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Phenomenology and the Philosophy of the Natural Sciences

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ABSTRACT

In the assessment of scientific theory and practice, the critique of the analytic/empiricist view of science made via the phenomenological orientation of Husserl, Heidegger, Merleau-Ponty and others towards the Lifeworld and Heidegger's hermeneutics (or interpretation) of experience has made it possible to assign different roles to theory and praxis. Theory is assigned to technological design for the purposes of environmental control, while praxis is assigned to ontological understanding for the purpose of human culture. Scientific theories then have a 'Janus-like face,' one side looks in the direction of computational and technological control which is not constitutive of scientific knowledge but is merely a resource or tool for multiple praxes, the other looks in the direction of human culture which is ultimately constitutive of ontological scientific knowledge.

This bivalence underscores the prevalence of metaphor in scientific discourse and, in particular, in medical science and clinical practice under conditions where modern culture and the analytic/empiricist view tend to mask the presence of metaphor in such discourse. It was shown, however, that under the broader analysis of phenomenology, metaphor is as fundamental for true scientific discourse as literality is for the analytic/empiricist view. Since the theoretical is mathematical and both the practical and the praxical are empirical, it makes no sense to predicate mathematical models literally of the phenomenological Lifeworld; at best, the two must come together consciously in some unambiguous but metaphorical way guided by professional experts in the spirit of (what Aristotle called) '*phronesis*' (prudent action), aware that they are seeking no more (and no less) than a praxical consensus about a set of relevant soluble Lifeworld issues.

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In different ways, both Edmund Husserl (1859-1938) and Martin Heidegger (1889-1976) were deeply and continuously involved with the philosophical nature of mathematics and modern science, i.e., post-Galilean, theoretical/experimental science.[1] Both tended to see mathematics as the study of implicitly defined idealities and, in the spirit of the Göttingen School of theoretical physics, they saw modern science as the projection of such idealities on the world of experience, that is, as interpretations of experience projected in terms of mathematical symmetries or invariants related to group theoretical operations or variations. In this way the empirical operations on the manifolds of empirical data were represented as mathematical operators on ideal numerical manifolds.[2]

The emergence of phenomenology reflects a philosophical division about modern science in the German Neokantian School in the early part of the 20th century. As Michael Friedman has shown in his book, *The Parting of the Ways*, Neokantianism in the early part of the twentieth century came to a parting of the ways. The Marburg School among whose members were Rudolf Carnap, Ernst Cassirer, and Hermann Cohen, was focused on the natural sciences and was animated by a political philosophy that saw the future of human society as tied to one universal cultural language modeled on the natural sciences. The South-West German School that included Heidegger and Heinrich Rickert, was focused on the social and human sciences and was animated politically by a respect for a hierarchic plurality of national cultures. Husserl, trained in mathematics at Berlin under Weierstrass and a member of the Faculty of Philosophy (that included Natural Philosophy) at Göttingen from 1901 to 1916, tended to follow the natural science interests of the Marburg School while not belonging to it politically. Under the political circumstances of pre-war Nazi Germany, members of the Marburg School were forced to emigrate and went to the USA, Britain, and other countries. Members of the latter group, however, remained in Germany and suffered the consequences of Germany's defeat. What began as a philosophical and political 'parting of the ways' in pre-war Germany led to a more literal parting of the ways as more and more members of the Marburg School crossed the Atlantic, settled in universities in the USA, and awakened there a sense of the intellectual, political, and technological importance of the natural sciences as models of the kind of knowledge that proved its effectiveness in winning military victory and economic success in its Cold War aftermath.[3]

It is then not surprising that after World War II phenomenology, which by that time had come to be associated almost exclusively with the human sciences, arrived late to the shores of the USA and that it bore the burden of being tainted by Heidegger's past expressions of loyalty to the national politics of defeated Germany. This history explains in great part why within the English speaking world today there is a radical gulf of communication and purpose between phenomenological thinkers and the analytic/empiricist descendants of the Marburg School. Phenomenology and analytic philosophy live in different cultural and linguistic worlds and work from radically different platforms, the former emphasizing the subject/object role of intentionality in knowing and the importance of conscious self-appropriation, the latter focusing almost exclusively on the objective role of knowing. The pre-requisites for a fruitful dialogue unfortunately require more than goodwill and mutual respect, they include the ability to share with some understanding and sympathy the incommensurable platforms they occupy as respective privileged philosophical spaces.[4] Nevertheless, there were some in the post-war era who found in phenomenological thinking elements of a significant, new and highly critical philosophical attitude towards the mainstream of British and American philosophy of science; the latter is often referred to in the USA as the "received view" of the philosophy of science.[5]

