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THE HERMENEUTICS OF LIFE

INTRODUCTION: THE POSSIBILITY OF NATURAL HERMENEUTICS

This is a lecture, which explains the informal language and sketchiness of the text. The paper deals with the idea of hermeneutics from the viewpoint of practical biology and cognitive science. This requires some clarification. Traditionally, the above mentioned disciplines, like many others, utilize little more than basic empiry and computational modeling. Philosophy is seldom cited, if ever; in particular, hermeneutics enters virtually nowhere except, perhaps, in the study of the *making* of biology. What the present paper suggests is something very different in spirit, namely, that hermeneutic concepts should play an important role in biology proper. The hypothesis is that hermeneutics should appear not just as a study tool *of*, but *in* biology. What will be outlined below is not the first presentation of this idea: the basic material comes from two earlier publications, a book devoted entirely to related topics in English and a casual essay in Hungarian [Kampis 1991a, Kampis 1992b].

To put things differently, I actively disagree with the often heard opinion that hermeneutics relates to man-made meanings *only*, or to human language *only*, and that consequently in Nature there can be no meaning claims, and no conventions, and therefore (so continues the argument) the applicability of hermeneutics in science is necessarily limited, confined to an analysis of what *scientists* do (i.e. of "laboratory life") or to studies of the language of science ("shoptalk") then to interpretations and meta-level connotations; in short, that hermeneutics may belong to science but never become a *subject* of science.

Yet there seems to be no a priori reason why humans should be favored as the bearers or prerequisites of hermeneutic relations. Looking with a naturalist eye, meaning-laden human communication becomes but an instance of interactions between natural entities. For the naturalist, hermeneutics is just one way of talking about things, and when applying hermeneutics to human dealings we should be able to ground its use by characterizing those specific interactions that make hermeneutics necessary as a descriptive language — that is, if we want to use the language of hermeneutics, or any other nonphysical language, we should reveal the conditions that make such a turn necessary. This is a program allows for an enactment of its own basic concepts.

Of course, quite a number of developments exist already that aspire to introduce separate languages for biology and similar domains. These range from the old theories of organismic biology [Bertalanffy 1949, Weiss 1969, Koestler and Smithies 1969] to alternate concepts of modeling [Polanyi 1968, Rothstein 1982, Elsasser 1966] to theories of biological semiotics [Salthe 1993, Emmeche 1994, Csányi 1982,1986]. Some of them exploit an explicit use of circularities [Cariani 1989], others exploit informational terminology. There are several competing theories for biological holism, closure, and autonomy [Rössler 1972, Pattee 1973, Maturana and Varela 1980, Rosen 1991].

Not entirely independent of these traditions, but with a different background, we will now try to sketch an alternative framework that grounds hermeneutic ideas within biology (or rather, in proto-biology, as we shall see). First, we characterize a stage of natural development, where, as I argue, a special form of *sign use* emerges, from which there is a conceptually direct way to man, his communication, language and culture; and second, I will suggest that this semiology of life invites a form of hermeneutics (that we could call "the hermeneutics of Nature", to paraphrase a well-known philosophical title), a concept that allows for a yet unexploited form of theory building in biology.[1]

At the same time, the fact that the suggested form is "new" also means that biology is in its present form not quite prepared for it, or for a like rethinking of its own roots in general. So let us make our position clear at the outset.

The prevailing view of the theory of life (that is, of the general and abstract concept of life) is dominated by a single monolithic conceptual system, characterized by some sort of naive materialism inherited from laboratory work and physico-chemical methodology, typified by such notorious examples as the loosely formulated gene concept. When suggesting hermeneutics as a relevant principle, this automatically means that the above picture of naive materialism is challenged. But that does *not* mean, and we should be very clear about it at this point, that the very physico-chemical approach is challenged in its own place, namely, in empiry.

That may sound paradoxical, but here we refer to an obvious distinction between experience and theory. Concepts applicable to the first may not be proper for the latter — we may parallel this with the situation in physics, where experimental research proceeds by classical methods deemed (strictly spoken) impossible by modern theory, using, for example, classical measurement or corpuscular state preparation methods. This can be done under the condition that the error does not interfere with the phenomenon under study. So the lab situation is that classical (or, in the worst case, semi-classical) tools are used for studying nonclassical systems. (A trivial example is the testing of the quantum properties of some solid state device on your desktop by measuring macroscopic voltages.) Likewise, biology *should* maintain a "classical" or physico-chemical core in the laboratory, but at the same time, it should open towards more general theories that refer to out-of-lab conditions. For instance, one basic difference in biology between what is amenable to experimental analysis and what is interesting for theory is in the variety of the time scales involved and in the permanent or non-permanent nature of the phenomena — things may look constant and wired-in in the short run but more flexible and conditional on a larger time scale. The point is that static structural concepts can apply to one situation, but the other may require interactive and more relational, or in fact "non-classical", notions. That is where hermeneutics may come in.

