

THE MINIMAL EPISTEMOLOGICAL AND ONTOLOGICAL CONDITIONS FOR A THEORY OF SYSTEMIC INTERDISCIPLINARITY

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The notion of interdisciplinarity is infiltrating the academic world with breathtaking rapidity. Whether in the arts, the humanities, the social sciences, or even the natural sciences, there is a growing consensus that the traditional disciplinary boundaries are ill-adapted for the information rich world we are creating. And yet, despite a general acceptance of the necessity to move beyond traditional academic enclaves, there is nothing approaching consensus regarding the exact nature and scope of interdisciplinary thought. It is indeed odd that so many scholars, researchers, scientists, and artists agree on a pressing need whose contours are left unexplicit and ill-defined.

Perhaps the main reason for the vagueness of much discussion on the notion of interdisciplinarity is that there has as yet been little work done on the fundamental ontological and epistemological conditions for an interdisciplinary world view. In other words, I believe that although interest in interdisciplinarity is the herald of a major paradigm shift in Western philosophical thought, a shift whose effects are proliferating, its conditions of possibility remain largely unexplored. It is beyond the scope of this essay to present a coherent theory of interdisciplinarity. However, in the interests of beginning a discussion of the nature of interdisciplinarity, I will attempt to outline a number of ontological and epistemological conditions which I believe are necessary for understanding interdisciplinarity.

In general, there are two kinds of approaches to the question of interdisciplinarity. The first I will label contingent interdisciplinarity. Although there are many versions of contingent interdisciplinarity, their

proponents tent to agree on the essentially ad hoc and external nature of their enterprise. Specifically, contingent interdisciplinarity sees the commerce among the disciplines to be characterized by chance contact, borrowing, or the vicarious experience of a subject from a different perspective. The contingent interdisciplinarian is a tourist in another country. Some, like Lyotard (1984), are tourists because they claim that the world is becoming so complex that the grand narratives uniting the old disciplinary nation states no longer exist, so we are all in a sense condemned to wander among their fragments. Others, like Rorty (1989), believe that in the absence of deep anchors, the human cultural world is infinitely malleable. For them, interdisciplinarity is a kind of performative redescription of the world that borrows from whatever disciplinary language might prove useful in a specific problem situation. Still others, and here I would include thousands of well meaning academics, are interdisciplinarian tourists because they have been convinced that the only depth the world possesses is that lent to it by a kind of cubist multiple perspectivism. All of these versions of interdisciplinarity share a belief that we live in a kind of world in which the intercourse among disciplines must be understood as the provisional and essentially ad hoc commerce among Wittgensteinian (1958) language games that are incommensurable to some degree.

It is not the aim of this essay to refute contingent interdisciplinarity. Suffice it to say that if the world is as I will describe it, then contingent interdisciplinarity can be dismissed because it is based on faulty ontological and epistemological assumptions. The second kind of interdisciplinarity I will label systemic interdisciplinarity. Systemic interdisciplinarity differs from contingent interdisciplinarity in that it supposes that the traditional disciplines are bound by a deep and non-contingent unity. There are many versions of systemic interdisciplinarity, but for the purposes of this paper I will consider two, the first of which I will discuss only briefly in order to avoid confusing it with what I consider to be the most powerful model of interdisciplinarity.

This first type of systemic interdisciplinarity I will call trivial systemic interdisciplinarity: the belief that the disciplines are united insofar as they are components of an eternal metaphysical schema, usually expressed in the form of a theological cosmology. The core of trivial systemic interdisciplinarity is that all the disciplines are expressions of an unchanging and totally closed set of principles. There is indeed great unity in the mind of

God, or among Plato's forms, but it is a sterile unity consisting of either a featureless plenitude or a pantheon of timeless and unchanging ideas. Although it is impossible to refute metaphysical interdisciplinarity (the non-existence of God being as difficult to prove as his existence), I take it to be trivial for the simple reason that, were it to accurately describe our world, it would suggest that the various disciplines, or fields of knowledge, would in fact be a realm of illusion which is disposable as soon as perfect knowledge has been attained. From the perspective of such knowledge, all interdisciplinary viewpoints would be trivial, as they would in the absence of such knowledge. Either way, the notion of metaphysical systemic interdisciplinarity is trivial and can be discarded.

