
Mathematical Hermeneutics

Ralph Abraham

Ralph Abraham is a professor of mathematics at the University of California in Santa Cruz.

The article is based on a talk given at the international conference, *Physis/To Inhabit the Earth*, held in Firenze, Italy, in October 1986.

Along with the advent of the computer revolution has come a shift of style in mechanics (the art of making mathematical models for processes in the phenomenal world) and in applied mathematics in general. This provides an opportunity for the re-enchantment of mechanics by integrating modeling more tightly in the hermeneutical circle of *action research*. This article introduces the basic concepts of this re-enchanted circle, *action mechanics*, and suggests its potential importance for postmodern society.

THE WORLD ACCORDING TO GROK

It would be convenient to shorten hermeneutics to *herm*, much as we substitute math for mathematics. However, we must also refer to hermetics, another child of Hermes, so instead we will use the term *grok* as a familiar name for hermeneutics.* This term suggests an English translation of *verstehen*, a principle aspect of hermeneutics, after Dilthey, rather than from the common German verb. We grok something (a text, artifact, art work, poem, archaeological find, letter, phone message, natural process, etc.) by a cycle of observing, thinking, poking, and so on. This is not the same as explaining it, representing it, or translating it, but is a cyclical activity basic to hermeneutical thought called the *hermeneutical circle*, sometimes thought of as a spiral, because the turning of this circle is the motor of the evolution of our consciousness or the convergence of our grokking.

In this short article, we cannot do justice to these important and difficult ideas, but will be satisfied to point out the extensive literature. To see the world according to grok, you might start with Bateson (1979), Berman (1981), Palmer (1969), and Paul Lee's article in this issue of *ReVISION*. Our goal is to view the mathematics and computer revolution of our times according to grok; this perspective may be crucial for our own evolution in the struggle with the challenges of postmodern planetary society (Abraham, 1986; Bateson, 1979; Bateson, 1984; Capra, 1987; Tillich, 1961; White, 1967).