WHAT THE HERMENEUTICS OF LIFE IS AND WHAT IT IS NOT

It will be clear from the ongoing discussion that hermeneutics will be understood in a very special form. In fact, it will be considered in a form that I believe is taken to its backbone. Unfortunately, for this enterprise, the historical layers that cover the word "hermeneutics" make it difficult to get rid of the connotations that seem inappropriate in our context.

So, to begin with the negatives, hermeneutics will not be understood as a method, in some Diltheyan sense, even less as an Essence of Being, following Heidegger or Hans Jonas. Nor will this concept be associated here with ideas of language philosophy, and still less with exegetic or even daemonological forms, as maybe in the tradition of Ricoeur. Instead, hermeneutics will be reconsidered here as something at the core of which there lies a certain general mechanism: *in ultimate analysis, hermeneutics will be conceived as a particular way of acting as related to the acquisition, processing, and generation of information*.

Accordingly, what we will understand by hermeneutics in the sequel is deceitfully simple. The most fundamental ingredients of a hermeneutic scheme will be postulated as this (and nothing else):

- there is an iterative unfolding of information content and a subsequent continual change of what is already unfolded;
- there is an historical element in this process;
- the key elements of the situation have a qualitative rather than quantitative nature;
- a certain degree of circularity is present.

Perhaps it is possible to reconstruct a common core of the various now-traditional hermeneutic theories from such an abstract definition. But that is not our intention. In fact, we proceed in the opposite direction: this scheme, when applied to our problems, will be related to *cognition* and not *understanding*: to *"Erkenntnis"* rather than *"Verständnis"*.

THE ORIGIN OF HERMENEUTICS AT THE ORIGIN OF LIFE

Now let us discuss the metaphysics of macromolecular reaction networks. We will claim that what makes life different from other phenomena of Nature (which are well off without a hermeneutic treatment) is found in these networks. Two confronting views will be presented:

Substance metaphysics or, essentially, philosophical atomism. This (mostly implicit) standpoint assumes that molecules come equipped with a pre--fabricated, finite and invariant set of properties, and that these properties in turn determine every interaction that the molecules can enter.

The ultimate modern form of this kind of essentialistic representation is what is called an "object" in computer science. Object-oriented programming (OOP) reveals in a dry contemporary technical language what good old-fashioned atomism explained philosophically. "Objects" (or, more precisely, the "classes" from which the objects are instantiated) correspond to abstract data types with a closed structure. Objects are close relatives to "frames", a term used in Artificial Intelligence after M. Minsky [1977]. Another not distant representational enterprise is "naive physics" [Bobrow 1984] (a misleading name that covers essentially nothing but a common representation of system processes with the system components that evoke them). "Objects" and "frames" consist of structured sets of declarations that specify a standardized interface to the "world". Through this interface, *and only through this* *interface*, is the communication and the behavior of the objects controlled, and they are controlled by the declarations alone; the integrity of the scheme is never disrupted.

This is particularly interesting when we consider dynamic interactions. Computer programs upon execution (much as molecules in chemical reactions) can bring forth new objects in runtime. This is achieved in OOP by generating new instances the pre-existing classes or by combining the properties of old objects into new ones, while always maintaining the closure that defines these objects as objects, i.e. domains not accessible by any other means than pre-designed. This ensures the *invariance*, *coherence*, and *transparence* of objects. In other words, objects cannot be broken up, or be changed, or be interfered with in irregular ways by any new operation whatsoever.

The perhaps best known biological example for the use of substance metaphysics is associated with the already mentioned notion of the "genetic code". This is perhaps the most often debated application of the concept at the same time (see, for instance, Mayr [1982]).

The "coding" concept for the gene implies that the information content behaves indeed, like an object. In the eye of the molecular biologist the "genetic material" (also a telling expression) becomes a storage place where things can be deposited for further use. As a consequence, molecular information appears as something absolute, objective (hence, context--independent), explicit, tangible, and relocatable. In other words, obviously, *molecular information* is conceived as if it were *structural information*. This hypothesis led to the birth of today's structural (i.e. molecular) biology. (It is proper to note that the classical gene concept of Mendel and even partly that of Morgan was a purely *functional* one, and structural biology in the modern sense began with Watson and Crick's ultimate proof that the gene was in fact a specific molecule, or better, one part, called the "cistron", of a molecule. This ended a long period dominated almost exclusively by high-level behavioral and organismic notions.)

