World Academy of Science, Engineering and Technology
International Journal of Humanities and Social Sciences
Vol:16, No:11, 2022

The Pragmatist Basis of Material Hermeneutics

Juho Lindholm

***Abstract*—**Practical hermeneutics explores the emergence of meaning in scientific practice. Visual hermeneutics is its subclass which explores the emergence of meaning in instrumentally mediated interactions with scientific objects. There remains to be explained, upon what theory of meaning their discussions are based. Linguistic theories of meaning seem utterly inappropriate for the analysis of the non-linguistic meanings that such hermeneutics invoke. In this article, it will be shown by conceptual analysis that the so-called "pragmatic maxim" provides sufficient resources for the philosophical analysis of such meanings. The "pragmatic maxim" states that the meaning of a thing consists in the potential practical effects of that thing. Because this notion is not confined to language, it can be broadly applied to anything meaningful, including practices and the instruments which are part of practices.

***Keywords*—**Hermeneutics, philosophy of science, pragmatism, theory of meaning.

I. Introduction

TRADITIONALLY, hermeneutics has been associated with the interpretation of texts. It has been generalized to cover any linguistic performance. Thus, it has been natural to understand hermeneutics as a methodology of the human sciences.

Joseph Rouse has always emphasized the material and practical dimensions of the natural sciences. He has argued that practices are meaningful on their own right and this applies to the practices of the natural sciences as well. But such meaningfulness cannot easily be captured by linguistically-oriented hermeneutics. Thus, he has examined possibilities for a practical hermeneutics. [1]

Don Ihde has investigated instruments and technologies of science with a phenomenological point of view. He has envisaged a visual hermeneutics on the basis of already established scientific practices pertaining to visual technologies and imaging and visualization of data. Again, linguistic accounts of meaning seem to have trouble with images. [2]

But neither Rouse nor Ihde has explained, what it *is* that their expanded hermeneutics interpret. That is, they have not explained, what they mean by "interpretation" of "meanings."

In this article, it will be argued that the pragmatist theory of meaning, first propounded by Charles S. Peirce [3, §§2.92, 2.275, 5.18, 5.28, 5.196, 5.400-403, 5.425-427, 5.438, 5.453, 5.457, 5.465, 6.481], [4, pp. 131-133], [5, pp. 134, 135, 140, 145, 234, 235, 339-341, 346, 354, 356, 400, 401, 447, 448], captures non-linguistic meanings and thus provides the conceptual resources for the hermeneutics of both Rouse and Ihde.

In the second section, Rouse's account of two kinds of hermeneutics – theoretical and practical – will be summarized. In the third section, Ihde's account of visual hermeneutics will be explained: how there is room for such discipline, how it is already prevalent in natural science, and how its insights can be extended. In the fourth section, Peirce's theory of meaning – the so-called "pragmatic maxim" – will be briefly cited. It will also be suggested that it easily accommodates the insights of Rouse and Ihde. In the fifth section, the argument of this paper will be concluded with some suggestions for further research.

II. Joseph Rouse

Joseph Rouse points out that the demise of traditional empiricism has suggested the notion that not only human science but also natural science is inherently hermeneutical. But he adds that interpretation can be taken in two different senses: theoretical or practical. In (e.g. Quinean) theoretical or linguistic hermeneutics, interpretation is likened to translating a sentence; in (e.g. Heideggerian) practical hermeneutics, to engaging in a practice [1, p.xii]. He asserts that this distinction parallels the distinction between two ways of reading Kuhn [3]. Usually, Kuhn is taken as a proponent of the theory-driven picture of science, but Rouse offers an alternative reading which emphasizes the practical aspects of his work [1, ch.2].

These two senses of hermeneutics can arguably be found already in Dilthey [4], [5]. The paradigm case is the interpretation of texts, but the idea can be extended by analogy to cover actions, tools, social roles, and individual lives which he considered as meaningful in the same way as texts are. For Dilthey, hermeneutics is part of the methodology of the human sciences (*Geisteswissenschaften*). He argued that this distinguishes them from the natural sciences. Thus, he defended the autonomy of the human sciences from the methodological imperialism of the natural sciences. Rouse, on the other hand, argues that natural science too displays significant hermeneutic features [1, pp.41-50]. Hence, if Rouse is correct, then Dilthey is wrong in opposing natural and human sciences.

According to Rouse, the hermeneutic features of natural sciences can be understood in two ways [1, pp.47-50]. His two kinds of universal hermeneutics are theoretical or linguistic and practical hermeneutics. In the former, interpretation takes place within language and concerns the translation of theories or beliefs. It underlies the philosophies of Quine, Davidson, Rorty, Hesse, Kuhn, and Feyerabend. In the latter, interpretation assumes the form of engaging with practices. It is manifest in the philosophies of the early Heidegger and the later Wittgenstein. The former kind of hermeneutics takes practices as *evidence* for the interpretation of certain statements or beliefs. It denies language- or theory-independent access to the

Juho Lindholm is with the University of Tartu, Tartu, Estonia (e-mail: juho.lindholm@gmail.com).

The author thanks the EU Regional Development Fund, Dora Plus, Estonian Research Council, and the Grant No. 462.

world. On the other hand, the latter kind of hermeneutics interprets *these practices themselves*. The practices are not understood simply by describing or predicting behavior; the very point and significance of doing certain things and not others must be taken into account as well.

A. Theoretical or Linguistic Hermeneutics

Rouse thinks that the pragmatism of the 80s can be seen to extend hermeneutics beyond human sciences. The result is hermeneutics as universal theory, or theoretical hermeneutics. It denies the difference between ordinary and scientific language and knowledge. On this account, interpretation consists of forming hypotheses. Unlike logical positivism, observation statements are to be construed not as foundational but as hypotheses: they do not wear their meanings on their sleeves but must be interpreted against the background of other hypotheses. Some hypotheses may be implicit in behavior and dispositions, but this account assumes that they can be made explicit, if need be. Only a relative distinction exists between observation and theory: the more directly a hypothesis is formed as a response to stimulations, the more observational it is; and what counts as a direct result of stimulation is itself subject to theoretical interpretation. This reflects the complexity of any experimental situation: many things must be presupposed in order for the tested hypotheses to have meaning; and if an experiment fails, it does not refute the hypothesis, since the failure might result from a mistaken background assumption. The situation is made even more complicated because of the theory-ladenness of experience, and the fact that evidence can only be stated in a language whose application presupposes certain lawlike regularities [1, pp.50-53].