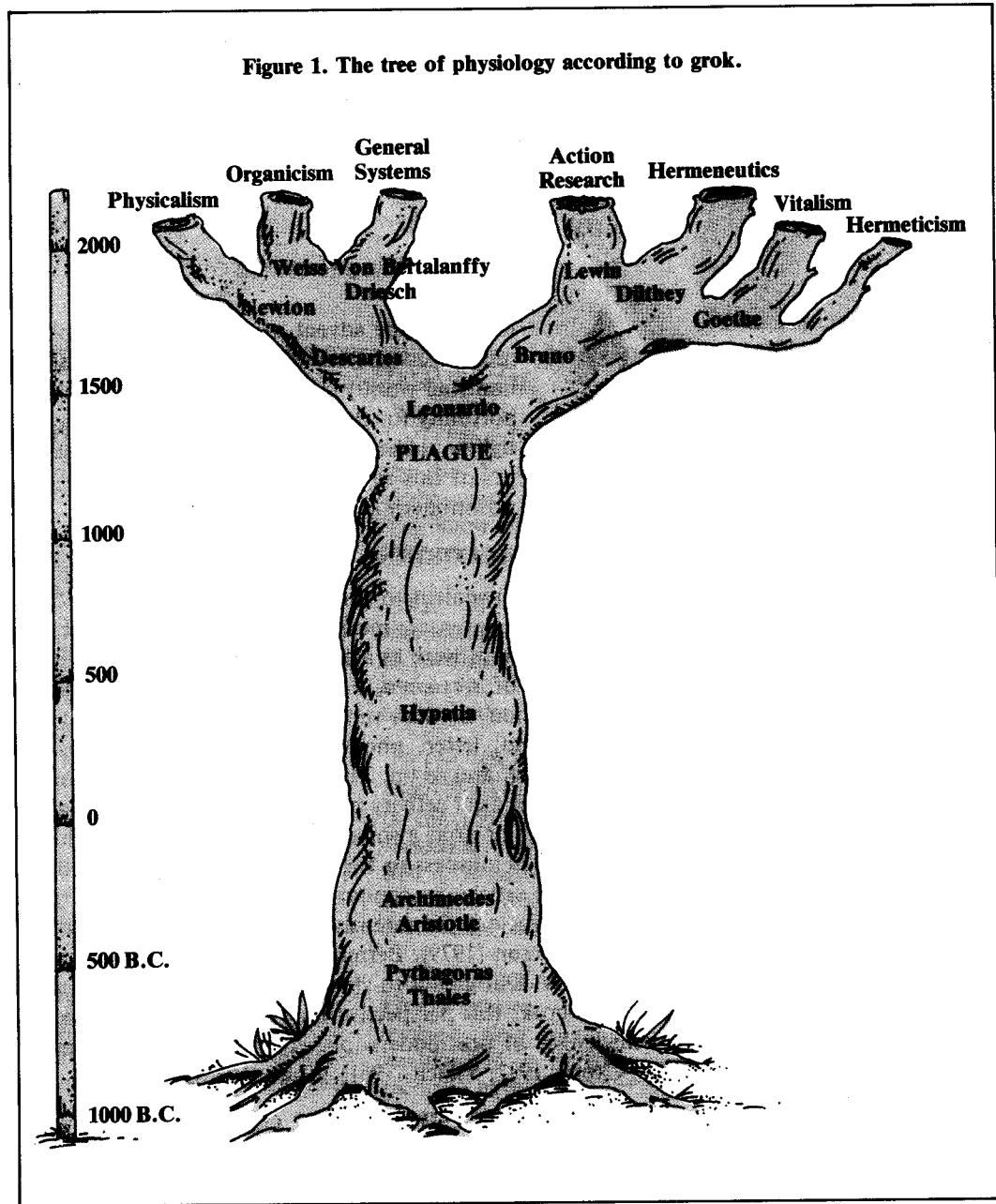
HERMENEUTICS, THE HISTORY OF CONSCIOUSNESS, AND COGNITIVE RESONANCE

The history of hermeneutics, which we may regard as the resynthesis of natural philosophy or *physiology*, may be traced back to the Cro-Magnon or Stonehenge periods at least. But here we will be satisfied with the historical tradition. The ancient Greek physiology has maintained its integrity from Thales to Hypatia, including the Mysteries (exotic pagan cults), the Hermetic corpus, its devious transmissions through the Dark Ages and its emergence after the Black Death of 1348. This is represented as the trunk of the tree of perennial philosophy in Figure 1.

And then suddenly we see the branchings. The basic split between physicalism and vitalism (Berman, 1981; Davis & Hersh, 1986; Kuhn, 1977) was triggered, perhaps, by the burning of Bruno. (Giordano Bruno was burned at the stake at Rome in 1600 for his heresy in maintaining the infinity of the Universe.) This conflict still dominates the growth of science. Soon after, Hermeticism broke away from vitalism and virtually died. Then came the birth of organicism from physicalism (Haraway, 1976), an attempt to regain the advantages of vitalism without its spirit. From organicism and holism arose general systems theory (Davidson, 1983), and recently, general evolution theory (Jantsch, 1981; Laszlo, 1987). Meanwhile, after Goethe, Hermeneutics split off from vitalism, trying to keep the flame alive in the

*The word *grok* was invented by Robert Heinlein for his science fiction classic, *Stranger in a Strange Land*, to signify a special form of deep understanding.

Figure 1. The tree of physiology according to grok.



openness of the social sciences after biology was converted to physicalism (Palmer, 1969). And from Hermeneutics came action research (Bateson, 1979; Lewin, 1948), courageously carrying out the grok program in the field of social science. As we see in Figure 1, these two inner branches, evolution theory and action research, are about to re-join in an attempt to repair the physicalist/vitalist split of 400 years and re-enchant the world.