It is well known that the simple picture of genes and molecular information breaks down when taken "too" strictly (of course, just what is too strict and what is not is not institutionally regulated). Yet it remains the most fruitful imagination for the laboratory researcher. The loose gene concept works well for him (or her) because the errors would occur only on evolutionary time scales where not just the individual genes flip, but the information content starts to "wobble" against the backdrop of the development of the whole genetic system. In the extremely narrow time windows and standardized environments (the "molecular ecology") in which the laboratory molecular biologist is interested, it is usually useful to assume that the information resides strictly in the physical structure.

In a closer analysis, genetic information turns out not to be physical at all, and to be subject to contextual modulations. Even the underlying coding system has been recognized as co-dependent with biological processes, being itself an actively maintained biological product. For instance, alternate genetic coding schemes exist in mitochondria that prove the possibility of the biological and relational manipulation of the primary information content; or a simple analysis of transfer RNA can prove that the coding triplets and the coded amino acids are unrelated by themselves, so any other pairs would also be biologically possible (because the two link to opposite ends of the tRNA molecule). The (almost) universal constancy of the genetic machinery (and with that, of the genetic information contents it defines) is today recognized as a unique dynamic phenomenon and is no more seen as a simple consequence of some structural property. Yet the conceptual leap, the break up with the structuralist concept, is still missing.

Here we come to the main point of the paper. By generalizing these observations we can get to an alternative hypothesis, which for lack of a better name will be dubbed "*molecular hermeneutics*". This metaphysics grasps the essence of the few examples we have presented so far: it suggests that structure is subordinated to function (while not forgetting that there are interesting aspects of structure). We propose these statements:

- "Properties" of biological compounds are a posteriori and relational rather than a priori or structural. Structures can be used in indefinitely many ways; in particular, old structures can be reused in different new functions.
- Information content is evoked by the embedding context, and does not exist before or after.
- Instead of isolated components, the units of analysis are situation-dependent chunks of co-existing components.

In other words, instead of assuming built-in properties, we postulate interactions that bring forth what in a permanent context would be thought of as a property. This has far-reaching consequences for the entire conceptualization. Let us mention a few. Properties, expressed in the language of natural science and mathematical models, become variables. The objects of OOP offered a special method for summarizing *variables* in a static definition. In contrast, our macromolecular production processes are now conceptualized as systems that continually produce new variables corresponding to new information content; in short, there are systems whose definition can grow or change.

Easy to recognize, such a system is no more well-defined; indeed, it is in some sense "indefinite": its informational growth is closer to contingency than to pre-programmed existence.[2] Because of the change in its basic properties, such a system can only be defined recursively, in what truly resembles a hermeneutic process or "dialogue" (of matter with itself). The components of the "dialogue" are the co-extant molecules or other systematic units, together with their interactions with each other or with their co-products; an elementary "communicative act" is the setting of a molecular environment for a new reaction, and the communicated "meaning" is the new information content (e.g. new genetic readout) evoked by this action. It is easy to see that such a process can proceed iteratively, so that the new information content in turn leads to still newer "properties" (variables) that evoke a still newer information content, and so on, in a permanent turmoil where there is a mutuality between producers and products, implying a kind of "semantic closure".

Applied to our all-too-well-known example of the genetic machinery, this framework of thinking yields a novel and fascinating picture:

The genetic code produces structural proteins and other gene products that in turn produce a translation machinery so that the latter defines the content of the code in such a way that the code prescribes the production of these very same proteins.[3]

Genetic information is a special case in that it is a persistent or permanent quality bound to a renewed production or indeed a *reproduction* of the same set of variables that evoke it. In other words, the *structural existence of information* is related to a self-consistent solution of an iterated unfolding process, similar to that of text and meaning. Such a dynamic instead of structural notion of existence points to biological reproduction as a process of particular importance. Several earlier authors such as J. von Neumann [in Burks 1970], V. Csányi [1982,1986] and O. E. Rössler [1984] have suggested this point independently. (Specifically, we mean here von Neumann's "Logical and Physical Theory of Automata", a series of Princeton lectures from 1943 edited by A. W. Burks, as the first place where JvN articulated his famous statement on self-reproduction as a cut-point in the development of Nature. In von Neumann's opinion, "below" that point of self-reproduction the complexity can only decrease, but "above" this point it can begin to increase, and evolution can take off. Not referring to von Neumann's logical study, the views of the other two authors are more biologically oriented, and generalize the notion of replication as a general vehicle of existence.)