The second kind of systemic interdisciplinarity is, in general, a view that postulates that the various disciplines used by human beings to describe the world are clues to the deep connectedness of the universe. There are many candidates for such a theory, but most, such as Marxism or Psychoanalysis, are either too limited, dealing only with phenomena at the human level, or already falsified by historical or scientific evidence. To my mind, only one theory of systemic interdisciplinarity, a theory postulating the universe as an evolving hierarchical system, is able to account for phenomena at both the natural and the cultural levels, and to be in step with the best available scientific knowledge. The remainder of this paper will be an attempt to sketch the minimum ontological and epistemological conditions for an interdisciplinary theory based on the premise that the universe is best described as an evolutionary system.

An Evolutionary Ontology

The major theoretical source for this paper is the work of J.T. Fraser (1987), whose central thesis is that cosmic evolution can be understood as the evolution of increasingly complex temporalities which are related to each other in a generally hierarchical fashion. That is, Fraser's evolutionary levels exist in such a way that more complex levels emerge from simpler ones while retaining the simpler levels as their microstructure. Simply, evolution is seen as a process of complexification that incorporates its past as the fine grain of the present. According to Fraser, time has evolved through the following levels:

Atemporality describes the world of electromagnetic radiation. "Atemporal conditions do not signify nothingness but rather that the proper time of particles that travel at the speed of light is zero" (p. 368).

Prototemporality, the time of elementary particles, "is an undirected, nonflowing as well as fragmented (noncontinuous) time for which precise locations of instants have no meaning. Events in the prototemporal universe may only be located in a statistical, probabilistic manner" (p. 368).

Eotemporality is the temporality of massive matter. "It is a continuous but nondirected, nonflowing time to which our ideas of a present, future, or past cannot be applied" (p. 368).

Biotemporality, the time of living organisms, "is characterized by a distinction among future, past, and present, but the horizons of futurity and pastness are very limited. . ." (pp. 368-369).

Nootemporality is the temporality of the fully developed human mind. "It is characterized by a clear distinction among future, past, and present; by unlimited horizons of futurity and pastness; and by the mental present. . ." (p. 367).

Sociotemporality is "the postulated level-specific reality of a time-compact globe. The study of sociotemporality encompasses issues in the socialization of time and in the collective evaluation of time" (p. 368).

An important consequence of Fraser's theory of temporal evolution is that as time evolves so does the knowable world. The major support for this claim comes from Jakob von Uexkull's (1957) notion of a biological Umwelt, the knowledge potentially available to a creature's receptors and effectors. Uexkull's Umwelt theory can be expanded to inform a general epistemology. The knowledge available to an entity is thereby defined as the sum of the possible information it can register (be in-formed by), manipulate, and transmit (in-form other entities with). Of course it is impossible that any given entity actually registers and transmits all the

information it is in principle able to handle, so actual knowledge will always be less than that which defines an Umwelt. An Umwelt is always the horizon of potential knowledge accessible at a given evolutionary stage.

Consequently, there is no such thing as the world. Like everything else in an evolutionary cosmology, world is an evolving object whose definition becomes confused if level distinctions are not respected. Since the world is a function of the Umwelt of entities experiencing it, there is literally more world available to entities occupying upper Umwelts than for denizens of lower levels.

A fundamental condition of systemic interdisciplinarity, then, is to abandon an idea that has remained basically intact from Plato to Derrida, that there is an ontological gulf between the world as revealed to human beings and the natural world. Instead, Being must be defined as a continuum of self-nested levels of complexity ranging from the utter simplicity of particles with zero restmass to the complexity of the human mental and cultural world. This evolutionary ontology rejects Cartesian dualism, Heideggerian mysticism, and Derridian deconstruction as inadequate descriptions of a world whose Being can only be properly understood if the specificity of its constituent Umwelts as well as the principles of their evolution are taken into account.

An Evolutionary Epistemology

An evolutionary ontology postulates that the universe is a hierarchical system of different levels of complexity. Now I turn to the basic epistemological conditions of a systemic interdisciplinarity.

