THE FOUND AND THE MADE: A Précis

There is a categorical difference between natural things and artifacts. The latter we construct, whereas the former we simply encounter. The only *certain* knowledge we can have is of our own creations, because—like the constructs of mathematics—they are what they are by definition. For this reason, Vico advised that knowledge of human institutions was more reliable than knowledge of nature.

If this distinction was not clear in the early development of science, it was probably because natural philosophers believed that nature *is* an artifact—albeit created by God rather than human beings. Human beings were positioned to understand the mind of God because they were made in the image of God. When that belief was no longer tenable, the distinction between natural things and artifacts continued to be ignored, because substituting mathematical models for the natural realities they model enables prediction. I have described this practice and its consequences elsewhere as *deductionism.*[1]

The reliability of mathematics was implied in Plato's notion of *forms*. Sensory knowledge was at best indirect and at worst illusory (mere shadows in the Cave). But, according to Plato, the intellect is privileged to have direct access to a priori truths. In a parallel vein, Descartes claimed that one could be deceived about appearances (as in Plato's Cave), but not about the fact that such appearances occur. However, Kant drew a distinction along a different line: one has access to the phenomenal realm of consciousness but not to the noumenal realm of whatever exists in its own right. The implicit assumption of science was that scientific constructs—and mathematics in particular—correspond to the noumenal realm, or at least correspond better than sensory perception or the phenomenal realm.

This assumption rests in practice on dealing only with select natural phenomena: namely, those that can be effectively treated mathematically. Historically this meant simple systems defined by linear equations, since only such equations could be manually solved with pen and paper. The advent of computers removed this limitation, enabling the mathematical modelling of non-linear phenomena. But it does not remove the distinction between artifact and nature, or between the model and the real phenomenon it represents.

The model, however complex, remains a product of human definitions. As such it is well-defined, finite, and oriented toward prediction. The real phenomenon, in contrast, is no such thing. "Definition" is a human action, not a property of real systems, which cannot be assumed to be clearly delimited or exhaustively knowable. The model is predictable by definition, whereas the real system is only predictable statistically, after the fact, if at all.

What is found?

Let us clarify what is found and what it means to make. At face value, it seems the "external" world is what we find when we examine the contents of our consciousness. But this seemingly real and external world is certainly not Kant's noumenon, the world-in-itself. Rather, while it is the basis of natural realism, the very appearance of realness and externality already presumes what Helmholtz called 'perceptual hypotheses.' The mind has already interpreted sensory input in the terms of internal schemata whereby the world is presented in consciousness as real and external. Overlaid are ideas about the nature of the natural world and what it consists of. The

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[1] See my paper "On Deductionism" 2017 [*https://philarchive.org/archive/BRUOD-2*]
and my book *The Found and the Made: science, reason, and the reality of nature* Transaction/Routledge, 2016.

modern physicist believes it to consist of elementary particles and fundamental forces.[2] The aborigine or the religious believer may have a very different cosmology. Thus, we must look to something more common to all as what is "immediately" found. This presumes a notion of subjectivity, a sort of interior world, the converse of the natural realism that views experience as external and independent of the subject. It involves what Husserl called "bracketing." That is, the content of consciousness is considered not as reality but as an apparition in the field of one's own consciousness. By implication, it is a product of the mind—even if it reflects the external world. What we "find," in this more immediate sense, is a display that Kant called the phenomenal realm.

In the modern scientific worldview, this display is produced by the brain—not normally in isolation, but in response to and co-operation with what is presumed to be a real external environment, including the body of which the brain is a part. In short, the modern view has amalgamated an objective and a subjective perspective in a dualism that involves the interaction of the organism with its environment. This raises the question of the nature of this interaction and of the relationship between the putatively real world and its representation in consciousness.[3] Unsurprisingly, so far there has been no scientific or philosophical consensus about how to resolve this question.

What is made?