On the one hand, Husserl's influence on phenomenology was to regard scientific theory and the resulting theoretical invariants as the historical expression of the transcendental *eidoi* intended by the infinite process of pursuing better and better empirical approximations in physical measurements. This is a view commonly held by theoretical physicists and scientists in many fields, as well as by a school of historians of science influenced by Alexandre Koyré, a close colleague of Husserl. These ideas had an important influence on generations of logicians such as H. Gödel; mathematicians such as O. Becker and G-C. Rota; psychologists such as M. Merleau-Ponty, K. Pribram, A. Damasio, and F. Varela; molecular biologists such as M. Polanyi and I. Progogine; medical clinicians and researchers such as D. Leder, and R. Zaner; theoretical physicists such as L. Brisson, W. Meyerstein, Heelan, and H. Weyl; historians of science such as Koyré and P. Kertzberg, and philosophers of natural science such as Heelan, T. Kisiel, J. Kockelmans, E. Ströker and A-T. Tymieniecka.

On the other hand and in contrast with Husserl, Heidegger saw these same mathematical models, not as transcendental *eidoi* or metaphysical entities, but as historical inventions of the human spirit intending to reduce the world of experience to manipulable ontic entities with the suppression of what is particular, historical, contingent, creative, poetic, and ontological in *Dasein's* 'being-in-the-world.' From the start Heidegger saw the scientific culture of modernity as the 'Age of the World Picture' in which the 'real' is constituted by the theoretical representations of modern science rather than a revelation of what is constitutive of the foundational structure of *what is*, that is, what Heidegger called, 'ontology' (Heidegger, 1977a, 115-154). In later criticism, Heidegger came to see modern science as essentially entangled with technology in the constitution of objective frameworks of 'standing reserves' ('*Bestand*') or 'mere value-neutral resources for human action' ('*Ge-stell*') (Heidegger, 1977a, 3-35).

Heidegger has not had a strong following among those interested in the positive development of, and understanding of, mathematics and the natural sciences. Heidegger's influence in this area tends to be interpreted in the USA as a call to return to American Pragmatism. Heidegger's radical ideas have had a significant influence on the phenomenology of research, technology, and culture today. Among those influenced by these ideas are, for example, K-O. Apel, B. Babich, A. Clark, R. Crease, I. Fehér, D. Ginev, J. Haugeland, Heelan, D. Ihde, Kockelmans, Kisiel, G. Markus, Polanyi, J. Rouse, and R. Scharff. Polanyi, a molecular biochemist and also an important philosopher of science with a continental background, who is often seen as standing outside of contemporary philosophical traditions claims, however, that his ‘tacit knowing’ comes to the same thing as Heidegger’s ‘being-in-the-world’.[6]

In his critique of modern science, Heidegger argues that theories and mathematical models are ‘inauthentic’ representations of Dasein’s ‘being-in-the-world’ and that they fail to establish modern science’s or modern culture’s relation to ‘*aletheic*’ truth,[7] i.e., truth based on ‘historicity,’ ‘authenticity,’ ‘openness,’ and ‘freedom’ (Heidegger, 1992, 33-39; 1977a, 3-35, and 1977b, 117-139).

‘Authenticity’ addresses the practice of a special phenomenological skill, that has to be learned, of avoiding that which in phenomenological analysis are the biases to ‘understanding’ introduced by objective uses of abstract (theoretical) concepts and models. This ‘world’ of Heidegger, this Lifeworld[8] of Husserl, is, perhaps, best seen for our purposes as the everyday world after the removal of all theoretical representational elements objectified as ‘real.’ However, in contrast with Husserl for whom the intention of truth is guided by unchanging ‘transcendental *eidoi*,’ Heidegger holds that abstract concepts coerce ‘being-in-the-world,’ into narrower or more determinate channels than those of the free, open, and historical life of the embodied inquirer thinking philosophically. Ironically, ‘authentic’ phenomenological thinking can never be fully mastered, because our everyday ‘praxical’[9] life world is never successfully purified of objects defined by abstract concepts, but is continuously challenged by them in a field of open inquiry. For Heidegger’s phenomenology, however, the demand for authenticity in the Lifeworld is local, historical, contextual, emergent, cultural, and the subjective embodiment of imaginative, scientific, and poetic mind in the Lifeworld that is lived for its own sake as a terminal goal with respect to which problem-solving serves only as a means to that end. The intention of truth is *aletheic truth,* ‘free’ and ‘open’ to emergent possibilities.

A developed phenomenology of nature would include *phenomena* revealed by natural science.[10] Phenomena (see Husserl, 1989 and Heelan, 1991b) are local, particular, historical, cultural, and contingent. Scientific phenomena then are the contingent appearances of scientific entities in the subject’s scientific -- or better, post-scientific -- Lifeworld. In contrast with this view, the classical tradition of Western scientific culture focuses on objective abstract concepts and seeks them out by '*epagoge*' (induction), dialectics, or theory formation; for they are the objective fulfilment of every classical inquiry and reveal, as it is believed, the *essences* of what *is*. Classical science sees nothing limiting and deficient in their objective use. Phenomenology uses the same theoretical concepts but they function differently in a phenomenological philosophy of nature from how they function in classical science. This will be taken up below. But it is only in the perspective of subjectivity, particularity, and history that the deficiencies of the objective use of theoretical concepts become manifest, for, in defining objective essences, they conceal the subjective, particular, and historical character of what *is, i.e., the intentional unity of subject and object in the Lifeworld*. For this reason. phenomenology sees theoretical concepts, not as 'pictures' of a classical 'world,' but as a factor, usually in tandem with new technologies, in adding new scientific furniture to a changing Lifeworld ... but more of this below.