Most theories of interdisciplinarity suffer by restricting the epistemic subject to a human being. An important consequence of Fraser's theory is that it can be used to extend the concept of an epistemic subject to the entire universe. Every entity in the universe, from the most primitive to the most complex, exchanges information with its environment. A rock obeys the laws of Newtonian physics as well as the regularities of its molecular and particle levels. The idea of obeying laws, anthropomorphic though it may sound, is, I think, a perfectly appropriate way to describe the way in which entities can respond appropriately to ambient information. Thus a rock falls in response to gravity (whether we understand

gravity in Newtonian terms, as action at a distance, in relativistic terms, as a warp in spacetime, or in quantum terms, as the exchange of gravitons) because it has “knowledge” of its environment. Of course this knowledge is not conscious, since consciousness does not belong to the eotemporal realm, but it is knowledge nonetheless. If knowledge is the exchange of information, and if, as suggested by an extension of Uexkull’s Umwelt principle, everything in the universe exchanges some kinds of information with everything else, then we can postulate that knowledge is a hierarchically arranged continuum of increasingly powerful information processing capabilities.

Interestingly, such an epistemology is at the heart of the evolutionary ontology outlined above. Anything in the universe which is in-formed by its environment and which in turn in-forms its surroundings can be considered as possessing Being. In short, Being is the exchange of information among beings. It follows that non-Being is defined by the absence of information exchange: an “entity” which neither informs nor is in-formed simply has no Being.

I now turn to two central epistemological concepts, the ideas of truth and representation. If by representation is meant the ability to produce an inner map of external conditions, then it is clear that only higher animals are able to represent the world. However, if we consider representation as an evolving concept, then it appears that such biological representation, clearly requiring a complex central nervous system, is simply an upper level description of a hierarchy constitutive of Being in general. Defined as the possibility of information exchange, or as the imprint of an outside upon some interior registering mechanism, Being is always representation. Although an entity existing in a primitive Umwelt, such as an electron, represents its world in an essentially stochastic manner, to the extent that it exists at all it registers a certain amount of the information available in its statistical world. Similarly, a rock’s sensitivity to the environment available to it is a kind of representation appropriate to its Umwelt, a range of information exchanges which is wider and more complex than that available to an electron, but primitive and narrow compared to the world of the crudest biological entity.

The concept of representation, therefore, must be conceptualized as an evolving process of information transactions. I appreciate that many philosophers might be uncomfortable about applying the notion of representation to entities unable to create an internal model of their environ-

ment, fearing that such an extension of a human concept may be nothing more than anthropomorphism. This problem is inevitable and unavoidable whenever a member of one Umwelt uses an upper level language to describe a lower level one. In a way there is no rebutting a skeptical critic who argues that it is in principle impossible to know if rocks represent anything. My only response to such a charge is that the skeptic's argument can be used in a Cartesian way to doubt anything, from the existence of other minds to the existence of a world in general, and that such idealism can no more be refuted than can the existence of colonies of invisible rabbits living in our homes. We must simply trust the dialectic between our senses and our minds to sketch a relatively accurate image of our environment, and insofar as that environment seems to be best described by evolution, we must assume that even skeptical idealism has been made possible by its habitation in lower Umwelts. We can therefore use Fraser's extension of the Umwelt principle to argue that even though representation is a concept whose genesis as concept occurred in the nootemporal Umwelt, because the nootemporal Umwelt is itself a palimpsest of its evolution, the microstructure of human representation is a hierarchy of lower, less complex, kinds of representation.

If we define truth traditionally, as the correspondence between representation and represented, then an evolutionary theory of representation ought to yield an evolutionary theory of truth. A hierarchical epistemology suggests that as we proceed up the levels of complexity constitutive of Fraser's Umwelts two things happen: representations become increasingly detached from stereotypical exchanges between entities and their environment and, as a consequence, truth becomes increasingly problematic. Simply, the more time available to an entity, the more likely a mismatch between representation and represented.