What is the nature of the representation? What sort of "thing" is a representation, or any idea, in contrast to what it represents or is an idea of? Such a question, we shall see, is relevant to understanding scientific representations as well as those of the brain involved in perception. Natural objects we encounter provide a model of *thingness*. But we are also able to *make* things—artifacts. These are not created ex nihilo but merely rearrange materials that are naturally found. The artificial environments of which our civilization consists are fabricated from natural ingredients. Even so-called synthetic materials are made from naturally occurring atoms and molecules.[4] So, the difference between an artifact and a natural object or phenomenon is not a question of the substance involved. It is rather a question of an idea or form imposed on substance. Believing that the natural world was God's mind imposed on primal substance, the first scientists were not obliged to consider how the appearance of the world was a result of their own minds' impositions.

A representation is an idea that stands for something else. A painting, for example, may represent a real scene, by using real materials to produce an image of the scene. The painting and the scene are material things, but the image is an idea that must occur in the mind of the artist and the onlooker. A painting may attempt to *copy* a real scene (or another painting), but this is the wrong metaphor to account for the inner representation whereby the brain monitors and represents to itself the world external to it. It is naïve to imagine that the phenomenal realm is in any sense a copy of the external world. A better analogy than a painting is a map. While still recognizably representative, a road map is highly selective and symbolic. If to scale, it faithfully represents relative distances and spatial relationships on a plane, but little else so literally. A

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[2] Or perhaps *information*, according to the latest vogue.

[3] This question is variously known as the mind-body problem, the explanatory gap, or the 'hard problem' of consciousness (to distinguish it from the "easier" problem of accounting for behavior in physically causal terms).

[4] This applies even to man-made elements produced in high energy experiments. They are possible on earth because they exist naturally at other times or places in the universe, in conditions artificially mimicked by experiment.

typical map of a subway system represents only topological features, such as connections between the various routes. The essential point is that a given map is made to serve specific purposes and is not a copy of reality. To understand the map as a representation, we must understand those purposes, how the map is to be used.

How does the brain use its map of the world? First let us note that this map is an artifact, *created* either in real time by the creature, through its interactions with its environment, or by the species through its adaptive interactions, which are inherited by the individual creature. The brain is sealed inside the skull, with no direct access to the world outside. The map is like a theory concerning what lies outside. The mapmaker has only input signals and motor commands through which to make the map in the first place and to use it to navigate the world. An analogy is the submarine navigator or the aircraft pilot flying by instrument—with the unrealistic proviso that neither navigator nor pilot has ever set foot outside the sealed compartment!

The knowledge of the world provided by real time experience, like that inherited genetically, consists in inferences gained through feedback. Sensory input leads (say, by trial and error) to motor output, which influences the external world in such a way that new input is provided, resulting in new motor output, and so forth. The pilot or navigator forms an idea of what is causing the inputs and upon which the outputs are acting. This idea works to the extent it enables predictions that do not lead to disastrous consequences. On the genetic level, it has resulted in adaptation by eliminating individuals with inappropriate connections. Real-time learning by the individual operates in a similar way, by eliminating connections that do not lead to a desired result. And so does scientific learning. In all cases, what the map represents is not the territory so much as a set of connections that work—that is, which at least permit the survival of the mapmaker.[5] It is not that the creature survives because the map is true or accurate; rather, the map is "true" or "accurate" because the creature survives! This must apply even to the scientific map.

The connections involved are actively made by the brain, based on its inputs and outputs. They constitute a representation or map insofar as an implicit or explicit theory of reality is involved.[6] While such a connection (in the physical brain) must be physical and have a causal basis (as in the forming of neural synapses), the connection itself is foremost logical and intentional. Compare the function of a wiring diagram for an electrical appliance. From a certain point of view (of the physicist, for example), the soldered connections of the wires and components are *physical* connections in which there is a causal flow. From another point of view (of the designer or engineer, for example), the wiring diagram expresses the *logical* connections of the system, which include the purposes of the designer and the potential user. In the case of a natural brain, the organism is its own designer and makes the connections for its own purposes. While the brain can be described as a causal system, such a description does not go far to explain the organism's behavior. It certainly cannot explain the existence of the phenomenal realm we know in consciousness and which we presume arises through the brain's internal connections.