We may regard the evolution of consciousness, and the growth of this tree, as a manifestation of morphic resonance. In this context, we call this *cognitive resonance*. For the process of the grok circle, in the mind of an

individual scholar, is an oscillation (perhaps within a relatively long temporal period). Thus, a group (circle, school, community) of scholars may be regarded as a *vibratory field* (Abraham, 1987). Through the mutual coupling of these oscillators, through written or spoken communications, the vibratory field evolves towards some kind of coherent behavior or self-resonance. Adjacent schools (for example, English and Continental schools of metascience) may then resonate with each other as do adjacent piano strings. In this way, the mechanics of resonance may be employed in a grok circle, supporting the understanding of the history of consciousness and the evolution of culture. The plane-

tary mind may itself be a resonance phenomenon, in which noogenesis is directed by Nature herself. It may even *be* Nature herself.

THE HERMENEUTIC CIRCLE, THE HISTORY OF SCIENCE, AND ACTION RESEARCH

In the history of science, the grok spiral is the basis of one of the main branches of the philosophy of science (Radnitzky, 1973). Lewin put it as simply as possible in 1945 (Sanford, 1970).

Action research consists of "analysis, fact-finding or evaluation; and then a repetition of this whole circle of activities; indeed, a spiral of such circles.

In fact, the cycle may be interpreted as observation/analysis, or experiment/theory, or participate/model. In any case, each side of the cycle is very complex and has an extensive literature.

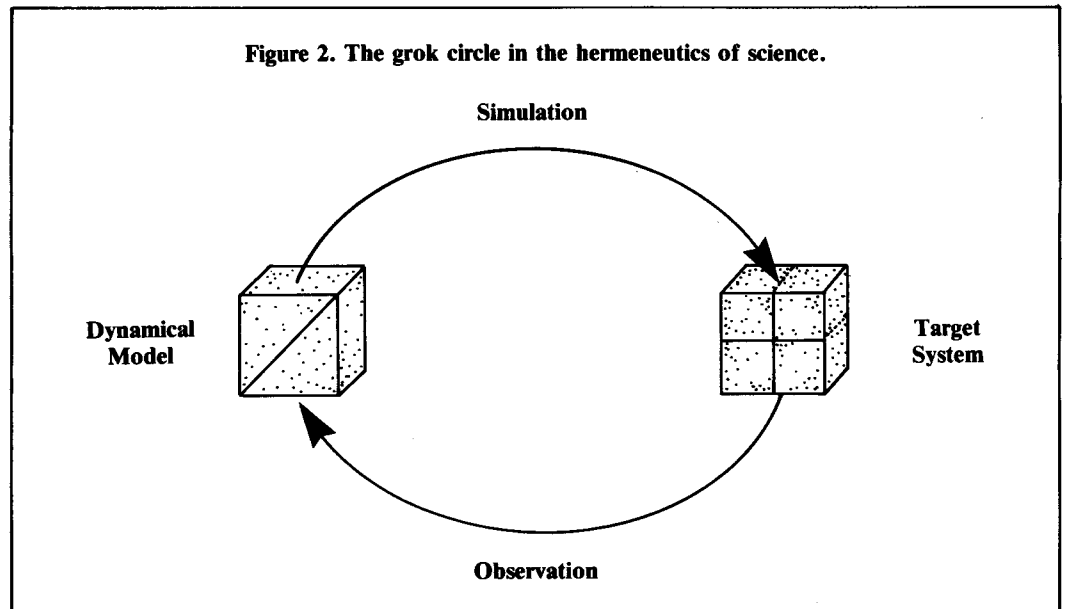
The concept of *model*, for example, varies through an enormous spectrum of meanings, from paradigm in the sense of Kuhn (1970), to homology, simile, analogy, metaphor, explanation, theory, or catachresis (Achinstein, 1968; Black, 1962; Haraway, 1976; Hein, 1971; Hesse, 1961, 1966; Kordig, 1971; Leatherdale, 1974; Maclagen, 1977, p. 66; Pepper, 1961), to artifact, exemplar, or just plain model. In fact, we are dealing here with attempts to circumscribe cognitive strategies of mimesis or representation in general, in a spectrum from larger to smaller representations.