A phenomenology of natural science that seeks beyond theory for the grounds of *'aletheic'* truth is founded on the existential hermeneutical spiral (or 'circle'[11]) that has a beginning in an original Lifeworld in which a problem is posed and ends in a transformed Lifeworld in which the problem is resolved (Heidegger, 1977a, 117-139; Gadamer, 1995, 265-380). The transformation referred to is effected by the emergence and 'naturalization' in the Lifeworld of new theory-based technologies of understanding among which in particular are standardized measuring instruments and standardized measurement-based technologies (for the analysis of measurement, see Heelan 1989a). These have been called 'readable technologies' (Heelan, 1983a/1988, 206), that is, technologies capable of being integrated with the embodied self in the Lifeworld as lived phenomenologically for its own sake.[12] What then would be the minimum core of the *aletheic* truth of mathematical/experimental science within the phenomenological spiral of scientific research? It should at least comprise answers to the following questions:

1. *How is modern science phenomenologically grounded in the local historical*

Lifeworld?

2. *How do theories mediate computationally between pre- and post-theoretical phenomenological 'data'?*

3. *What part do the 'theoretical entities' of science play in the dynamic of change in the phenomenological Lifeworld?*

Firstly, the trajectory of a scientific inquiry is not a closed loop beginning and ending in the Lifeworld as unchanged; it is rather an existential hermeneutical spiral that involves Lifeworld change. Each successful advance in a scientific inquiry *via* the hermeneutic spiral changes the original Lifeworld in which the problem is initially located and embodied, into a transformed Lifeworld in which the problem is existentially resolved. By depositing in the Lifeworld new theory-designed processes (technological and/or institutional) that link emergent (perceiving) subjects and emergent (perceived) objects, new phenomena are, to use Fleck's words,[13] 'generated and developed.' This mutual adaptation of subject and object in the new Lifeworld is due in scientific studies to their 'entanglement' with a readable technology.[13] Included among readable technologies are legal instruments or institutions that can also produce new phenomena both social such as, say, universities, and physical such as, say, electrons, by re-defining the political, social, and environmental structure of human agents and of the Lifeworlds they live in.

In these new and transformed Lifeworlds, new local scientific presences or *phenomena* (for example, electrons) are revealed directly, not as theoretical entities (or literally as 'theory-laden' entities) since these are abstract, but as new phenomena revealed by the manifolds of data produced by measurement processes. These processes use theory-designed technologies of the kind that enter praxically into the research life of the community (Heelan, 1989a). Though the production process is theory-laden, such data and the scientific phenomena they refer to are not *theory-laden* but are or become *praxis-laden* in the new Lifeworld. The crucial fact is that the existence of scientific phenomena (and data about them) is not grounded on argumentative or theoretical grounds but on the success of such data and phenomena in transforming the

Lifeworld; that is to say, in contributing to the goals of the research community within the praxical culture of research. The goal of this culture is to contribute to a new, different, and hopefully more desirable, quality of life 'indwelling' through science within the Lifeworld. Regrettably, there is no guarantee that these new local scientific presences will be benign presences, for how they enter into the scientific Lifeworld is in the hands of those who manage the new technologies or institutions.

Secondly, *how does theory computationally mediate between the original and the transformed Lifeworlds*?

Consider medical research: scientific technologies can serve merely as indeterminate resources (or *Ge-stell*) or they can be specifically functional as *praxes*, dwelt in for their own sake. As specifically functional, some are invasive of the integrity of what is studied as in the killing by staining of living cells. And some are non-invasive of the integrity of what is studied, say, by imaging processes, such as sonograms or MRI. And some can be Lifeworld-changing, quality-of-life-changing such as prostheses for the disabled or everyday user-friendly technologies because of the way 'readable technologies' mutually transform both (perceiving) subjects and the (perceived) environment as described above. All of these cases can be studied in various scientific fields. For example, in the field of scientific medicine, Fleck gives a wonderful account in his book, *Genesis and Development of a Scientific Fact*, of the way his Lifeworld as a medical researcher was changed by the progress of his research. He notes how under the influence of serological tests, the background and language under which he saw the patient's symptoms gradually changed until there was slowly revealed to him the presence of a new entity that had not hitherto been recognized as an entity. It was the disease entity to which the name 'syphilis' applied. This process of discovery has the structure of an existential hermeneutical spiral.