Hesse has suggested that such network of hypotheses could be modeled as a self-reprogramming learning machine which has three internal feedback loops which update representations and is independent of who does the representing (e.g. an individual scientist, a body of scientists, of the institution of science). The first feedback loop readjusts the programming of input. The second loop redefines the predicates of the classification language [6, pp.125-128] The third loop adjusts the coherence conditions themselves. Rouse defines theoretical hermeneutics as "a view of interpretation as modelable by such learning machine […] possessing all three kinds of internal feedback loop." Moreover, it "takes interpretation to be the coding or reclassification of how the world impinges upon the interpreter," and "is a theory about how we acquire our best theoretical representation of the world, and it is itself part of that best theory." Thus, the aim of theoretical hermeneutics is truth, or accurate representation [1, pp.53-55].

As indicated above, theoretical hermeneutics denies pre-linguistic access to the world. According to Rouse, this follows from Quine's criticism of "the idea idea," which implies that there are no "meanings" for interpretations to correspond with or to be judged by. Hence there is no pre-linguistic fact of the matter. It does not make sense to say, what the objects of a theory are, if "object" is understood as independent of theory. Any reference to an object already involves theoretical commitments. Rather, it makes sense to explain how one theory of objects is interpretable or reinterpretable in another [1, 55, 56], [7, ch.3].

Theoretical hermeneutics has some interesting features. Interpretation of nature is on a par with interpretation of utterances, since both owe whatever determinacy they have to a taken-for-granted background of theory. Rouse states that the indeterminacy of translation is equally a problem for reading Shakespeare and reading bubble-chamber photographs or the color of an object in front of us. Even if a theory of nature is settled upon, translation will still be indeterminate. But Quine distinguishes the indeterminacy of translation from the empirical underdetermination of theories. These things seem to make theoretical hermeneutics universal: *everything* is interpreted by devising hypotheses against a presupposed background of theory. Because a language is presupposed, intersubjectivity is a condition for theoretical hermeneutics; Quine follows Dewey in his denial of private language. Dilthey himself would have disagreed, but the distinction between understanding nature and understanding people collapses in theoretical hermeneutics. [1, pp.56-58], [7, ch.3].

Theoretical hermeneutics is a theory-dominant philosophy of science which is epistemically anti-foundationalist but ontologically relativist. The theory-dominance has two senses: (1) theory guides and gives sense to experiment, and therefore both the starting point and the end of an inquiry are theories; and (2) theory is conceived as disengaged from and independent of practice, agent or knower, and social context. The latter sense is compatible with the Cartesian notion of a disembodied subject, and experiment seems to be only accidentally connected to the business of science. From this point of view, the actual circumstances of discovery and validation – the local site of investigation, the experimental construction, the technical facilities involved in that construction, the particular networks of social relations within which the scientists are situated, and the practical difficulties of getting on with research – are largely matters of indifference for science, for only their rational reconstruction is theoretically significant. Science in this sense aims at the universal and ignores the particular. The latter merely provides an instantiation of or a counterexample to the former. A scientific claim which applies only to particulars is always vulnerable to charges of being an artifact. Therefore, experiments have significance only provided that they qualify as generally interpretable instantiations of universally quantified theoretical claims which have invariant truth conditions and from which indexicals are removed [1, pp.69-72].

Rouse also observes how the thesis of the theory-ladenness of observation seems to make science theory-dominant. If the thesis holds, then observation does not provide independent evidence for or against theories. Many have claimed that it undercuts the evidential grounding of theories altogether. Laboratories could even be seen as superfluous if they are understood as merely theory by other means, or, even worse, unindependent means [1, p.98].

According to Rouse, the theoretical attitude is well expressed by Popper [8, p.107]. Rouse does not provide an explicit judgment himself, but he seems to be insinuating that this kind

of hermeneutic is overintellectual and narrow. His account on practical hermeneutics might be understood as an attempt to make up to the inadequacies of theoretical hermeneutics [1, pp.96, 97].

B. Practical Hermeneutics

Rouse's inspiration for his outlining of practical hermeneutics as an alternative to theoretical hermeneutics is the early Heidegger's *Sein und Zeit* [9]. Heidegger considers human existence (*Dasein*) – that is, our everyday practices – as itself hermeneutical. For him, hermeneutics is not the methodology of interpretation but the act of interpretation itself. Moreover, hermeneutics in this sense is the way of discovering a person's concealed authenticity (*Eigentlichkeit*). Rouse suggests that scientific practices can be regarded as hermeneutical in Heidegger's sense [1, pp.58, 59].

According to Rouse, everyday practices embody an interpretation of the world which needs not be representational. He means the different ways of taking account of things. Using equipment is one instance: an instrument acquires an orientation, a focus, a significance, or a function through its use; and Rouse counts that as hermeneutic activity. Other examples of interpretation in this sense include avoiding things, taking note of them, caring for them, or discarding them. He explains that what and how things show up in the ways we deal with our surroundings; and we thereby interpret the world by (consciously or unconsciously) adjusting our behavior in response to the presence of things or events. In a word, both interpreting practices and the practices themselves are hermeneutic. Time and space are interpreted so that a passage of time can appear as serene and a space (say, by being architecturally construed in a certain way) can appear as awe-inspiring. We interpret them by acting in response to them. Moreover, a practice can be an interpretation of another practice, which makes the ensemble of all human practices its own meta-practice. By being reflexive in this sense, interpreting the world in this way is completely naturalist [1, p.59].