Similarly, *observation* has its own spectrum of meanings, ranging from the detached observer totally isolated from the target system to the diary of a lover: the spectrum of participation or involvement. It is implicit in grok theory that *the model and the observation are linked*. They are linked in the grok circle, as shown in Figure 2. Thus, observation is done in the ambiance of a model, and the model is created in the context of an observation strategy. In the rotation of this cycle evolves the adequacy of the model and the observation, hence the understanding of the world around us.

The antithesis of this grok view of the history of science is the dogma of *scientism*, in which a particular model becomes identified with the target system in nature. This sin is, ironically, particularly prominent with the fancier mathematical models of physical processes made in the style introduced by Newton in 1685, a Hermeticist throughout his life (Dobbs, 1975). According to grok, mathematical models are just another way of grokking, particularly useful for the more complex dynamical systems.

DYNAMIC MODELS, CYBERMIMESIS, AND ACTION MECHANICS

With this introduction to hermeneutics behind us, we may now turn to the role of mathematics (and especially *dynamics*) in the evolution of culture and planetary society, as seen from the viewpoint of grok. Mathematics does not belong to science; mathematics is its own universe. However, some signifi-



cant part of mathematics lives only to serve. And its main service, according to grok, is to supply models for phenomena and processes observed in nature. Thus, some small part of science is extensively involved with mathematical models. *Dynamics*, from the time of Newton, is the part of mathematics used to model processes. And *mechanics*, from the time of ancient Greek science, refers to the model-making art.

We now specialize the word *model* to mean dynamical model. Moreover, we intend to include with the mathematical formalism a computer program for its simulation. In short, by a model we now mean what is known to contemporary science as *a dynamical model and its computer simulation*. We also refer to this as *cybermimesis*, as it provides a cognitive representation of the target process.

The cybermimesis of mathematics itself may be the grok interpretation of Godel's famous results on incompleteness, more a problem for logical formalists than for hermeneuticists (Findlay, 1952). We now consider the grok circle to consist of cybermimesis and observation. The observations must be linked to the model, which means in this context that the data must be machine readable. Thus, experimental data and simulated data may be compared, for example, by the animated computer graphic presentations that have become standard in the simulation profession.

This cybermimetic grok circle is endemic in the sciences today, particularly in biology (Avula & Rodin, 1987; Greco & Kohn, 1986; National Research Council, 1985) and increasingly in social theory as well (Sorenson, 1978). Because of the capability of this strategy to understand large-scale complex, hierarchical systems (holarchies) and chaotic behavior, it may extend grokking to systems that otherwise would be totally beyond our ken. In combination with the involvement of action research, cybermimesis becomes *action mechanics*. Thus, we may undertake some degree of self-direction of our future evolution.

Through cybermimesis, mechanics may reverse its bad connotation (as in *mechanistic*) and once again (as in the time of Leonardo) become spirited. What is needed is the reconnection of the models (especially for social and ecological systems) to the people comprising the planetary society. At present, cybermimesis is used extensively by the scientific elite (for cognitive resonance)

and by the military establishment (for cognitive dissonance). When home computers attain usable cybermimetic software and high-capacity networks, we may see a new direction in cultural evolution. In fact, the roles of the model and the target system may merge, or even reverse, as envisioned in cyberpunk literature (Gibson, 1984). The question is, may we consciously participate in our own evolution through self-resonance, or must we entrust our future to the random program now running the show?