Science as cognition

Science is a refined form of cognition and an extension of human perception and capability. Scientific theories and models are human artifacts, just as technological productions are. They

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[5] The mathematical concept of *mapping* is significant here: a mapping is a transformation of one set into another, according to a rule that connects each element of one set with element(s) of the other.

[6] Helmhotz's perceptual hypotheses are implicit theories, whereas scientific theories are explicit hypotheses.

bear the same relationship to the world-in-itself that perceptual hypotheses bear to the organism's environment. The scientist is in a similar position as the submarine navigator or pilot flying by instrument—that is, in the same epistemic situation as the brain. There are two chief differences: first, the scientist uses artificial sensing devices in addition to the natural senses; second, the scientist can draw upon natural perception to guide the formation of scientific concepts, whereas the brain must invent that perceptual knowledge in the first place.

The latter difference is both an advantage and a hindrance to scientific cognition. Because scientists are living organisms, scientific concepts cannot help but be grounded in everyday experience, derived from their senses. On the other hand, the motivation for scientific thought and method in the first place lies in the limits and defects of sensory perception and ordinary experience as a guide to what "objectively" exists. Science is a search for invariances (order) in the world, within the constantly changing appearances of experience. In order to find that order, the properties of the world itself must be sorted out from the properties of experience that derive from the nature of the organism. The objective must be distinguished from the subjective. Scientific method is a protocol for eliminating at least the idiosyncrasies of particular subjects by standardizing observers and methods of observation. Trained observers should be interchangeable; experiments should be repeatable. This does not eliminate what observers have in common, however, namely their nature as organisms.

Because we are natural organisms, the scientific picture of the world is built on natural perception. They are different maps of the world, which overlap because they have a common motivation and purpose: survival. Yet, there is no reason why the scientific map should resemble the perceptual one, except that both facilitate—or at least permit—the existence of the organism. (More than one mapping[7] might serve that end.) Yet, the natural tendency is for scientific concepts to be based on notions that arise in ordinary experience—beginning with the categories of 'space' and 'time' and 'object'. The notion of force derives from proprioceptive experience—from the bodily sensations of acting and being acted upon by other objects. The notions of temperature and pressure similarly derive from bodily sensations. Most physical concepts rely on the visual sense, however.[8] The notion of objectivity itself is intimately tied to vision, which is the paramount distance sense for primates. Light does not impact on the body in the major way that tactual contact does. The momentum of photons striking the retina is negligible compared to that of macroscopic objects hitting the body. More importantly, the *significance* of the contact is utterly different. By definition, the distance senses place the organism at a remove from danger, allowing a more detached stance in regard to the stimulus. This allows for *monitoring* the environment as opposed to immediate reaction.

The extension of ordinary notions into science operates through visual imagination and metaphor, followed by reification. A prime example is the concept of *field,* which was initially no more than a descriptive mathematical device. Faraday perceived that test objects close to magnets and electric charges behaved differently than when further away. It seemed that some invisible force guided their path. But the idea of instant action at a distance had been the bugaboo of Newtonian physics, so an invisible entity surrounding these charges was imagined to be responsible for the causal transmission of this force.

Similarly, the behavior of invisible atoms and electrons, and their interaction with light and other radiation, suggested the notion of the atom as a miniature solar system. Indeed, the

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[7] See footnote 6.

[8] Kinematic and dynamical descriptions, such as position and momentum and their time derivatives, can be inferred from watching the interactions among objects as opposed to sensing them tactually.

notion of *particle* is grounded in the ordinary notion of a macroscopic object. The concept of *wave* (electromagnetic, gravity, and even "probability" waves) is metaphorically based on ocean waves and ripples in ponds. The difficulty of these metaphorical extensions is that, although intuitive, they often do not work. Microscopic "particles" do not behave like macroscopic ones. If there is an "ocean" for electromagnetic waves, its presence is undetectable. At the other end of the scale, the largest and most forceful structures in the universe do not behave like familiar objects and forces. In many ways, black holes resemble elementary particles in having very few discernable properties. Gravity at the largest scale seems to be repulsive. The universe as a whole can scarcely be conceived as an "object" at all, if no other reason than that we cannot stand outside it, either physically or epistemically.