Rouse explains that practices and the interpretations they embody hang together; or, in other words, any particular activity acquires its interpretative sense and its intelligibility from the coherence of practices, roles, and equipment to which it belongs. By an analogy to equipment, Rouse denies that practices and roles be strictly individuated. Speaking about a practice or a role presupposes a nexus of other practices or roles [1, pp.59, 60].

Rouse seems to argue that interpretations by practices are not *explicit* or *cognitive* but rather a kind of tacit know-how or skills; but he does not say that explicitly. He also does not say, whether the kind of practical knowledge he describes is or can be propositional despite being inarticulate. Rouse distinguishes practices and skills (which he seems to consider as largely, if not entirely, implicit) from beliefs, dispositions, and rules (which he seems to consider as explicit). He describes the learning of a skill as learning a grasp of a field of possibilities. Again, by relying on Heidegger's notion of *being-towards-possibilities*, he argues that this grasp of a field of possibilities is not explicit. Echoing Heidegger, he explains that we always find ourselves in a world whose sense is already laid out toward concrete possibilities, and our grasp of practical possibilities emerges out of this context which we largely take for granted and obvious. Unlike theoretical hermeneutics, he is not talking about propositional attitudes like belief or background assumptions when he describes these possibilities. Rather, he is talking about *ways to be in the world* (Heidegger) or *forms of life* (the later Wittgenstein) or *styles of reasoning* (Hacking). He considers these things as more basic than and the condition of the possibility of representations [1, pp.60-63].

Rouse warns not to mistake Heidegger's notion of "understanding" for something numinous and ineffable somehow lying "behind" our possibilities. He explains that we do not need to look "behind" practices for some hidden understanding. On the other hand, in Rouse's interpretation, Heidegger denies that this understanding could be grasped as something formal or otherwise abstractable from our actual involvement with each other in the world. Rouse takes "understanding" to mean local, existential knowledge: it is bound to concrete situations, embodied in an actual tradition of interpretive practices, and located in persons shaped by specific situations and traditions. Hence, in a word, understanding is not a conceptualization of the world but a performative grasp of how to cope with it. Rouse states that what is understood is the way a person's actual situation hangs together and makes sense as a field of possibilities for interpretation: it is the way in which a person's situation has direction, by which he means what points beyond itself towards future possibilities. The object of understanding is not mechanically added to things but the very way in which these things hang together (in the way the German *Zusammenhang* suggests) as a meaningful situation within a form of life which allows individual things to be identified and to make sense [1, p.63].

Rouse continues that theoretical hermeneutics would presuppose some basic beliefs and values, where the choice is in principle arbitrary; but practical hermeneutics cannot choose the configuration of the world which it presupposes in order to make sense of things. In the former case, presuppositions are beliefs which *we* have; in the latter case, they are a way into the world that "has" us. The former presuppositions might, at least in principle, be formalizable and representable in a calculus; the latter presuppositions are irreducibly material. Renouncing them would be to lose grip, not to make interpretations clearer. Theoretical hermeneutics aims at representing accurately what is the case; practical hermeneutics considers interpretation to be a concern for what *matters*, that is, values. In the former case, the presupposed beliefs are just like others and can be altered and rejected by the feedback loops of Hesse's learning machine. Hence, they do not matter to us; we remain indifferent about them. But in the latter case, our actual involvement with a situation that matters to us is what governs the interpretation. In other words, we can make sense of the world only because something already matters to us. Abandoning our most important practical commitments as matters of indifference could potentially result in death [1, pp.64, 65]

In theoretical hermeneutics, the context of interpretation is a "web of belief"; in practical hermeneutics, a configuration of

equipment, persons, and physical setting which is already directed and opened towards possibilities. In the former, interpretation is set against a background of representations; in the latter, against a configuration of presences and absences. It may involve representations, but they are not privileged or universal. In Rouse's interpretation, Heidegger would allow the possibility of encountering the world without the mediation of theories or hypotheses but not without presupposing a form of life [1, p.65].

Practical hermeneutics is as universal as the theoretical one: everything we do is interpretive. Our behavior may be consistent with interpretive hypotheses. But the latter are empirically underdetermined. A theoretical description of our demeanor will always miss what is at issue and hence remain inadequate [1, pp.66, 67].

The difference between theoretical and practical hermeneutics could, perhaps, be crystallized into the statement that in the former, interpretation discloses what the *case is*; in the latter, what it is to *be*. The latter is exhibited in the degree of coherence of what we *do*. It is shown rather than said, and some instances show it better than others. Theories are not in a dominant position in practical hermeneutics even though it emphasizes presuppositions and interpretation [1, pp.67, 68].

Both theoretical and practical hermeneutics collapse the distinction between human and natural sciences, though differently. Now the common denominator need not be the necessity of theoretical presuppositions, though that can be the case too. Rather, it is the fact that both human and natural sciences consist of practices which are inherently hermeneutical.

C. The Significance of Practical Hermeneutics for Philosophy of Science

First and foremost, Rouse's practical hermeneutics directs attention to the *material and practical dimension of natural science*. Scientific practices like experimentation can be understood as *interpretation of nature*.

Rouse refutes four arguments for the distinction between the natural and human sciences by Charles Taylor and Hubert Dreyfus [1, pp.166-181]. But he has not shown that a better argument for an essential difference between interpretation of nature and interpretation of men is impossible. He proceeds, however, to judge that they are not likely to be forthcoming. One important consequence is that the concept of "nature" is thoroughly political.