It is not in medical research alone that measurements play complex hermeneutical roles. They do so also in natural science, with special attention to the very large and the very small, to cosmology and quantum physics.

To illustrate what a phenomenological hermeneutic of natural science can do, let me consider the role of theory in the 'received view' of science. It is important to understand how in this view theory serves to 'explain' a phenomenon and how an 'explanation' is used to solve a scientific problem by 'computation' or 'calculation.' It does both usually by predicting the occurrence (or non-occurrence) of a phenomenon. A theory 'explains' by providing an ideal computational model that purports to represent the causes relevant to the occurrence (or non-occurrence) of the phenomenon under 'standard' circumstances. The model (as an ideal objective reconstruction) aims to replace the confused Lifeworld subject matter of inquiry, not for any and every purpose but for the (often tacit) 'standard' purposes of the scientific inquiry. These purposes are achieved by using the model computationally to predict real Lifeworld outcomes in a Lifeworld transformed or to be transformed by equipment standardized for this purpose. The fact that the beliefs surrounding the 'received view' work successfully for prediction and control in 'standard' ranges of scientific phenomena, does not, however, imply that the 'received view' is correct in its assumption that it is theory that constitutes the phenomena of science for the implications of 'standardization' are not part of this analysis. It is well then to reflect, say, on what Heidegger says (e.g., Heidegger, 1992, 69-70) of what is implied by the meaning of theory in science as in ordinary life.

He begins with a worker engaged in a building project, using a hammer. The hammer unexpectedly breaks. Let us suppose that a replacement can't be found and that he has to have one made. He asks: what are the specifications of a hammer (of the kind he needs to finish the job)? The answer to this question will be a theory (about hammers) that explains a hammer's ability to do the hammer's job. What is a hammer's job? It is the 'meaning' of a hammer. In this case it is a *cultural praxis-laden meaning* dwelling within the context, let us say, of the building trade. Note that without a specification of context, the question is relatively indeterminate. In the context of the 'received view,' however, the hammer is a physical entity specified by its specifications, it is a *theory-laden meaning* that lays out the physical conditions under which *it can become the host of the cultural meaning of a hammer. But whether or not it is assigned this* *cultural function is a separate and contingent matter*. The two meanings are not independent. The *theory-laden* meaning makes sense only if a local contingent existential condition is fulfilled, namely that the hammer-referent is *praxis-laden* in the conventional sense.

If this condition is fulfilled, the hammer is a public reality constituted by a cultural meaning. But what if the existential condition is not fulfilled? 'It' would not be a hammer. It would not make sense even to call 'it' theory-laden. Finally, 'it' would have no more title to being listed in the hammer category among any categorial listing of the furniture of the Lifeworld than any old boot that could be used to drive a nail. 'It' would become (in Heidegger's words) 'a mere resource' ('*Vorhanden'* or *'Bestand'*) for hammering or some other indeterminate function, or just 'nothing in particular' (Heidegger, 1992, 42-43; 1977a, 3-35).[14]

Despite the fact then that (hammer-) theory 'explains' (hammering-) praxis, the language of theory and the language of praxis belong to different though locally and contingently coordinated perspectives. Coordination does not imply, however, isomorphism between the two perspectives,[15] for someone working on a carpentry project could, perhaps, be served on this occasion by an old boot or something other than a hammer. Since theory and praxis are merely coordinated but not isomorphic, they can be taken as axes for a kind of cultural phase space within which there are zones of uncertainty between explanatory theory and Lifeworld praxis. This even suggests a general principle, a kind of Heisenbergian indeterminacy principle in theory-praxis phase space.

When we reflect on the fact that individual things in our Lifeworld experience are never without a role to play in the routines of human life, indeed that each may play multiple roles and be open to ever new roles, we realize that these routines belong to the Lifeworld and share the character of that world as historical, contingent, changing, praxical, and lived for its own sake. Everything in our experience then, including scientific entities, bears some resemblance to a hammer, or other tool or equipment and has (at least) two perspectives: (1) a *praxis-laden* cultural perspective (possibly with multiple *praxes*) that is constitutive of the Lifeworld, and (2) a *theory-laden* perspective – possibly multiply theory-laden -- that 'explains' this cultural perspective, makes it possible under appropriate conditions, *but does not constitute it.* If 'being-in-the-Lifeworld' is -- as I believe it is -- the revelation to and for humans of what is constitutive of the foundational structure of *what is*, then scientific activity has a place in it and constitutes within it a powerful engine of change. But it is an engine of change within the dynamic of 'being-in-the-Lifeworld' and not a substitute for it. And so we come to the third question: *what part do 'theoretical entities' play in this dynamic?*