Although the possibility of developing a level-specific epistemology is a challenging one, in this essay I will restrict myself to the consequences of such an evolutionary epistemology for a human epistemic subject seeking to establish a theory of interdisciplinarity. I will therefore consider two specific kinds of knowledge available to human beings. The first, knowledge as shared representation, opens the possibility of direct communication between human beings and the natural world. The second, knowledge as indirect representation of the world, suggests a way to avoid the idealizing tendencies of constructivist theories of scientific knowledge. It is hoped that when combined, these views of human repre-

sensation will yield an evolutionary epistemology capable of supporting a theory of interdisciplinarity.

Knowledge as Shared Representational Modalities

A fundamental implication of Fraser's philosophy of time is what he calls the "extended Umwelt theory," the idea that residents of an upper Umwelt can experience the more restricted worlds of lower Umwelts by engaging in a kind of time travel. In the following two sections, I hypothesize that the extended Umwelt principle may have one of two modalities. The first, possible only for biotemporal and nootemporal entities, is to represent something as object. The second, a mode of knowledge available to the entire world, is to represent the way something represents the world. The former, experience as indirect representation, or knowledge as knowledge of something, is the subject of the next section. In this section, I will address the possibility that knowledge may be understood as shared knowledge — that is, as the direct experience of the representational modalities of lower Umwelts.

The kind of shared experience I have in mind is not that afforded by the human imagination. Human beings, and possibly other mammals, are able to represent information which is not accessible to their sense organs. In fact, our ability to exist in counter-factual worlds, in bizarre scientific hypotheses such as Hawking's imaginary time, and in the teleologies and eschatologies of traditional mythological and theological speculation, is clearly a cornerstone of the incredible plasticity and inventiveness of the nootemporal Umwelt. We could therefore suppose that the extended Umwelt principle relies exclusively on our imaginative faculty. Although the imagination is an important aspect of the enormous span of the nootemporal world, to suggest that communication with lower Umwelts occurs solely through the imaginative faculty leaves the extended Umwelt principle open to charges of idealism or anthropomorphism. In other words, if all we know of the non-human world is filtered through nootemporal representations, such as scientific theories and imaginative recreations, then there is no possibility for empathy with pre-human creatures and things.

All non-hierarchical epistemologies must reduce human communication with non-nootemporal entities to at best heavy distortion and at worst

narcissism. The only way to entertain the possibility of a kind of direct commerce with the world is if we conceive of the universe as a hierarchical system in which the upper levels contain, as their microstructure, lower levels. Human communication with lower *Umwelts* becomes possible, then, because we are, in part, these levels, or to put the matter slightly differently, because these levels are actually earlier versions of ourselves upon which evolution based its subsequent development but which it never abandoned.

Such an evolutionary hierarchical view of shared knowledge resolves the old dilemma of inter-level otherness. Clearly communication with something which is totally alien would be impossible, yet communication with an other conceived of as a version of oneself is the essence of solipsism. If, however, other entities in our world are evolutionary stages of which we are still composed, then communication is neither impossible nor superfluous. The notion of hierarchy gives the other its dignity while relieving it of the burden of pure and unbreachable alterity.

Therefore, the idealist dangers of the top-down kind of communication implied by the imagination model are mitigated if to it we add a level-specific model. This model suggests that since the world of a given evolutionary level includes the worlds of lower integrative levels, the general modalities of knowledge opened up by a specific *Umwelt*, although not its specific representations, are available to the higher *Umwelts*. In other words, it is possible to imagine a resident of an upper-level *Umwelt* directly experiencing lower-level worlds because the hierarchical structure of the higher *Umwelt* includes, as its fine structure, the information processing technologies of the lower integrative levels. Needless to say, by direct experience I do not mean something like what Derrida understands to be the dream of metaphysics — the erasure of the signifier. All experience is representation, that much goes without saying. My point is that a hierarchically arranged entity can experience its constituent levels in two ways: with top-down representations of a given *Umwelt* and with level-specific representations of the world as experienced by that *Umwelt*.

A simple example might help. Let us compare the *Umwelts* of a rock (eotemporal), a rat (biotemporal), and a human (nootemporal). I am claiming that the human can participate directly in the worlds of the rock and rat in two ways.