First, he anticipates the criticism that men are self-interpreting while nature is not. Culture is constituted by such interpretation, the criticism goes, but nature is what it is independently of interpretation. Hence, in human sciences, interpretation matters to us, but in natural science, it does not. This would amount to realism with regard to nature and anti-realism with regard to culture. He replies that much of our self-interpretation and self-understanding is accessed by natural science. Nature is accessed through practice. Hence, what it is to be natural is at issue in such practice. The world has a different hold upon different cultures. Self-understanding in the agents' projection of possibilities is partly achieved through the understanding of the world as a field of possible action. In short, a practical, purposive configuration of the world *which includes the agents* and *which extends to the practices of natural science* is the condition for anything to be intelligible. Rouse concludes that meaning is the "formal" condition on the intelligibility of beings rather than a substantive characteristic of some particular being. It is not the case that language and our practices constitute us but only allow nature to reveal itself as it is independently of us. The former claim is true but the latter is false for three reasons: (1) the natural world acquires a definitive character only within a purposive configuration of practices; (2) who we are is equally much at issue in the natural sciences as in human sciences, including the political aspects of self-interpretation; and (3) who we are can be worked out only through an understanding of the world, and it is not we who are at issue, but what it means to *be*. Thus, our self-interpretation is at stake also in natural sciences [1: pp.181-184]. He points out that we understand ourselves partly as natural beings [1, p.197].

Rouse suspects that the distinction he rejects is based on a misunderstanding of the import of Heidegger's hermeneutics. Dilthey emphasized the meaningful character of the *object* of interpretation and that the hermeneutic circle involved an interplay between the object as a meaningful whole and the parts that both compose the whole and acquire their sense from it. But for Heidegger, the hermeneutic circle is an interplay between the *understanding* of the world as the meaningful configuration within which things are manifest as what they are and the *interpretation* of particular things within the world. Heidegger's hermeneutic circle is independent of the object – and even of whether it has meaning in itself – and thus applies equally to the interpretation of persons and to that of things [1, p.182].

Taylor and Dreyfus argue that a configuration of language and practice is required for the understanding of political action. Rouse adds that scientific practices, and the way the natural world shows up through those practices, are an important part of that configuration. He reminds that Foucault pointed out that to govern means, in an ancient sense, to *structure* the possible field of action, and this governing can result both from nature itself and human deeds [10, p.221]. A field of action depends crucially on material surroundings, technical capabilities, and the shared understanding of what it makes sense to do and to be in such circumstances. Science can transform all of these. That makes natural science (and technics) profoundly political in the sense that it has influence upon the practical configuration within which politics takes place [1, pp.184, 185]. For example, the scientific revolution in astronomy and mechanics not only changed the understanding of the natural world but also what physics was *about*, that is, what is at issue in understanding nature. According to Rouse, this entailed a change in what it was to be human: the notion of the Cartesian ego emerged from the reflection on how the corresponding physical order could be known; the relation between man and God took new shapes; there arose the problem, whether and how physics and morals be compatible; and the gendering of nature and the sexual imagery of our knowledge of it were revised. Rouse concludes that when the concept of nature changes, our practices change,

and therefore nature itself as a field of activity changes. Nature is not neutral but plastic [1, pp.185-187], [11]-[14].

Another political issue is the notion of objectivity, also influenced by our understanding of nature as an "object" which is somehow opposed to a "subject." If this (modern) distinction, which has come under criticism, is presupposed, understanding nature "objectively" cannot be separated from the political question of who we – the "subjects" – are. "Nature" as something given has been used to justify and parallel gender, biological, anthropological, and cultural distinctions and roles. In biology and biochemistry, "master molecule" accounts of controlling substances seem to suggest one-way causal influence (rather than multilateral interaction, or "intra-action" [15] and thus the possibility of unconditional control (rather than mutual influence, response, and adaptation between each factor). This bears on our notion of agency, and vice versa. The counterfactual import of causal claims is justified by our possibility of intervention. Hence different conceptions of agency may yield different understandings of causation. In this way, a political notion like agency can influence the understanding of science. To be sure, the one-way causal influence is what scientists usually try to attain in experiments; but what an experiment reveals can be causally more complex [1, pp.187-191], [16], [17, esp.pp.38, 39, 120].

III. Don Ihde

Don Ihde argues that science can do a "hermeneutics of things" by turning them into scientific objects [2, p.139]. He begins by assessing the contemporaneous situation in philosophy of science and technology and argues that "the field is clear" for the introduction of his ideas – "to reconverge what began to diverge with early modernity." He points out that the opposition between traditional (Diltheyan) hermeneutics and logical positivism, which he calls "the H-P Binary," has dissolved for three reasons: logical positivism has dwindled, the sociology of scientific knowledge (SSK) has arisen, and feminist philosophy of science has emerged [2, ch.11]. Then he proceeds to outline a "weak program" of identifying hermeneutic dimensions implicit within current science praxis [2, ch.12]. He concludes with a sketch of a "strong program" which examines the cutting edges of science's knowledge constitution in a hermeneutic way [2, ch.13]. He defines the "weak program" as "an attempt to reconstruct accounts of science praxis, showing the implicit *hermeneutic practices* already at play within science" [2: p. 152]. He defines the "strong program" as "potentially more normative" and as "an attempt to push, positively, certain P—H [phenomenological and hermeneutic] practices by way of suggestion and adaptation toward science practice" [2, p.152]. Ihde's description of the "strong program" and how it differs from the "weak program" are vague. It seems that the "strong program" builds upon the "weak program" but extrapolates already existing possibilities into the future.

He is not claiming that science is exclusively hermeneutic or that it lacks other dimensions. He considers that to be too reductionist. His thesis is merely that by reframing our understanding of science in terms of interpreting much of its praxis as hermeneutic, we gain certain insights into those operations. He also points out that the hermeneutics of science is of a special kind: not necessarily linguistic or even propositional but first and foremost *perceptual – visual* in particular. But whereas many imaging technologies retain an isomorphism with their objects, there is an important class of technologies which produce significantly non-isomorphic images. The output remains visual, but the "resemblance" to the object becomes more graphic or text-like and requires more hermeneutic activity from the user [2, pp.184, 196].

Like traditional (Diltheyan) hermeneutics, material hermeneutics too denies that single interpretation could be absolute, final, or even universal. But there can still be better and worse, critical and uncritical, or insightful and blind interpretations. For example, if a reasonable interpretation of information is an action, it can be performed in different ways, and only some of them are productive. Fallibilism applies not only to theories but to practices as well. Moreover, a hermeneutic reframing of science understanding is not neutral and contains its own dangers, [2,: pp.197, 198].