Science is a human cultural activity more than an objective window on the world. Scientific entities and laws are made as much as they are found. Experiment serves as an arbiter among theories that are in turn highly dependent on experiment in a dialectic cycle. Observer-independence actually means commitment to the visual sense. Objectivity means intersubjectivity among the community of scientists. Scientific method bears some resemblance to jurisprudence. Both deal in evidence, testimony, protocol, law, consensus and judgement. It also bears some resemblance to religion, which is not surprising given the rise of modern science in devout Europe. But, then, religion is also a human cultural activity and a form of cognition. Like religion, science seeks a singular, definitive, correct, textual account of reality. Theory, like theology, attempts to axiomatize the unknown. Along with capitalism, science has become the modern secular religion—how we manipulate nature directly instead of by appeal to the gods. How, indeed, we attempt to become "as the gods."

Determinism

Like the notion of fate, the concept of determinism affords a god-like perspective outside the system observed. Determinism means utter reliability, which is highly desirable unless you happen to be part of the deterministic system, in which case you have no free will! Viewed from the outside, determinism is psychologically reassuring, because everything is predictable, at least in principle; but there is no guarantee that deterministic systems correspond to reality. Quite the contrary, they are convenient scientific fictions. Only products of definition can be truly deterministic, because only deductive systems afford tautological knowledge. Otherwise, we are always only guessing at the intricacies of nature.

Natural laws are descriptions not prescriptions. The illusion of "governing power" that laws might seem to have comes from translating empirical findings into theorems of a deductive system. Ambiguously, the word *determine* means either to *fix* or to *ascertain*. But when we ascertain the regularities of a system and state them as a "law," as Hume pointed out there is no guarantee that the pattern will continue in future. Transcribing an observed pattern as a law fixes it in our imagination but not in reality. The law has no power of its own. The notion of *law* is extended from jurisprudence into science by the same metaphysical sleight of hand by which ascertaining becomes fixing. Law ambivalently now means either pattern or decree. The religious heritage of science held the laws of nature implicitly as divine edicts. Natural laws codify data as compressed empirical descriptions. Yet alongside that understanding, we persistently have the false idea of *governing* laws of nature. An algorithm may govern the behavior of a computer, but not that of nature.

Determinism implies no more than a unique (mathematical) mapping from one domain to another. Laws, as expressed by differential equations, seem to be time-reversible because the equations make no distinction between t and $-t$. Time-reversibility is a property of equations, not of nature. Moreover, precise inputs can only be *specified*, never measured; the imprecision of real inputs to non-linear equations leads to "deterministic chaos." Th precision of deductive systems exists by definition, and is not to be confused with the precision of statistics, which is a matter of indefinitely large ensembles or runs.

The notion of *prior probability* invokes well-defined conventions, situations, and artifacts such as the conventional coin or six-sided die. Nature does not conform to these conventions nor contain such artifacts. Probability is based either on reasoning about such idealized situations, or else on actual past experience gathered over many instances. The two approaches should be clearly distinguished. Predicting a *single* event from statistics in a real situation is problematic. For example, you cannot predict the time of your death from actuarial statistics or even from medical prognosis. One should be equally circumspect in reasoning about probability in cosmic terms. Some would say that it is merely improbable, not impossible, for an automobile to assemble itself. Given enough tries, like the proverbial monkeys at typewriters, eventually all the atoms of the automobile might come together accidentally in just the right way. If so, then perhaps the universe could assemble itself by chance. This would presume, however, an infinite number of tries.

If determinacy is not a property of nature, then neither is indeterminacy. Both refer to a state of knowledge rather than a state of the world. Randomness (chance) cannot coherently be defined, except (circularly) as the ability to pass randomness tests. All we mean by 'random' is that no pattern has been found. It cannot be proven that no pattern exists.