NOTES ON CIRCULARITY

From this point on, we confine ourselves too brief remarks on applications. The so-called hermeneutic circle is said to consist of a process that leads from some pre-understanding to a better or more complete understanding which, when re-used as a new basis of pre-understanding, in turn leads to a still different reading, and so on, and finally to an unfolding of the "meaning" of the text or whatever medium; whereby inherence and iteration (or interaction) play equal roles, for neither can exist without the other. A molecular counterpart for such a process would be a growing reaction network.

But there is another, subtler form of the parallel between the two domains, and that brings a distinction between Dilthey's and Gadamer's hermeneutics to mind. Dilthey maintains that in order to understand a text, or any other meaningful human act, the life history of the interpreter and indeed of the whole of mankind should be taken into account. Gadamer, on the other hand, points out that the tradition mediated by the text, and the consciousness that functions through history are not independent; not only the mind, but also the text and its meaning are products of a development; on a historical scale, of the same common development.

We can play around with these notions to see how they "naturalize". The role of the historical element in Dilthey's hermeneutics reminds us of some form of an observer-problem: that no observation can be performed without adding a new layer separating object and subject, a layer that acts as a filter which is not part of the observed and adds its own properties to the latter (this would be an essentially Stegmüllerian position [1969]). Gadamer can be viewed, then, as focusing on what is sometimes called "the observing of the observer", which means bringing the observer's abilities into relation with the properties he or she observes (you see what you are because the world is like you). While the first simply introduces indirection between the observer and its target, the second re-establishes a correspondence similar to that of a lock and a key.

Taking a liberal attitude, several things including coherence theories, evolutionary epistemologies, "second-order cybernetics", and radical constructivism could be brought up to discuss in the same fashion; in them, we bounce into self-reference and circularity, two fashion-words.

Circularity might be an important phenomenon, but "molecular hermeneutics" as an alternative of substance metaphysics does not depend on it. "Molecular hermeneutics", as it were, is based on a transitory rather than self-referential scheme; therefore, its best relatives are not *coherence theories* but *process philosophies*. In this sense, the "hermeneutics of life" is akin to conceptions first discussed by Heraclitus, Whitehead and Bergson, and brought to theoretical biology by R. Rosen, M. Conrad, K. Matsuno, S. Salthe and the numerous others who have contributed to the shaping of non--structuralist thinking in theoretical biology.

THE "PHYSICS" OF HERMENEUTICS

We now reflect on a central problem of hermeneutics, that of the relation between subject to object, and discuss its bearing on our issues.

It has already been mentioned that one of the most important concepts of hermeneutics is that of pre-understanding. This is the very point where connections between hermeneutics and the studies of observers in natural science and in the philosophy of science already exist. Pre-understanding can be conceived, for instance, as an a priori frame of knowledge, which shapes observation.

From this, it would seem plausible to believe that one needs observers in order to have hermeneutic relations. If we cling to our starting hypothesis that humans are not extraordinary beings as regards their ability to make an iterative use of meanings, it would seem to follow that natural hermeneutics necessarily implies a standpoint according to which in Nature we deal with systems that observe themselves (or observe each other) — yielding a form of pan-cognitivism, animism or, maybe, pantheism: "All things are full of gods", and maybe the Universe is potentially conscious, and who knows what else.

My response to this is a most radical refusal.

Hermeneutics is impossible without signs, yet we should avoid exporting man's symbols and signs to places where they do not belong (remember Peircean symbols). Our task is that of grounding, and not that of projecting meaning. Indeed, the natural signs (or information contents, molecular and biological) that we were suggesting to consider are very far from man's cultural symbols. The use of signs is possible without having an observer in the psychological or epistemological sense, or even in the sense as it appears in the Copenhagen interpretation of quantum mechanics (meaning an irreversible measurement process). Nothing shows this point better than the existence of fields such as, for instance, zoo- and phytosemiotics [Sebeok 1979, Hoffmeyer 1994] that deal with plant and animal communication. The same mechanisms typical of higher animals or plants occur at various levels of organization and can be generalized down to unicells and molecules. In summary, we can conclude that signs (but not symbols) and meaning (but not intentions) can occur at various places in the material world where we don't find observers, conscious or otherwise.