According to Ihde, a visual hermeneutics in science is a material counterpart in a different context to the invention of written language – but not because science be a language analogue. He considers writing, more broadly construed as "inscription," as the technologizing of language. The result of visual hermeneutics is not primarily linguistic but, rather, the visualization of things as scientific objects. His "universal hermeneutics" is a hermeneutics of things, not of language alone [2, p.187], [18]-[20].

A. Forerunners of Visual Hermeneutics

First, there no longer remains opposition between positivism and hermeneutics. Positivists associated their program with science and positioned hermeneutics *outside* science – which is exactly where Dilthey wanted it to be placed. Dilthey was concerned about the autonomy of human and social sciences and wished to protect them from materialist reduction. The problem for the self-understanding of science was that this opposition completely ceded science to positivism and thus, for decades, prevented the analysis or appreciation of the deep hermeneutic elements to be found in actual science praxis. But the opposition has faded because of figures like Karl Popper, Imre Lakatos, Thomas Kuhn, and Paul Feyerabend. Postpositivist science has become fallibilist and problem-oriented; Ihde even suggests "pragmatic." At any rate, science is no longer considered as describing unambiguous observations of an uninterpreted reality in a univocal language. [2, pp.142-144].

Second, as the resistance of positivism has weakened, the SSK has imported hermeneutic elements to science studies. Positivism passed over the social dimension of science, but nowadays its existence is widely acknowledged. SSK has also importantly focused attention to scientific praxis [2, pp.144, 145].

Third, feminism has arrived at science studies to accompany SSK. Feminists emphasize that science is a thoroughly socially, culturally, and politically embedded phenomenon which

upholds gendered discourse. The upshot is that they want to discredit the idealized picture of science as perfectly rational and disinterested [2, pp.145, 146].

Ihde credits Rouse [1] and Latour [22] for anticipating his expansion of hermeneutics. He states that Rouse shows how the hermeneutic approach to science becomes relevant within the postpositivist philosophies of science and that Latour develops a somewhat postmodernist approach to hermeneuticizing science. Ihde suspects that the so-called "analytic pragmatism" of Davidson, Putnam, Rorty, Laudan et al. remains in the field of theoretical hermeneutics and retains the linguistic heritage of traditional hermeneutics. On the other hand, he himself continues practical hermeneutics which he considers "ontological" in emphasis [1, pp.147, 148].

Latour's significance is in his method of working from the product of science – texts – backwards to how they are produced. Ihde considers the crucial step to be in the transition from texts to the laboratory. The latter is not merely the place where scientists perform their work. It is also the place where inscriptions are produced. For Latour, the laboratory instruments are inscription-producing devices. Latour defines an instrument (or inscription device) as "any set-up, no matter what its size, nature and cost, that provides a visual display of any sort in a scientific text" [22, pp.67, 68]. Latour's hermeneutization of the laboratory involves two steps: (1) the text is never autonomous but refers beyond itself to the work which produces and lies beneath the text (the text is designed to efface itself); and (2) that reference is to the work which produces the claim of the text, to the laboratory where an instrument is set up to produce an inscription or visual display. Ihde means that data, say the trajectories of certain variables, are recorded, and this record is then shown in an image. Ihde concludes that if Latour is right, the instrument is already a hermeneutic device; and that hermeneutic practice lies in the very heart of the laboratory. In a word, laboratory both produces inscriptions and is also the environment where they are made readable [1, pp.148, 149].

B. The "Weak Program"

Ihde proceeds to describe laboratory hermeneutics. He suggests the metaphor of "giving voices to things" or "letting things speak for themselves" to describe the process of manipulating non-linguistic entities so that they can be interpreted so as to yield information – here in visual form, like a diagram or a plot of trajectories of variables. Following Husserl and Merleau-Ponty, he considers such interpretation to be *bodily* and *fully perceptual* [2, p.151]. But the "voice" – that is, the visualization of data – which an experimental manipulation produces is a "duet": it is not only the object but also the experimental apparatus that "speaks." If the object or the apparatus is changed, the "voice" will be different. This becomes one reason for introducing what Ihde calls "instrumental phenomenological variations" into letting things speak, that is, the use of multivariant instrumental measurements [2, pp.151, 152].

Ihde's first step in expanding hermeneutics into the natural sciences is to modify the phenomenological—hermeneutic tradition itself by its own insights. The tradition has evolved when positivism still was opposed to hermeneutics and hence conceived science as distinct from the lifeworld. But Ihde argues that some results of the tradition itself show that science has never left the lifeworld because of its being materially embodied in practices and instruments. He continues that hermeneutics must accept within itself the mediated forms of intentionality which come through technologically mediated experiences, alongside and with all other bodily perceptual activities like Heidegger's hammer and Merleau-Ponty's feather [2, p.153].

The objects of science to which concepts ultimately refer are not taken naïvely as "given" but must be made "readable" scientific objects. That transformation is usually technologically mediated. But the results are repeatable, variable *perceptual Gestalts* which are not so much "textlike." Ihde calls them *depictions*. They need to stand forth with the greatest possible clarity and within a context of variability and repeatability. This requires maximal transparency from the instruments of observation, recording, and imaging: the instrumentation must have as little influence as possible (though it will never disappear entirely) in the visualization of data to allow the measured phenomenon to manifest itself in maximal clarity. Here we encounter an important feature of scientific inquiry: effort is needed, not to change a phenomenon, but emphatically to make it manifest as authentically as possible to exclude artifacts and noise. In part, this becomes a reason in late modern science for the deliberate introduction of *multivariant* instrumentation or measurements which Ihde calls *instrumental phenomenological variations*; he means that different instruments are used to study the same phenomenon in order to take into account the effect of each instrument and to discover what remains invariant in each case. Ihde argues that this functions as a kind of perceptual hermeneutics which takes place in science [2, p.163].