REFERENCES

- Abraham, R. H. (1986). Mathematics and evolution: A manifesto. *IS Journal*, 1(3), 4-7.
- Abraham, R. H. (1987). Mechanics of resonance. *REVISION*, 10(1), 13-19.
- Achinstein, P. (1968). *Concepts of science: A philosophical analysis*. Baltimore, MD: Johns Hopkins University Press.
- Avula, X. J. R., & Rodin, E. Y. (1985, July). Mathematical modeling in science and technology. *Proceedings of the Fifth International Conference on Mathematical Modeling 8*, Berkeley, CA.
- Bateson, G. (1979). *Mind and nature: A necessary unity*. New York: Bantam.
- Bateson, M. C. (1984). *With a daughter's eye: A memoir of Margaret Mead and Gregory Bateson* (p. 182). New York: Morrow.
- Berman, M. (1981). *The reenchantment of the world*. Ithaca, NY: Cornell University Press.
- Black, M. (1962). *Models and metaphors: Studies in language and philosophy* (chap. 8). Ithaca, NY: Cornell University Press.
- Capra, F. (1987). *The role of physics in the current change of paradigms*. Unpublished manuscript.
- Davidson, M. (1983). *Uncommon sense: The life and thought of Ludwig von Bertalanffy (1901-1972), father of general systems theory*. Los Angeles, CA: J. P. Tarcher.
- Davis, P. J., & Hersh, R. (1986). *Descartes' dream: The world according to mathematics*. New York: Harcourt Brace Jovanovich.
- Dobbs, B. J. T. (1975). *The foundations of Newton's alchemy, or, "The hunting of the greene lyon."* Cambridge, England: Cambridge University Press.
- Findlay, J. (1952). Godelian sentences: A non-numerical approach. *Mind*, 51, 259-265.
- Gibson, W. (1984). *Neuromancer*. New York: Ace.
- Greco, W. R., & Kohn, M. C. (1986). Simulation in cancer research. *Bulletin of Mathematical Biology*, 48 (3,4).
- Haraway, D. J. (1976). *Crystals, fabrics, and fields: Metaphors of organicism in twentieth-century developmental biology*. New Haven, CT: Yale University Press.
- Hein, H. S. (1971). *On the nature and origin of life*. New York: McGraw-Hill.
- Hesse, M. B. (1961). *Forces and fields: The concept of action at a distance in the history of physics*. London: Thomas Nelson.
- Hesse, M. B. (1966). *Models and analogies in science*. Notre Dame, IN: University of Notre Dame Press.
- Jantsch, E. (Ed.). (1981). *The evolutionary vision: Toward a unifying paradigm of physical, biological, and sociocultural evolution*. Boulder, CO: AAAS.
- Kordig, K. R. (1971). The theory-ladenness of observation. *Reviews of Metaphysics*, 24, 448-484.
- Kuhn, T. S. (1970). *The structure of scientific revolutions* (2nd ed.). Chicago, IL: University of Chicago Press.

-
- Kuhn, T. S. (1977). *The essential tension*. Chicago, IL: University of Chicago Press.
- Laszlo, E. (1987). *Evolution: The grand synthesis*. Boston: Shambhala.
- Leatherdale, W. H. (1974). *The role of analogy, model and metaphor in science*. Amsterdam: North-Holland.
- Lewin, K. (1948). *Resolving social conflicts*. New York: Harper.
- Maclagan, D. (1977). *Creation myths: Man's introduction to the world* (p. 66). London: Thames and Hudson.
- National Research Council (1985). *Models for biomedical research: A new perspective*. Washington, DC: National Academy Press.
- Palmer, R. E. (1969). *Hermeneutics: Interpretation theory in Schleiermacher, Dilthey, Heidegger, and Gadamer*. Evanston, IL: Northwestern University Press.
- Pepper, S. C. (1961). *World hypotheses: A study in evidence*. Los Angeles, CA: University of California Press.
- Radnitzky, G. (1973). *Contemporary schools of meta-science*. Chicago, IL: Henry Regnery.
- Sanford, N. (1970). What ever happened to action research? *Journal of Social Issues*, 26(4), 3-23.
- Sorenson, A. B. (1978). Mathematical models in sociology. *Annual Review of Sociology*, 4, 345-371.
- Tillich, P. (1961). *How has science in the last century changed man's view of himself?* Unpublished manuscript, Massachusetts Institute of Technology, Cambridge, MA.
- White, L., Jr. (1967). The historical roots of our ecological crisis. *Science*, 155(3767), 1203-1207.