Math and Physics

Mathematics describes the world effectively because it abstracts real general properties to begin with. Phenomena are selected that can be described by simple mathematical expressions, leading to selection bias. The "unreasonable effectiveness" of mathematics suggests to some that math is a higher version of reality, that physical reality is but a "subset" of mathematical reality. This could support the delusion that nature involves only select causal factors or consists only of what is defined in theory at a given time. Above all, math is a cognitive tool. Yet, it is also a self-contained domain, an axiomatic system, the paradigm product of definition. Its very nature is to raise generalizations to axiomatic status. Nature "follows" these generalizations to an undetermined extent, but also sometimes leads the way to mathematical discovery.

Mathematical and real space are poorly distinguished. Spatial dimension, for example, is an abstract concept; real space has no "dimensions," which are artifacts of a geometrical definition. Moreover, geometric 'dimension' should be distinguished from algebraic 'parameter'. Despite being represented graphically, the n dimensions of phase space, for example, reflect an algebraic concept that should not be confused with the three dimensions of physical space. However convenient, the four-dimensional spacetime continuum is similarly a mathematical artifact. The laws of physics are human constructs, not eternal Platonic forms. They have no power to "select" the number of dimensions of the universe.

Like life itself, scientific knowledge has a physical context. It depends on relative isolation of effects on different scales, without which the 'isolated system' would not have been a fruitful idea. Perhaps nature has intrinsically discrete aspects at various scales. Yet that discreteness (which may prove only apparent) should be distinguished from the mathematical discreteness that is a product of definition.[9] Quantum particles, like natural things in general, may have other properties than those currently defining them.

<u>Nature's immanent reality</u>

We perceive the world to be real because it has real effects upon us and we upon it. The meaning of "realness" lies in the consequence to the organism. (The fantasy of a rapidly approaching bus will not harm you in the way that the real bus will.) The *quality* of realness with which the world seems imbued reflects the ability of things to do us biological harm and good. À la Kant, the realness and externality of the world are fundamental categories of thought and perception, like space and time, without which we could not survive. But because we distinguish appearance from reality, subjective from objective, we have a notion of the intrinsic reality of things as opposed to their functional appearance to us, however essential the latter may be. The distinction can only be meaningful to a creature capable of believing that all of experience might be illusory or artifactual in some sense. Eastern metaphysics is renowned for the former, while western science arose trading on the latter.

The medieval Christianity into which science was born denied nature's inherent reality by holding it to be a divinely created artifact. Matter had the reality conferred upon it by divine will, but not an immanent reality belonging to it in the first place. Non-living matter, at least, was supposed to be passive, insofar as it could only react to forces imposed from without. While organisms did not fit easily into this scheme, the mechanist outlook largely prevailed. The compelling tacit payoff was that nature, being a product of rational thought, could be fathomed by rational thought.

But if nature has its own immanent reality, there is no such guarantee. Immanent reality implies that nature may transcend any thought system, however complete. It also suggests that the physical world may have unsuspected powers of self-organization—or at least that its nature does not preclude this. The current assumption in physics is that a complete "theory of everything" is possible and imminent. But this is a perennial expectation that has no basis unless the universe happens to be finite and finitely structured. Various schemes are embraced to support this assumption, such as "digital physics," the "mathematical universe," the idea that "information" is the basic stuff of physical reality, and the idea that the brain can be scanned to reveal its "connectome," its essential functional structure.[10]

A theory is a simulation. It can be commensurate with another theory or simulation, since both are deductive systems—artifacts. But unless nature itself is a simulation—an artifact or deductive system—no theory, model, or simulation can exhaustively describe it. For nature to be immanently real means that no algorithm can be generate or reproduce it. While that is an unprovable metaphysical assertion, it stands as an alternative to the current unprovable metaphysics of science, and as the basis for an alternative research program.

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[9] There may or may not be real entities or properties that have the perfectly unitary quality of the integer *1*, as opposed to the convention, for example, of *spin 1*.

[10] The basis of transhumanist hopes to survive death in a digital state: uploaded to cyberspace or downloaded into a new body.