First, imagination allows the human to attempt to see the world as if

he or she were a rat or a rock. Although this approach has undeniable advantages, it is perhaps a better description of how a human being acquires human knowledge than how he or she communicates with lower *Umwelts*. Actors pretending they are rats or rocks are de jure doomed to failure because, among other things, rats and rocks can't pretend.

Second, insofar as the nootemporal *Umwelt* includes the biotemporal and the eotemporal, the human can experience the worlds of a rat or a rock. For example, when I walk, I have biotemporal knowledge through my muscles and my autonomic nervous system. When I fall, when I am subjected to acceleration, and when I demonstrate the physical law that two objects can't occupy the same space, my experience is eotemporal.

Perhaps the most important consequence of this hypothesis is that it claims that human knowledge need not be actually or potentially conscious. Even Freud, who did more than anyone else to popularize the idea of an unconscious, could never conceptualize the unconscious as anything but a relatively sophisticated brain process. Freud's *Id* may be primitive, but it is certainly no more primitive than the biotemporal *Umwelt*. I am suggesting that level-specific knowledge of the world of a rat or a rock is for the most part so primitive that it is in principle unavailable to conscious reflection except as a top-down theory or fiction. The reason for this is quite simple: most of the universe's lower *Umwelts* don't include something like consciousness, so the knowledge available to them cannot include nootemporal (or advanced biotemporal) consciousness. It is becoming increasingly clear in such fields as neurophysiology and neural net artificial intelligence that the conscious part of the brain sits atop an immense and tangled hierarchy of unconscious processes. Perhaps the best demonstration of this claim is through introspection on introspection. A little introspection reveals how remarkably inefficient introspection is. No amount of introspection can reveal anything but upper level mind events. When it comes to the majority of the brain's work, introspection is useless. Try to figure out how words come to you as you speak the most banal of sentences to get my point. Therefore, if even the great bulk of upper level brain events are unconscious, then a fortiori events occurring in lower mental or physical *Umwelts* are essentially unconscious. When I stand up and walk, I am using a part of my nervous system that I share with a rat, and because a rat's brain is not large enough to allow self-reflection, I am in principle not in a position to raise my direct knowledge of walking to consciousness. A rock's *Umwelt* is

orders of magnitude smaller than a rat's, since it does not include the world opened up by a nervous system. Yet, when a human falls, his or her body has knowledge of gravity which is identical to the knowledge which a rock can possess. In short, the theory of direct shared knowledge claims that a hierarchically arranged system can experience directly the kinds of knowledge typically associated with its embedded layers, but because such knowledge must be level-specific it occurs mainly below the level of conscious awareness.

I would like to add a note of caution to this theory of inter-level communication. If it needed to monitor the functioning of every neuron, a human brain would crumble under the weight of its own officiousness. In fact, as Douglas Hofstadter (1979) argues, hierarchical systems tend to seal off lower-level information from direct higher-level awareness except in the form of "chunked" summaries. Thus, an architect needn't know how to manufacture nails in order to design a house. Instead he or she relies on chunked knowledge of nail-making, namely that it is possible to have a contractor order them from a manufacturer. I appear, therefore, to be contradicting myself. On the one hand I am claiming that Fraser's extended Umwelt principle enables inter-level communication, on the other I am acknowledging that for the most part, higher levels abjure the clumsiness of lower-level detail for the usefulness of chunked summaries. However, I think that the contradiction can be resolved if we are careful to distinguish between two kinds of information available to a hierarchical system.

The first, Hofstadter's, is a kind of translation of lower-level information into a form which is useful at an upper-level. Chunking is a summary of lower-level processes encoded in upper-level language. For example, when I press "save" on my computer, I am chunking a series of commands and paths written in machine language which I in no way need to understand, when I turn on my radio I am chunking its circuitry and the laws of electro-magnetism, and when I move my arm I am chunking the laws of biology, chemistry, and physics. Hofstadter's concept of chunking, therefore, sacrifices precision for flexibility and direct knowledge of lower-level events for the pragmatic advantages of delegation.

