008 and forthcoming). Along these lines and without referring to Heidegger, Rom Harré has paired mundane examples with those from technoscientific laboratories:

> Generalizing the notion of affordance we can say that an apparatus/world complex can afford things. For instance, wheat, yeast, and a stove can afford loaves of bread. A lathe can afford chair legs, and a discharge tube can afford gamma rays.
> An apparatus/world complex can also afford activities. For instance, some rapids can afford whitewater rafting. A reamer can afford boring, and a chemistry laboratory can afford gravimetric analyses. (2003, p. 37)

This is not the place to detail the history and meaning of "affordance" as a technoscientific cousin to the scientific notion of "disposition" (Harré 2003, p. 37): Water has the disposition to form ice at a certain temperature, and it affords the quenching of thirst when it is drunk. Of the various similarities and differences between dispositions and affordances, two are especially relevant in regard to the question of objectivity: Whereas dispositions are latent properties that belong to the nature of a thing and that become manifest only if and when the proper conditions obtain, affordances are known features of human interactions with a thing. And whereas knowledge of dispositional properties requires validation of lawful or probabilistic relations between stimulus conditions and responses, affordances are exhibited and attain robustness through the technological criterion of simple functioning.[24]

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[23] This account relies primarily on Heidegger's 1950 essay "The Thing" (2000, pp. 165-187). However, In that essay and its discussion of a pitcher the thing is said to be worldly in that it gathers together heaven and earth, mortals and immortals. The discussion in the 1953 essay on the "Question concerning technology" is less obscure in its reference to Aristotle's four causes that are gathered together in the making of a silver chalice (2000, pp. 9-13).

[24] Compare Cartwright (1989) for an account of "nature's capacities" that do not require lawful regularity but attain salience, exhibit their efficacy and become visible in the technological setting e.g. of a double-blind experiment. Here, Cartwright moves away from a scientific perspective (regarding the agreement of theory and reality) to a technoscientific perspective (regarding the acquisition and demonstration of capabilities to control phenomena).

V. Conclusion – normative grounds

According to Paul Forman, it was virtually impossible until about 1980 to appreciate Heidegger's claim that science is applied technology. Forman shows that some of the most astute readers of Heidegger dismissed his claim as hyperbole that cannot be taken literally (Forman 2007, pp. 8-10). Only with the rising prominence of the technosciences and only with a cultural orientation that subordinates scientific research to technological development was it possible for Heidegger's project to gain traction – and with this rediscovery of Heidegger came the resurgence of the "thing" rather than the object, fact, or sense-datum as a unit of historical and philosophical analysis.[25]

In the preceding pages, a similar argument was made for Friedman's reception of Heidegger. He reads him without acknowledging even the possibility that the relation between science and technology could be inverted. As long as the common concern of science, epistemology, and philosophy of science is seen as "assuring us of the unity of the objective world" (Habermas) or as "securing objects of experience in thought" (modern epistemology as seen by Heidegger), the role of technology is only to serve as an aide or instrument in accomplishing that task. Heidegger is not only a critic of this conception of science but challenges us to consider an alternative view of the common concern of science, epistemology, and philosophy of technoscience. On this view, modern science brings forth things and along with them produces the modern world including its "gigantic power plants, airplanes, telephone and television, and all of technology which has transformed the earth and humans beings more than they are aware of" – it does so not as a by-product or application of theoretical knowledge but by employing conceptual tools that harness nature as a resource for such world-making.

However, one does not have to accept Heidegger's challenge and view all of science technologically. And quite possibly on normative grounds, Friedman does not. Instead, one can insist upon the cultural significance of the opposition between science and technoscience. As defined by Friedman (and Habermas), science should be conceived normatively in terms of communicative rationality and universal Enlightenment, and thus decidedly in contrast to instrumental reason and technology. The notion of technoscience lacks this normative dimension. It is defined as the acquisition and demonstration of conceptual and practical control of phenomena such that the science/technology distinction becomes irrelevant.

These different ways of valuing scientific research – valuing it as a search for critical understanding or as a strategy for experimental innovation – are hugely significant and would

[25] Compare the consideration of things by Davis Baird, Paul Rabinow, Hans-Jörg Rheinberger, Bruno Latour, Lorainne Daston, Bernadette Bensaude-Vincent, and others.

remain significant even if it were the case that all of modern science can be redescribed as technoscience (Nordmann 2010). To the extent that the philosophical tradition of Cassirer, Carnap, and Friedman values science for its non-coercively consensus-creating dynamics of reason, it cannot and ought not see Heidegger as a philosopher of science. This is all the more reason, however, to pursue a philosophy of technoscience that uncovers the inherent normativity of technoscientific research, its epistemic and technical values, rules of inference, and criteria of validation. Once we appreciate how differently these complementary analytic perspectives reconstruct even the same research activities, we can then debate the shift in recent decades of the cultural prestige accorded to the ideals of critical science and innovative technoscience, of communicative and instrumental rationality. And for this debate, Michael Friedman has provided an invaluable contribution by working out the intellectual unity of an idea of scientific knowledge that persists through a wide variety of disciplines and the succession of paradigms.

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Contact

Alfred Nordmann
Professor of Philosophy
Technische Universität Darmstadt

nordmann@phil.tu-darmstadt.de

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