Every theory is a network of relationships among its terms. Usually the relationships are mathematical and the terms are quantified by measurement. In the 'received view,' those terms and relationships constitute a 'model for,' by being a 'representation of,' some standardized aspect of the 'real' world. They are called 'theoretical entities,' meaning entities defined by a theory. Through the network of relationships, they 'explain' the state that existed prior to the inquiry but was not previously 'understood' as 'explained.' What are we looking at? Let us name some of them: atoms such as carbon and hydrogen, molecules such as H_2O and CO_2, genes and proteins in living bodies, also their constituent protons, neutrons, electrons, quarks, etc., and the properties of matter that they share, namely, local and temporal spatiality, energy, momentum, wave length, spin, and so on. These terms belong in the first place to the imaginative representational and constructed world of mathematical scientific models. Some of those terms in addition, however, manifest themselves as 'entities' in public fora. In the 'received view' they are taken to have 'metaphysical' or 'real' status like trees and tables. How are these terms assessed on Heidegger's philosophical platform? What do the terms stand for? How are they to be understood?

To belong to the Lifeworld has its own criterion: it is the possibility of realizing the named entity as a Lifeworld phenomenon.[16] This is achieved in the first instance by standard processes of measurement in a basic laboratory, for when a quantified variable is measured, the named entity (object) to which it belongs shows itself as present locally in the Lifeworld space of the laboratory as shaped by the practices associated with the standard measurement setup. In addition to being a public phenomenon in that forum, there are other public fora in which the named entity also has a presence with the status of a cultural phenomenon. These public fora feature, for example, everyday technologies, clinical medical procedures, pharmaceuticals, agricultural chemicals, finance, politics, religion, art, media, and others. All of these fora -- like the basic laboratory -- are local fora in which a named scientific entity, always in some familiar technological context, can play the role of a dedicated cultural resource (for everyday life, for clinical medicine, for pharmaceutical therapy, for agriculture, finance, politics, religion, art, media, and so on) and in this context can become part of the local furniture of the Lifeworld.

While the distinction between invasive and non-invasive measurement processes is clear in biological research, the same distinction holds also for non-biological objects of research. For example, electrons within atoms ('bound' electrons) are studied mostly by non-invasive methods, such as spectral analysis of emitted and absorbed radiation. With these methods the holistic being of the atom is preserved and the bound electrons have to be treated just as so many functions of the controlling atom. In contrast, invasive methods destroy the internal environment of the atom and thereby free the electrons and the nucleus from their mutual bonds to make them independent phenomena. In the former (non-invasive) case the Lifeworld phenomenon is the atom. In the latter (invasive) case the electrons and the nucleus are freed from each other and they become phenomena each with their own constitutive properties in the Lifeworld and independently of the atom. However, antecedent to the emergence of atoms in cosmic history the properties of atoms as emergent holistic phenomena cannot be predicted just from the electronic properties of its constituents.

In all the local public fora mentioned above, the scientific entity and its Lifeworld data are meaningfully bivalent (possibly multiply so) and emulate the relationship between theory and praxis in the study of a hammer. If no distinction is made between invasive and non-invasive measurement processes, and no attempt is made to specify the kind of local forum in which the phenomenon will make its appearance, putative 'data' cannot be assigned to phenomena in the Lifeworld.[17] Having no determinate phenomenological Lifeworld meaning, such 'data' must be treated as indeterminate resources -- or, on occasion, just noise.

By way of illustration of what has been said, consider how the Lifeworld of Europe was changed in the *quattrocento* with the invention of perspectival projection and the *camera obscura.* Terms of a new kind, scientific and theoretical, came to be introduced into everyday language with new practical -- more precisely, *praxical* -- measurement-based cultural meanings such as one universal mathematical Time, Space. and Calendar. The techniques of mathematical perspective revolutionized the Lifeworld of Italy and later of Europe, through art, architecture, urban planning, navigation, warfare, and much more. The geometry-filled productions of what were just craft skills in optics, astronomy, map making, painting, music, weapons' design, and other arts and skills prepared the way for the *elevation of practical artistic skills* to become known as applications of *scientific theory*. The products of the new arts came to be regarded no longer as works of art, but as works of geometrical reason or science (Crombie, 1994, 499-680) Among other things the works of geometrical reason changed the public urban space of Europe from a quilt of diverse local spaces and local times into a single universal space and uniform cosmic time based on measurement with standard rigid rulers based on common units and mechanical clocks synchronized with the stars. For those who looked for a unified cosmology, the way was prepared for Galileo and the Copernican revolution (Heelan, 1983a/1988, chap. 11; 1994). It was Galileo who helped convert works of thoughtful art -- his deft experiments, such as, timing balls rolling down an inclined plane -- into a world of science and reason, a move on which we now look back with more knowing and critical eyes.