Of course, it would be tempting to ask “What is a sign?” now. While not trying to give any answer, a very short and tentative statement can be risked for the sake of local coherence of the text. In a "minimalist" approach we can grant signs the often heard property that their effects, or meanings, are something not physically determined. In this sense, self-modifying systems and changing codes can be good candidates for semiotic objects; the contexts that define them are almost as good at freeing information from physical structure as are cultural conventions.

AN APPLICATION TO EVOLUTION THEORY

Hermeneutic phenomena can be found at several levels of biological existence. Molecular hermeneutics may serve as a template for these. Cellular logic or the logic of the immune system are candidates for systems that literally "talk to themselves"; self-recognition, autoimmune diseases, nontrivial replication and the like could be discussed at this point. This lies far beyond the scope of the present paper.

Instead, as a simple application, a discussion of biological evolution theory will be given.

Classical evolution theory (in the sense of the neo-Darwinian or modern synthesis) describes the growth of life as a unidirectional communication between Nature and the living organisms. This is best reflected in the very notion of "natural selection". Natural selection places the driving force of evolution outside the evolving objects. Darwin's theory was developed as a generalization of knowledge obtained from artificial breeders (where the asymmetry between the selector and the selected is obvious); Darwin linked this knowledge to Malthusian growth to obtain the notion of differential survival which Spencer later called "struggle for life".

This unidirectionality is exemplified by many kinds of evolution-based models, such as genetic algorithms. These are computer procedures that stand in parallel with supervised machine learning (i.e. learning with a teacher). But where there is a teacher, the solution is already known. This family of models depicts evolution as an optimization process, where there is an outside goal to be fulfilled. In other words, selection, understood in the above restricted sense, rests on the idea of an external, omniscient God-like agent that stands outside matters and controls them with his infinite wisdom.

Let us note as an aside that, paradoxically, this stance narrows down Darwinism, an originally free-development-based idea, to those earlier orthogenetic concepts that assumed the pre-existence of a certain divine plan for governing change. In one word, the modern concept of selection is inherited from the same absolutist tradition Darwinian theory was originally invented to replace (more about this controversial feature of evolution theory can be read in Kampis [1991]).

"Natural selection" is, however, but one-half of the whole process. Much as the genetic code cannot be confined to DNA content, but is rather based on a feedback between various classes of cell components, also the selective forces of evolution become products rather than prerequisites of the evolution process. Co-evolution (in the sense of Van Valen [1973], Stenseth and Maynard Smith [1984], and others) is a newer concept which attempts to address this mutuality. The informal meaning of the statement that life's development is co-evolutionary is that we have a two-directional process where the results of previous selections can become selective forces for new development.

I would like to point out that by its own logic this idea goes beyond substance metaphysics, and needs hermeneutic concepts to describe. In substance metaphysics, once the structure is defined, the selective force determined by the structure is also defined; if we operate with objects with closed definitions, they never combine into things with genuinely new properties. "New" forces would then simply be functions of the old ones. An iterative mutual growth of causes and effects is not possible. Evolution would come to a halt.

Imagine a neo-Darwinian world which operates as just described. The properties of such a world can be nicely illustrated on recent computer simulations of co-evolution. Dewdney's co-evolving plant and plant-eater "biomorph" ecosystem [1988], based on R. Dawkins' earlier idea [1986], is a splendid example of what mutualism can achieve, but it never escapes from a battle of bigger spines for the plant and longer necks for the animal. In half an hour or so, the game starts repeating itself. By contrast, in a similar situation, real plants would evolve auxiliary properties to change the rule of the game "in runtime". For instance, they would develop protecting hard skin or poisonous flowers, where the neck of the animal is just irrelevant.

Also commercial programs like SimLife or ElFish, promoted by leading biologists such as John Maynard Smith, prove not to be stronger than "gene recombinator engines" that scan a huge genetic search space where every genotype has an a priori value against every other genotype of every other species. By the definition of these genes, no context-dependent development can take place. As a result, you never get sustained evolution.

Finally, the perhaps best known simulation of all, Tom Ray's Tierra [1991] (and its relatives or predecessors, such as Psoup, Core War, or Vyssotsky's Darwin from the seventies) shows the same remarkable monotony. In these simulations, every organism stands in competition with every other, and as a consequence of that, there is but one selection force, which favors brute reproduction speed. In a real co-evolving ecosystem reproduction speed is not important in itself, only in comparison with organisms of the same niche; the elephant does not compete with the mouse. An important target of evolution is the opening and closing of niches, and a consequent shaping of new selection forces, accompanied by competition avoidance.