As opposed to chunking, Fraser's extended Umwelt principle suggests that besides summaries of lower-level information written, as it were, in upper-level languages, levels in a hierarchical system have direct access

to their own microstructure. Thus, whereas my brain works best when the various societies of neurons of which it is composed send each other, and especially the complex super-societies which probably constitute consciousness, chunked summaries of their work, I, as a holistic organism nevertheless have knowledge of the kind of knowledge to which my individual neurons are open. Of course, neurons are rather primitive biotemporal entities, well below the threshold of consciousness, so my level-specific knowledge of my neurons cannot be conscious. Furthermore, the biological usefulness of neurons is not in "how" they know, but in "what" they know, and to that I only have access in a highly chunked way. Nevertheless, since neurons are part of me, and since their Umwelt describes a horizon of possible knowledge, I too have direct knowledge of the kinds of information exchanges they are open to.

Because the concept of selfhood has all too frequently been restricted to that part of a human being which is selfconscious, such lower-level knowledge tends to be neglected or denied. It is only when we reject the phenomenological reduction of the self to consciousness that the economy between chunking and the extended Umwelt principle as direct representation can be articulated. Whereas much contemporary theory considers hierarchies as oppressive and ethically suspect, I am arguing that a kind of genuine connectedness with nature is possible precisely because human beings are part of an immense natural hierarchy. Of course such level-specific communion with lower Umwelts should not obscure what is properly and remarkably human, the stunning freedom of the nootemporal bought in part through the sacrifices implicit in chunking. However, if as many feminist and ecologist theorists maintain, a crucial concern for our Postmodern society should be the establishment of a genuinely respectful relation to nature, I believe it is important for our souls that we remember such commerce is possible due in large measure to nature's passion for hierarchy.

Indirect Representation

The kind of level-specific knowledge described in the previous section constitutes the basic pre-critical connectedness of upper levels in Fraser's hierarchy with the levels beneath them. Although its importance cannot be stressed enough, insofar as it serves as a kind of glue uniting disparate

elements in a hierarchy, it is nevertheless knowledge which is for the most part unavailable in useable conscious form for nootemporal creatures. In other words, although direct knowledge connects human beings with the rest of the universe, it does so largely at an unconscious level, so it is not available for the proper work of nootemporality — the creation of theories, hypotheses, works of art etc. — except at a somatic and pre-somatic level. As such, it may provide a fundamental, largely pre-linguistic grounding in the world essential for interdisciplinary thinking, but it offers little support for an actual theory of interdisciplinarity. For that, it will be necessary to proceed to a consideration of the second kind of knowledge suggested above, knowledge as indirect representation, or knowledge as a relation to the world in which objects at different levels are represented by nootemporal models.

I will begin with a consideration of science, which I believe to be the most efficient method for a nootemporal subject to make upper-level descriptions of the lower evolutionary Umwelts. Of course, assuming a traditional correspondence theory of truth, there is clearly no such thing as the truth at the nootemporal level. A seemingly innocent statement about the eotemporal world, such as “Water is composed of hydrogen and oxygen,” can be surprisingly problematic. The nootemporal world is so complex that even when it is engaged in describing an Umwelt which time has collapsed into relative stability, it can muddy things up with infusions of higher level information. Thus, Wittgenstein’s demon can always claim that “Water is composed of hydrogen and oxygen,” or some chemical-mathematical representation of the same fact, was meant as a poetic evocation of mood rather than as denotative statement. It is undeniable that such confusion is always possible. And although we are able to use history, institutions, gestures, linguistic markers etc. more or less successfully to engage in context control, thereby specifying which level-specific language is currently operative, the kinds of context slippage signalled by Wittgenstein and Derrida are an unavoidable component of nootemporal representations.

However, I think that the sort of constructivism which maintains that interpretative contexts have no basis beyond the contingent stability lent by nootemporal institutional, political, and historical determinations mistakes the price paid for nootemporal truth with the truth itself. A radical constructivist view of science is anthropocentric insofar as it ignores the hierarchical nature of the universe. By way of contrast, a