Variations with many instruments and many objects are provided by radio astronomy; those with many instruments and one object, by X-rays (1896), radioactive tracers and "dyeing" (1911), ultrasound (1937), MRI (1971-1972), computer-assisted tomography (roughly at the same time; according to Ihde, computer thereby becomes a hermeneutic instrument), PET (1975), and fMRI (the 1990s); those with many instruments and converging formations, by uranium series dating, carbon 14, electron spin resonance techniques, and thermo-luminescence techniques; those with single instrument and many objects, by DNA fingerprinting; and those with multiple instruments and new disciplines, by MDNA lineage tests [2, pp.173-176]

Ihde sketches a history of visualization in science. He identifies three trajectories. The first trajectory is constituted by optical technologies and isomorphic and "transparent" imagery. In Galileo's time, illustrations were drawings. The invention of photography in the early 1800s made images more repeatable. Photography also brought a transformation of time to scientific attention. Eadweard Muybridge and Thomas Eakins pioneered stop-motion photography at the end of the nineteenth century. The Mach brothers produced the first evidence of shock waves

by photographing a speeding bullet in 1888. In each case, the visualization remains isomorphic to its object. The second trajectory involves a degree of both isomorphism and non-isomorphism and exceeds optics. It begins with X-ray imaging since 1896. MRI and fMRI scans, CT tomography, PET scans, and sonograms were introduced later. In all these cases, an optical result is attained by non-optical means. The third trajectory is microscopy, which developed significantly later than telescopy. It begins with an optical technology but ultimately goes beyond it. Now it includes electron microscopes, scanning, tunneling processes, the processes which even produce images of atoms and atom surface structure, radio crystallography, and chromosome and genetic fingerprinting processes. This micro-imaging has a counterpart in macro-imaging. It begins with astronomy and the earth sciences and what Ihde calls "whole Earth measurements." Like in the previous two trajectories, these technologies retain some isomorphism with their object [2, pp.163-166; ch.4].

So far, the discussed technologies have retained a degree of isomorphism with their objects. But when charts, graphs, models, and the whole range of "readable" inscriptions, which remain visual but which are no longer isomorphic with the referent objects or "things themselves," are taken into account, the case can be made even stronger. This suggests the generalization that the less the image resembles its object, the more it requires interpretation.

When it comes to non-isomorphic imaging, oscillography and spectrography are salient examples. An oscilloscope image does not "resemble" the sound which produced it. However, skilled scientists can identify the source of the sound merely by looking at the image. Something similar seems to be the case with the spectra of heavenly bodies [2, pp.167, 168].

Ihde interestingly points out the straightforwardness and analogousness of older instruments with their objects. Older thermometers signified high temperatures by the altitude of the mercury column. Graphs retain this convention: up and down for high and low values of variables. False color in the rainbow spectrum is also used to denote values of variables: red for high, blue for low. But the convention must be known in order to "read" such images [2, p.168].

Ihde suggested that even mathematics could be materially embodied and hermeneuticized. Visual hermeneutics can be applied to mathematics too. That science has often been conceived as purely conceptual or theoretical, but computers have changed that – to the annoyance of "pure" mathematicians. Curves and surfaces can be visualized using computer graphics, with or without false color, which allows them and some of their properties to be directly observed, calling for a different way of interpreting them than "pure" equations. The visualization of fractals, chaos, and random phenomena can, perhaps, yield information which would be more difficult to obtain merely by calculating [2, pp.184-187].

C. The "Strong Program"

Ihde emphasizes that the interpretation of visualizations of data is a matter of *learning to see* – to figure out which patterns indicate something else and which do not. Such learning takes place dialectically with the development of the instruments of observation, recording, and visualization. As historic examples, he cites microscopy, photography, and X-rays [2, pp.177-180]. An initially fuzzy image can be made clearer by developing forms of image manipulation, which Ihde shall call *image reconstruction*. The significance of an image often appears only because of transformations performed upon it; this seems to be a central insight of Ihde's "strong program." Manipulation techniques include enlargements, enhancements, contrasts, and false color. Some image manipulations even make it possible to convert non-isomorphic images into visual ones. The use of computers creates richer and more flexible possibilities for manipulation. For instance, the effect of the atmosphere can be computationally removed from telescope images [2, pp.180-182]. Microscopy was for a long time excluded from biology not only because the image was blurred but also because many of its objects are translucent and therefore difficult to observe. This changed when aniline dyes begun to be used to mark the specimen with false color and when flint glass was developed to deal with refraction [23, p.185], [24, p.193].

An important class of manipulations consists of composite images where several sources of visual information are fused. "Whole Earth measurements" [2, ch.4] are a case in point. Even the human body can be visualized in a single depiction using composite computer imaging: an image of a male or a female body can be observed layer by layer, rotated, realigned, and sectioned [2, p.183]. The topography of the ocean floor can be mapped into one three-dimensional composite image. Ihde reports that a wide-scan process via a Geosat satellite using a multibeam sonar (he does not explain how) is used first. Then the image is improved by calculating gravity effects and vessel-towed, undersea multibeam sonar. Finally undersea photography via robot or submersible is used for both confirmation and refinement [2, p.189].

Ihde maintains that despite these manipulations, his material or instrumental hermeneutics qualifies as realist in Hacking's sense: if a thing is "paintable," then it is real [2, p.181], [24]. He points out, however, that "instrumental artifacts" and calibration errors must be accounted for when judging the information conveyed by an image. Multiple instrumentation, multivariant set of measurements, intersubjective checking, deliberate application of focus shifts, and figure/ground reversals can compensate for that [2, pp.185, 186].

Ihde points out some phenomena produced by electronic communication and computer technologies. One is the notion of *avatar*, which he characterizes as "magnified non-presence." Technology has made online conferences possible in the beginning of this millennium – as the present pandemic has made necessary [25, p.150]. Contemporary technology provides a trajectory of "cyberspace multistabilities" ranging from on-the-screen presence (like text on a display) to through-the-screen presence (like computer graphics in games) to in-the-screen presence (like in virtual reality) [25, pp.145-148]. Maybe holography should be considered here as well [25, pp.164, 165]. The monosensory visual technologies can be made into full body measurement devices by applying the developments of virtual reality [2, p.172].