It follows from what has been said that the furniture of the Lifeworld is not fixed with respect to categorial kinds, being dependent on the kinds of methods we use to realize them as recognizable 'free' phenomena and to investigate them as such. Included among them are those like the Wassermann Test created by cultural institutions such as medical research laboratories. Some are categorized resources that are not functionally assigned ('*Bestand'* or *'Vorhanden')*, such as, chemicals, reagents, and appliances in central storage available for a variety of uses (Heidegger, 1992, 42-43; 1977a, 3-34). Others are functionally assigned ('*Zuhanden'*), such as those actually used in surgery (Heidegger, 1992, 69). Only the latter enjoy a meaning in the Lifeworld that is actually specified for definite tasks and, consequently, are part of the furniture of the Lifeworld.

Fleck, in his history of the scientific theory of syphilis, recognized the fact that in establishing the meaning of the new scientific term, 'syphilis,' some special usage had to be negotiated between scientific terms normed by the 'thought collective' of the research community and everyday terms normed by the 'thought collective' of everyday life. To quote Barbara Duden:

> "... as a practising bacteriologist, [Fleck] knew that his eyes were caught, not only in the norm imposed by the collective of the laboratory, but equally by the thought style characteristic of his everyday family life. It is this double anchorage – in the laboratory and at the table – that makes the scientist a conduit through which scientific facts become confused with cultural interpretations. As a result, scientific facts ... have a Janus-like face" (Duden, 1993, 69).

What would result if the Janus-like face of a scientific fact were to go unnoticed or were to be flouted or ignored by convention in public fora of communication? This happens all too frequently, partly as a consequence of the widespread acceptance of the 'received view' and partly because of the limitations on public discourse caused by the difficult subject matter. The result is distortions in communication. Two systematic errors become possible. Each, in its most innocent form, leads to the more or less conscious use of a figure of speech, something like a metaphor. (1) In one strategy the post-scientific praxis-laden perspective of the laboratory Lifeworld zone is simply re-described metaphorically in terms of the theoretical scientific meanings (Halliday and Martin, 1993; Bazermann, 1988, 201-299). Under such conditions, theoretical descriptions replace practical descriptions. But if the metaphorical character of the predication is not recognized, it is easy to take the replacement to be exclusive and metaphysical, and to think that the Lifeworld conditioning of phenomena no longer exists, and that only the theoretical scientific world exists. For example, perceptual space is assumed to be modeled by Euclidean geometry, colors by electromagnetic wavelengths, sounds by pitch and loudness, and syphilis by a positive Wassermann Test, when all such predications are no more than metaphors apart from the collaboration of the human senses, language, and cultural environment. Perceptual space, color, sound, and syphilis exist only as the product of interpretation through which they in their Lifeworld involvement become intelligible as phenomena of human experience. Modern scientific medicine then has been often charged with a weakness for reducing patients to a bundle of anatomical parts and physiological processes, each having its scientific model at the level of chemistry, molecular biology, or physiology, and with little regard for the human life in which they are engaged and that uses such systems to cope, well or ill, satisfactorily or unsatisfactorily with the challenges of the patient's Lifeworld. All would agree that, ultimately, scientific medical models should not replace the Lifeworld of the patient and should be at the service of the patient's quality of life as lived in and tested by his or her Lifeworld.[18]

(2) In a quite different strategy the theory-laden perspective which is privileged in the 'received view' is simply re-described metaphorically in terms of pre-scientific ('naive' or 'folk') Lifeworld meanings. In other words, since the scientific terms are not well understood in many public fora, they are simply filled with the old familiar pre-scientific Lifeworld meanings, possibly with a more or less conscious sense that this involves a metaphorical construction. From this awareness comes a warning, that should be heeded by ethicists, media pundits, and public policy makers who, confusing the context of science with that of Lifeworld ontology, so

easily and offhandedly fill scientific terms with prescientific Lifeworld meanings in their public discourse.[19] For example, in such discourse, scientific terms such as ‘cells,’ ‘organs,’ and ‘bacteria’ are treated as (‘naive’ or ‘folk’) ‘things’ like machine replaceable parts violating their natures as integral parts of a living organism, for unlike machine parts these organic terms are constituted by the continuous flow of chemical and energy exchanges across their interfaces with surrounding tissues.

What follows from the non-recognition of these (at their innocent best) metaphorical transitions is, for instance, confusion in the public debate about such contentious practices as abortion, cloning, disease prevention, AI (artificial intelligence), and much more, where scientific model terms, such as, ‘fetus,’ ‘genotype,’ ‘bacteria,’ and ‘neural networks,’ are filled in public discourse with meanings taken from related practical everyday (‘naive’ or ‘folk’) contexts, making them falsely synonymous with the everyday uses of the related everyday terms, ‘child,’ ‘adult,’ ‘cause of disease,’ and ‘intelligence,’ etc., respectively. This usage may be good politics, but it is itself a form of cultural disease.[20]