modest realist position would maintain that a function of science, though by no means its only function, is to allow human beings to employ a particular nootemporal formalism, mathematics, in order to communicate with the natural world. In other words, science attempts to translate the languages of our evolutionary past into nootemporal terms. It chooses mathematics because, as Fraser suggests, mathematics is an upper-level translation of the fundamental mathematical reality of the lower Umwelts. To put the matter simply, science works, it has cross-cultural instrumental efficacy, because nature is mathematical enough to respond to the scientist's equations. The inverse square law of gravitation is not a socio-political construct except on a trivial level — on the contrary, it is the translation into nootemporal terms of certain mathematical principles underlying the eotemporal Umwelt. Thus, the disciplines of physics, chemistry, biology etc. are what Ilya Prigogine (1984) calls "a dialogue with nature," that is, a dialogue with the extant remains of past evolutionary inventions. In other words, science is a conscious peek into our past. To claim otherwise smacks suspiciously of the worst kind of Renaissance humanist creationism: the belief that "man", which in its contemporary incarnation becomes "institutions," is the measure of all things. Humans may have the largest ruler, but theirs is not the only one.

The theory of indirect representation eschews metaphysical certainty and constructivist smugness in favor of conceptualizing knowledge as a range of probabilities. In general, I hypothesize that from the perspective of the human cultural world, the probability of correctly modelling a given cosmic level increases with its increasing age and decreasing complexity. The more primitive layers of the universe have a high probability of being represented adequately because they are simple and determinate enough to be mapped by the mathematical formalisms employed by the natural sciences. That is why experiments on lower Umwelt regularities are repeatable and in general conform to the scientific method. Therefore, we should expect that the probability for objective knowledge increases as the object of inquiry decreases in complexity.

I should hasten to add that all of Fraser's Umwelts are infinitely complex; however, since as modern mathematics has shown us, not all infinities are equally large, it is possible to claim that lower Umwelts are in fact both infinitely complex yet much simpler than upper Umwelts. I would also add that these lower levels can be modelled using other representational means, such as literal and metaphoric natural language. Such

representations tend to have a higher probability of correctly mapping the referent than nootemporal representations of nootemporal objects, but, since they are inherently more complex than quantitative formalisms, they can never approach the high probability of correspondence to lower Umwelts enjoyed by mathematics. Of course, they frequently do not aspire to such rigor, thereby making its probability a moot point. In general, using natural language rather than mathematics to represent the natural world sacrifices determinism for flexibility and semantic richness. My basic point, however, is that scientific epistemology is so well represented by a correspondence theory of truth because atemporal, prototemporal, and eotemporal objects and processes are relatively simple and determined systems conducive to rigorous mapping by mathematical formalisms.

The intermediate levels of cosmic evolution, those studied by the social sciences, are too complex and too ductile for adequate quantitative modelling, yet not so complex and ductile that such modelling is completely useless. Therefore, the social sciences function most efficiently by employing a combination of mathematics and natural language. This kind of hybrid representational system is able to model a much greater and more complex range of information than can the natural sciences, in part because it must include, as its microstructure, Popper's World 1, but it must pay for its power with a lower probability of accurate correspondence between map and object.

Nootemporal models of nootemporal objects, the humanities and the arts, deal with a fabulously complex evolutionary level which is still in the process of creating itself, so the rigor of traditional mathematics (an exception, perhaps, is chaos theory) is nearly useless in representing it. At the nootemporal level, the correspondence theory of truth is vitiated by the complexity of the object of representation, the complexity of the medium of representation, (natural language and the arts), by the fact that representation and represented are partially on the same evolutionary level and can thereby generate Gödelian incompleteness, by the tendency of nootemporal representation to be prone to continual selfmodification, by the necessity to respect the constraints imposed by the lower Umwelts, and by the fact that the level itself is largely inchoate. Therefore, the modes of representation typically applied to nootemporal fields like the arts and the humanities are rich enough to represent an enormous amount of information, but their robustness must be bought at the price of a

relatively low probability of a strict correspondence with their representations.

In sum, the theory of indirect representation is able to account for the qualitative difference between truth claims in the arts and humanities, the social sciences, and the natural sciences by arguing that the very notion of truth must be applied in a level-specific manner. Thus, it claims that for a nootemporal epistemic subject, a correspondence theory of truth has an increasingly better probability of success as the object Umwelt decreases in complexity by descending Fraser's hierarchy of Umwelts, and, conversely, that a correspondence theory of truth becomes increasingly inadequate as the object Umwelt approaches the nootemporal. Therefore, if what we mean by indirect representation is the ability of nootemporal subjects to create models of the world, these models become increasingly more map-like as the evolutionary level being modeled decreases in complexity and increasingly painting-like as it increases in complexity. To put it simply, epistemology and ontology become more and more differentiated as a human subject considers earlier Umwelts and more and more entangled as he or she seeks to represent nootemporal objects.