D.Beyond Visualism

Ihde speculates about the possibility of a multisensory hermeneutic which would mimic synesthetic perceptions. Many technologies are already multisensory. But the pioneers in this area have often been in entertainment, not science. This has already taken place in the development from the *camera obscura* to photography and moving pictures (1895). He adds that this development was paralleled by auditory technologies like the telephone (1876), early phonographs (1877), and early radio (1920). These trajectories coalesced in audiovisual media like "talkies" (1922). But *virtual reality* (VR) could, perhaps, be promising [2, pp.189, 190].

Simulated learning environments were arguably the first forays into VR technology. One of the first instances was the Link Trainer (1929) which was a flight simulator used to train fighter pilots quickly. Nowadays surgeons, instrument operators and technicians benefit from simulator training as well [2, pp.190, 191]. He suggests that whole body simulation calls for whole body "isomorphism." He means that simulators should replicate real-life scenarios and experiences as faithfully as possible to be effective [2, p.191].

He points out that VR functions within a closed environment. Its extension has, however, become possible in the form of *augmented reality* (AR) where "isomorphic" displays of visual information are enriched with VR information whose purpose is to aid the user in making decisions and using the controls. For example, an AR display attached to the window can be used to pinpoint the next object to be picked to an operator of an industrial crane [2, pp.191, 192].

He also projects a virtual laboratory. It focuses upon whole body action. It employs virtual interventions and manipulations with the objects of VR. Opportunities for remote sensing and remote action can be implemented. This has become reality as well: such operations are performed on Mars probes. Feedback has been implemented so that the operator can "feel" the responses of the real thing [2, pp.191, 193].

Contemporary fighter pilots, in addition to simulator training, use VR also in real situations. The cockpit of the fighter involves a heads-up display helmet to facilitate full-body response to the large amount of information the pilot has to process in real time. The captains of ships are also aided by VR (or AR) displays which make navigation easier also in difficult weather like fog by, for instance, plotting charts or even underwater topography [2, pp.194, 195]. Again, the underlying argument is that such technologies require non-linguistic interpretation or bodily, material, or instrumental hermeneutics. For example, an operator of an industrial crane is a professional hermeneuticist who interprets the manufacturing process directly by their control decisions, usually without the intermediary of language. If the information must be first encoded in a language and only subsequently acted upon, the process may become more "cognitive" in some sense but also slower and more cumbersome. Language seems like an unnecessary external appendix to such operations. Ihde admits that these are not science examples. But nothing in principle makes analogous applications in science impossible [2, p.195].

IV. Pragmatist Theory of Meaning

Charles S. Peirce (1839—1914), the founder of pragmatism, proposed the following definition of "meaning" in 1878: "Consider what effects, that might conceivably have practical bearings, we conceive the object of our conception to have. Then, our conception of these effects is the whole of our conception of the object." [26, §5.402], [27, p.132] This definition has been called the "pragmatic maxim." He explains what he means in the same paper: "[…] what a thing means is simply what habits it involves" [26, §5.400], [27, p.131].

After 1903, Peirce realized that his notion of "practical bearings" should not be restricted to what actually takes place. Rather, it should encompass what *would* take place, if certain states of affairs *would* obtain [26, §§5.425ff., 5.438ff.], [28, pp.340ff., 346ff.], [29], [30, pp.53-56]. Moreover, as it can be seen from his definition, he did not restrict his notion of "meaning" to language, but it certainly does include language as a special case. To know the meaning of a thing – be it a word, a sentence, an entity, or a situation – is to know what to do with it or in response to it. Thus, it seems that Peirce's theory adeptly accounts for non-linguistic meanings. Now, what Rouse's practical hermeneutics and Ihde's visual hermeneutics interpret are precisely such non-linguistic meanings.

Rouse conceives practices as themselves meaningful. To interpret a practice, there can arise another practice, and Peirce's and Rouse's accounts seem compatible with that.

John Dewey has enriched the pragmatist theory of meaning by explaining in more detail, how it is connected with the experimental method. He argues that meaning arises from experiment. First, a known change is introduced. Then something else (possibly nothing) changes as a result. This change is measured. Then these changes are correlated. If the correlation persists in varied circumstances, an experimental practice can arise, whereby these changes become signs of each other: the presence of one is a (fallible) sign of the presence of the other [31, p.84], [32, p.320], [33, ch.V]. Then the task of science (and technology) is to convert causes into means and effects into ends: to make use of knowledge in the solution of practical problems [33, pp.369, 370]. Thus, to understand a phenomenon is to be able to make use of it, if an occasion arises.

Applying Dewey's insights, Ihde's visual hermeneutics can be more easily understood. A visualization of data suggests possible courses of action, including possible technological applications, to an experienced interpreter. Thus, again, what a thing means is what actions it makes possible and intelligible.

It seems that already the classical pragmatists understood Rouse's and Ihde's hermeneutical ideas – though mostly implicitly. If the pragmatist theory of meaning is correct, it should have been obvious to the classical pragmatists, how deeply science is hermeneutical, when conceived as practice [26, §§1.232-235], [28, pp.129-131], [31, pp.83-88, 102, 103, 167, 193], [33, ch.IX]. Rouse, and especially Ihde, on the other hand, made the pragmatist principle explicit and described its application in a large variety of concrete instances.

V. Conclusion

The practical hermeneutics of Joseph Rouse and the visual hermeneutics of Don Ihde have been outlined. It has been argued that Charles S. Peirce's "pragmatic maxim" provides a theory of meaning upon which these hermeneutics can be founded.

Rouse has at least once claimed to profess pragmatism [34, p.194]. Hence it seems strange that he never cites classical pragmatists like Peirce, James, or Dewey. It seems even stranger that he never mentions the pragmatist theory of meaning which has a lot in common with his own theory. Ihde has founded the program of *postphenomenology* which draws upon classical phenomenology, pragmatism, and empirical philosophy of technology [35]. Hence it might have been expected that he would already have aligned his expanded hermeneutics with the pragmatist theory of meaning. This article corrects these glaring omissions.