Despite the problems created by possible metaphorical usages due to the complementarity of explanatory scientific theory and preventive medical practices, scientific theories have been a very positive force in shaping the contemporary Lifeworld. There is no need to press this point. The bacterial theory of infection led to a host of new cultural practices dealing with food handling, personal hygiene, sewage and water systems, the urban environment, and the treatment of bacterial diseases. But these practices, of course, have to be carefully designed and prudently implemented. However, as scientific theories grow and change, a train of new and often contentious practical problems are beginning to emerge: for instance, genetic theory has led to noisy debates as to whether or under what conditions genetically modified (GM) foods should be admitted to the food chain. New cultural practices found to be effective also lead in their turn to new scientific theories, which in turn lead to better medical practices, which may lead to better scientific theories, and so on. Though often treated by public fora and sometimes even by the medical profession as stripping the mystery from Nature and as exposing what is constitutive of what ‘really is,’ scientific theory is in fact no more than a tool for, or a way of coping with some living function of the human body constituted as meaningful by a lifestyle in the patient’s Lifeworld. Because of the zone of uncertainty between theory making and cultural practices, and another between pre-scientific and post-scientific Lifeworld terms, there is an inescapable tension in the public mind that can -- and often does -- result in changes, possibly also in confusion, concerning conditions for meaning-fulfillment and norms for public policy. Noting such changes, one captures something of the historicity and contingency of hermeneutic truth.

A critical example from medicine illustrates how the multivalence of scientific descriptions can create new moral perplexities in the Lifeworld. Duden (1993), historian of the woman’s body in clinical medicine, questions the scientific term ‘fetus’ that belongs to contexts of scientific imaging and biology, and asks whether it is being abused in public fora of discussion when substituted for the term ‘child’ that is used in the Lifeworld context of pregnancy and maternity. She asks: has the separateness of contexts between model-scientific, pre-scientific Lifeworld-processes, and post-scientific Lifeworld-processes been illegitimately suppressed in our medical culture, in the media, and in public policy discourse? The terms ‘fetus’ and ‘child’ are, of course, correlative (each in its own context reveals something about what the other term refers to) but they are not isomorphic and interchangeable. A ‘fetus’ is a term whose primary owner is the medical profession. A living fetus is recognized by sonographical and other imaging techniques apart from the mother’s context in the everyday life-world. Even while inseparable from the living tissue of the mother, the fetus is generally described as a ‘thing,’ as if, like a pre-scientific machine part, it had an existence separate from the mother. Duden notes with some concern that ethical rules and legislation in Western countries concerning pregnancies are presently being written in terms of the ‘fetus’ where that term slurs the difference between the fetus as part of the scientific model, the fetus as an organic part of the post-scientific Lifeworld, and the child as an element in the mother’s (usually) pre-scientific pregnant life. Duden is unhappy with this and asks: should the difference between the two cultural perspectives be recognized and an accommodation found that defers to the special cultural role of the mother in decision-making about the child?

Summary

In the assessment of scientific theory and practice, the critique of the analytic/empiricist view of science made via the phenomenological orientation of Husserl, Heidegger, and Merleau-Ponty towards the Lifeworld and Heidegger's hermeneutics (or interpretation) of experience has made it possible to assign different roles to theory and praxis. Theory is assigned to technological design for the purposes of environmental control, while praxis is assigned to ontological understanding for the purposes of human culture. Scientific theories then have a 'Janus-like face,' one side looks in the direction of computational and technological control which is not constitutive of scientific knowledge but is merely a resource or tool for multiple praxes, the other looks in the direction of human culture which is ultimately constitutive of ontological scientific knowledge.

This bivalence underscores the prevalence of metaphor in scientific discourse and, in particular, in medical science and clinical practice under conditions where modern culture and the analytic/empiricist view tend to mask the presence of metaphor in such discourse.[21] It was shown, however, that under the broader analysis of phenomenology, metaphor is as fundamental for true scientific discourse as literality is for the analytic/empiricist view. Since the theoretical is mathematical and both the practical and the praxical are empirical, it makes no sense to predicate mathematical models literally of the phenomenological Lifeworld; at best, the two must come together consciously in some unambiguous but metaphorical way guided by professional experts in the spirit of (what Aristotle called) '*phronesis*' (prudent action), who are aware that they are seeking no more (and no less) than a praxical consensus about a set of relevant soluble Lifeworld issues.

NOTES

1. Husserl's influence on science and its critique, see, for example, Husserl (1970, 1989, 1991).

For developments of Husserl's approach to mathematics and modern science, see, for example, the work of A. Gurwitsch, P. Heelan, T. Kisiel, J. J. Kockelmans, J. N. Mohanty, and H. Weyl. For Heidegger's critique of modern science, see, for example, Heidegger (1992, 1977a). For developments of Heidegger's thinking about modern science, see, for example, B. Babich, R. Crease, D. Dahlstrom, H. Dreyfus, T. Glazebrook, P. Heelan.