A hermeneutic treatment of selection forces could add more flexibility and get closer to the "real thing". At the same time, the suggestion has several far-reaching implications that go beyond biology. The notion of iterative development pushes the modeler to drop the idea of apriorism, or omniscience, together with the usual birds-eye view of the scientific models — just in the same way as the detached position of the reader should be abandoned when interpreting a text.

Extending this side remark, a new development in natural philosophy, called "endophysics" is closely related. Endophysics was initiated by theoretical physicist D. Finkelstein and theoretical chemist O. E. Rössler. The expression means "inner physics", or, still better, "Nature inside". Endophysics deals with the world of internal observers and is concerned with the constraints and peculiarities that arise when the observer is bound to the same laws as those of the system to be observed. Several results show the viability of this approach in several problem fields [Kampis 1993a, Svozil 1993, Löfgren 1993, Atmanspacher and Dalenoort 1994]. It was suggested by the present author that the hermeneutic closure of (co-)evolutionary forces is best expressed in an "endo" approach of evolution [Kampis 1994a], where the epistemological and ontological constraints of the changing system can be taken into account; endophysical modeling is perhaps a chance for co--evolution to set through.

AN APPLICATION TO COGNITION

Another brief illustration comes from cognitive science. This will be a most positive example, that offers exactly the same kind of thinking as promoted by "molecular hermeneutics". It's about Gordon Pask's Conversation Theory [1975], a little known but important work. Pask has recently been quoted by Winograd [Winograd and Flores 1986] and others as a pioneer of interactive representations.

Pask defines intelligence, understanding, and meaning within a cybernetic framework. He derives intelligence from communication (it is important to note that the motivation of Pask's study came from the analysis of man-machine systems). An advanced mathematical development is given that assigns a precise meaning to the terms communication, understanding, and intelligence. This makes it possible to derive a methodology where statements can be proven. The flavor of these statements can be illustrated on an example. For intelligent communication it is sufficient for one of the partners to be intelligent; from here, Pask proceeds towards an unusual learning theory and a new methodology of knowledge representation.

More important is the idea that, in Pask's definition, intelligence corresponds to the ability to conduct a dialogue in which understanding is achieved. Understanding, in turn, is defined as the ability to reproduce the derivation of the statements that are understood.

The notion of derivation plays a central role in the whole theory: communication is conceptualized as a two-level process in which both statements and the methods by which the statements are obtained are exchanged. Accordingly, the two levels of a dialogue correspond to what we can call a *factual* and a *procedural* level, and a dialogue means an iterative exchange that concerns both. Dialogue of Conversation Theory take place in some previously fixed language, with the aim to achieve a state where there is an agreement on both dialogical levels. That corresponds to the point where both partners can reproduce each other's derivations within the given domain of conversation. At that point, the "concepts" of the participants form a stable and self-coherent set which arises as a fixed point of the transformations that lead to it. At every stage of the dialogue, received information is interpreted by means of the respective participant's current methods and statements. As the dialogue develops, this basis changes, and so do the participant’s answers.

In other words, Conversation Theory as a computerized methodology has an explicit concern with the historical knowledge background of the individual, and with the change of this historical knowledge background, and so this theory is indeed hermeneutical in the sense we used throughout this paper. Of course, it is yet to be seen whether Conversation Theory (from which computer-based dialogue systems have emerged) or Winograd's more recent systems [Adler and Winograd 1992] will ever be developed to a level of usefulness that compares to their theoretical originality; anyway, the ideas are there.

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NOTES

[1] An analysis of the relationship of the present approach to other cited works, as well as to philosophical predecessors such as Bergson, Whitehead, or H. Weyl, was offered in a number of earlier writings [Kampis 1989, 1991a,b, 1992a, 1994a].

[2] A study of definability and computability issues can be started at this point. For a discussion of such problems, see [Kampis 1994b].

[3] I can hear some readers say that part of this sentence could just as well come from the autopoiesis theory of Maturana and Varela. However, in autopoiesis self-production is a primitive concept and not a derived one, as here; therefore, it is logically possible to accept autopoiesis but to reject self-modification or molecular hermeneutics, and the other way around. For instance, the use of an informational language or the idea of grounding the properties of a closed organization in elementary interactions is entirely excluded from autopoiesis by its very definition, as that theory is based on a form of irreducible self-reference.

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