The hermeneutics of Rouse and Ihde seem to be generalizable beyond science – to any practices and to any use of visualizations. This suggests a quasi-empirical research program, in accord with Peirce's theory of meaning, about whether, and to what extent, a given practice or technology can be conceptualized according to practical or visual hermeneutics. Such research program narrows the gap between science and technology studies (STS) and pragmatism. It even suggests an affinity between STS and semiotics.

References

[1] Joseph Rouse: *Knowledge and Power: Toward a Political Philosophy of Science*. Ithaca and London: Cornell University Press, 1987.
[2] Don Ihde: *Expanding Hermeneutics: Visualism in Science*. Evanston, IL: Northwestern University Press, 1998, pt. 4.
[3] Thomas S. Kuhn: *The Structure of Scientific Revolutions*. Chicago: University of Chicago Press, 1996 (3rd edition).
[4] Wilhelm Dilthey. *Gesammelte Schriften, Band V*. Stuttgart: Teubner, 1956.
[5] Wilhelm Dilthey. *Gesammelte Schriften, Band VII*. Stuttgart: Teubner, 1957.
[6] M. Hesse: *Revolutions and Reconstructions in the Philosophy of Science*. Bloomington: Indiana University Press, 1980.
[7] Joseph Rouse: *How Scientific Practices Matter: Reclaiming Philosophical Naturalism*. Chicago and London: University of Chicago Press, 2002.
[8] Karl Popper: *The Logic of Scientific Discovery*. New York: Harper and Row.
[9] Martin Heidegger: *Sein und Zeit*. Frankfurt am Main: Vittorio Klostermann, 1977 (*Gesamtausgabe* 2).
[10] Michel Foucault: "The Subject and Power," in H. Dreyfus & P. Rabinow (Eds.): *Michel Foucault: Beyond Structuralism and Hermeneutics*. Chicago: University of Chicago Press, 1983, pp. 208—26 (2nd edition).
[11] A. Koyre: *From the Closed World to the Infinite Universe*. Baltimore: Johns Hopkins University Press, 1957.
[12] Thomas S. Kuhn: *The Copernican Revolution*. Cambridge: Harvard University Press, 1957.
[13] C. Merchant: *The Death of Nature*. San Francisco: Harper and Row, 1980.
[14] Evelyn Fox Keller: *Reections on Gender and Science*. New Haven: Yale University Press, 1985.
[15] Karen Barad: "Meeting the Universe Halfway," in L. H. Nelson & J. Nelson (Eds.): *Feminism, Science, and the Philosophy of Science*. Dordrecht: Kluwer, 1996, pp. 161—94.
[16] Evelyn Fox Keller: "Feminism and Science," in *Signs 7*, pp. 589—602, 1982.
[17] G. H. von Wright: *Explanation and Understanding*. London: Routledge & Kegan Paul.
[18] Lewis Mumford: *Art and Technics*. New York: Columbia University Press, 1952.
[19] Marshall McLuhan: *The Gutenberg Galaxy: The Making of Typographic Man*. London: Routledge & Kegan Paul, 1967 (2nd edition).
[20] Marshall McLuhan: *Understanding Media: The Extensions of Man*. Corte Madera, CA: Gingko Press, 2003 (2nd edition).
[21] Don Ihde: *Instrumental Realism: The Interface between Philosophy of Science and Philosophy of Technology*. Bloomington and Indianapolis: Indiana University Press, 1991.
[22] Bruno Latour: *Science in Action: How to Follow Scientists and Engineers through Society*. Cambridge, MA: Harvard University Press.
[23] Don Ihde: *Technology and the Lifeworld: From Garden to Earth*. Bloomington and Indianapolis: Indiana University Press, 1990.
[24] Ian Hacking: *Representing and Intervening: Introductory Topics in the Philosophy of Natural Science*. Cambridge: Cambridge University Press, 2010 (2nd edition).
[25] Don Ihde: *Experimental Phenomenology: Multistabilities*. Albany: SUNY Press, 2012 (2nd edition).
[26] Charles S. Peirce: *The Collected Papers of Charles Sanders Peirce* (C. Hartshorne, P. Weiss, & A. W. Burks, Eds.). Cambridge, MA: Harvard University Press. (8 Volumes. Vols. 1—6 edited by Charles Hartsthorne and Paul Weiss, 1931—1935; vols. 7—8 edited by Arthur W. Burks, 1958.)
[27] Charles S. Peirce: *The Essential Peirce: Selected Philosophical Writings, Volume 1* (N. Houser and C. J. W. Kloesel, Eds.). Bloomington: Indiana University Press, 1992.
[28] Charles S. Peirce: *The Essential Peirce: Selected Philosophical Writings, Volume 2* (The Peirce Edition Project, Ed.). Bloomington: Indiana University Press, 1998.
[29] T. L. Short: "The Development of Peirce's Theory of Signs," in Cheryl Misak (ed.): *The Cambridge Companion to Peirce*, pp. 214—40. Cambridge: Cambridge University Press, 2004.
[30] T. L. Short: *Peirce's Theory of Signs*. Cambridge: Cambridge University Press, 2007.
[31] John Dewey: *The Quest for Certainty: A Study of the Relation of Knowledge and Action*. New York: Minton, Balch & Company, 1929.
[32] John Dewey: *Democracy and Education: An Introduction to the Philosophy of Education*. New York: The Macmillan Company, 1916.
[33] John Dewey: *Experience and Nature*. London: George Allen & Unwin, Ltd., 1929 (revised 2nd edition).
[34] Joseph Rouse: *Engaging Science: How to Understand Its Practices Philosophically*. Ithaca and London: Cornell University Press, 1996.
[35] Don Ihde: *Postphenomenology and Technoscience: The Peking University Lectures*. Albany: SUNY Press, 2009.