Interdisciplinarity

If the world is as I describe it, that is, if it satisfies the minimum ontological and epistemological conditions I have set forth, then the most powerful way to interact with it would be through a systemic interdisciplinary approach. Clearly, what is at stake is less a specific theory but a world view or paradigm. Interdisciplinarity as described in this essay would necessitate a fundamental shift away from the two dominant world views of the contemporary world — relativist textualism and reductive science — towards a paradigm which models the universe as a evolving, hierarchical, dynamical, and innovative system.

Systemic interdisciplinarity is based on the premise that the universe is a hierarchical system whose constituent levels can be known by a human epistemic subject in two kinds of ways. Direct representation offers an interdisciplinary mood, the sense shared by many mystics, scientists, philosophers, and artists that the world is a deeply connected system. Indirect representation consists of translations of the world's languages into human terms. Some of these translations, especially those

originating in the lower Umwelts, are quantitative. Others, especially those whose object language is an upper Umwelt, display such complexity that quantitative means of representation become increasingly inadequate. Finally, nootemporal objects and representations are frequently identical, or more correctly, nootemporal objects frequently are representations, and nootemporal representations frequently become entities to be studied, thereby making translation more and more into performance or creation.

The various disciplines composing our institutions of higher learning are, in some sense, centers of translation. However, although specialized translators are essential, there are times, usually during periods of epistemic crisis, when a specialist's vision is too narrow. During moments of upheaval, it is frequently necessary to appeal to another kind of knowledge, a kind of meta-translation or meta-knowledge. In other words, specialization works well when a culture is engaged in business as usual. However, when, for whatever reason, business as usual is interrupted, a specialist dominated perspective must be supplemented by one in which the whole hierarchy of languages addressed by specialists can be held in view. Frequently, such an upper-level interdisciplinary perspective on the world requires translations of translations, as for example when the mathematical formalism of quantum physics gets translated into natural language. Of course, much detail will be sacrificed in exchange for the usefulness of such second order translation, but the point is that interdisciplinarity is not intended as a substitute for disciplinary rigor but as an addition to it. Seen as a supplement to disciplinary specialization, interdisciplinarity is a holistic view of the complex functioning of both the universe as a systemic whole and of its maps and paintings in the traditional divisions of university departments (with the possibility that new knowledge, scientific, humanistic, and artistic, will change the shape of the model). If, as much current speculation stemming from many fields such as quantum cosmology, fractal geometry, chaos theory, and the theory of self-organizing systems suggests, the universe is the complex interaction of its information technologies, then systemic interdisciplinarity offers human beings the opportunity to encompass the regularities that characterize our world and, according to the circumstance, to respect them, finesse them, or supplement them.

References

- Lyotard, Jean-Francois. *The Postmodern Condition: A Report on Knowledge*. Minneapolis: University of Minnesota Press, 1984.
- Fraser, J.T. *Time The Familiar Stranger*. Redmond, Washington: Tempus Books of Microsoft Press, 1987.
- Hofstadter, Douglas R. *Godel, Escher, Bach: An Eternal Golden Braid*. New York: Basic Books, 1979.
- Popper, Karl R. and Eccles, John C. *The Self and its Brain*. Boston: Routledge & Kegan Paul, 1977.
- Prigogine, Ilya and Stengers, Isabelle. *Order Out of Chaos: Man's New Dialogue with Nature*. New York: Bantam Books, 1984.
- Rorty, Richard. *Contingency, Irony, and Solidarity*. New York: Cambridge University Press, 1989.
- Uexkull, Jakob von. "A stroll through the worlds of animals and man," in Schiller, C.H. ed. and tr., *Instinctive Behavior*. New York: International Universities Press, 1957.
- Wittgenstein, Ludwig. *Philosophical Investigations*. New York: Macmillan Publishing Co., 1958.