2. See Heelan (1991b).

3. See Hollinger (1996), 17-41.

4. See Richardson (1968).

5. The 'received view' is the name often given to the mainline analytic/empiricist tradition in the anglo-american philosophy of science that stems from the influence of Descartes, Kant, and particularly, the Marburg School of Neokantianism (cf. Friedman, 2000), whose principal exponents in America were R. Carnap, C. Hempel, H. Feigl, and the contributors to the *Minnesota Studies in the Philosophy of Science Series* and the *Boston Studies in the Philosophy of Science Series*. For a further account, see the Introduction to Suppe (1974).

6. Polanyi's distinction between 'explicit meaning' and 'tacit meaning' parallels the distinctions made in Heidegger, 1992, 33-39. In the Preface to the 1964 Torchbook edition of *Personal Knowledge*, Polanyi writes "Things which we can tell, we know by observing them; those that we cannot tell, we know by dwelling in them. All understanding is based on our dwelling in the particulars of that which we comprehend. Such indwelling is a participation of ours in the existence of that which we comprehend; it is Heidegger's *being-in-the-world.*"

7. As an aside on *aletheic* truth, see Bakhtin (1986), 126.

8. For the notion of the Lifeworld, see Husserl (1970); also Heelan (1989b and 1991b). I am using the terms 'life-world' or 'everyday world' in a non-technical sense. The term 'Lifeworld,' however, is used in the technical phenomenological sense.

9. *Praxis* is the name Aristotle gives to a human activity that is pursued as an end in itself, that is, as a terminal goal of human living rather than as practical problem-solving (Aristotle's *techne*) that serves as means to that end. *Techne* is related to 'technical,' 'computational,' or Heidegger's 'mathematical.' *Praxis* is more difficult to translate. It is not just unreflective absorption in the activity of life, but an absorption that is continuously aware of the availability

under the right circumstances of theoretical concepts as tools for action. They are not objectified realities but more like what B. Lonergan calls, 'differentiations of consciousness' (Lonergan, 1971, 85-99).

10. See Tymieniecka (1998, 2000) for another expression, deeply informed and scholarly, of the task of developing a phenomenological philosophy of science with special reference to certain aspects of new scientific thinking, especially in molecular biology, neuroscience, and evolution.

11. The existential hermeneutical spiral must be distinguished from the philological textual or deconstructive hermeneutical circle that begins and ends in meanings that may or may not be fulfilled in experience. The existential hermeneutical spiral begins and ends in meanings fulfilled in their respective Lifeworlds.

12. Researchers in the area of robotics, such as Andy Clark (1997), have adopted a cognate attitude towards robotics, that is, towards robotics as a 'cognitive technology.'

13. Taken from the title: *Genesis and Development of a Scientific Fact*, Fleck (1979).

14. Kant, arguing from the *necessity* of natural scientific knowledge, found that its necessity was grounded in the apriori theoretical structure of human understanding, which he took to define the intelligible structure of empirical scientific phenomena (Kant, *Critique of Pure Reason*, B xii-xiv). To the extent that scientific understanding -- in the long run at least -- is historical and contingent, theory and experiment have come to be seen as mutually adaptable in the simultaneous creation of new scientific phenomena and new scientific theories. Though each *ideally* depends on the other, *in the practical order* as well as eventually *in the praxical order* the relationship depends a background condition, 'all things being equal,' that is not theoretically definable but subject to the practical/praxical judgment of experimenters in actual situations. It was the breakdown of such situations that eventually led to the need for relativity physics and quantum physics.

15. By *isomorphism* is meant a one-to-one translatability of any statement in one language into a unique statement in the other language. The two context-dependent languages refer to the same things but from different, often interacting and mutually interfering, actual perspectives. I have argued that these languages are related among themselves within a lattice structure which includes a least upper bound (lub) and a greatest lower bound (glb) as well as complements. This

thesis is presented in Heelan (1983a/1988), chaps. 10 and 13; see also Heelan (1975b).

16. For a fuller account of what constitutes a ‘phenomenon’ in Husserlean phenomenology, see also Heelan (1983a/1988; 1991b), and cf. Heidegger (1967).

17. I am assuming Husserl’s analysis of a phenomenon as the object of a noetic-noematic intentionality-structure, where the structure is group-theoretic relative to the connected set of variations (e.g., perceptual profiles) that maintain the invariance of the interest the subject has in the phenomenon, see Husserl (1999), pp.163-185, and Heelan (1991b).

18. ‘The worlds of theory and the worlds of common sense partly interpenetrate and partly merge. The results are ambivalent ... [for] it will also happen that theory fuses more with common nonsense than with common sense, to make the nonsense pretentious and, because it is common, dangerous and even disastrous.’ Lonergan (1991).

19. This is a warning that is more often heeded by historians of science and medicine than others.

20. From the point of view of contemporary functional linguistics, see, for example, the work of Halliday and Martin (1993), Bakhtin (1986), Bazermann (1988).

21. See Bazermann (1988); Fiumara (1995); Heelan (1998); Hesse and Arbib (1986); and Lakoff and Johnson (1999).

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