THE WORLD FUTURES GENERAL EVOLUTION STUDIES
A series edited by Ervin Laszlo
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Mauro Ceruti

Constraints and Possibilities

The Evolution of Knowledge and Knowledge of Evolution

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Introduction to the Series

The World Futures General Evolution Studies series is associated with the journal *World Futures: The Journal of General Evolution*. The common focus is the emerging field of general evolutionary theory. Such works, either empirical or practical, deal with the evolutionary perspective innate in the change from the contemporary world to its foreseeable future.

The examination of contemporary world issues benefits from the systematic exploration of the evotionary perspective. This especially happens when empirical and practical approaches are combined in the effort.

The World Futures General Evolution Studies series and journal are the only internationally published forums dedicated to the general evolution paradigms. The series is also the first to publish book-length treatments in this area.

The editor hopes that the readership will expand across disciplines where scholars from new fields will contribute books which will propose general evolution theory in novel contexts.

Foreword

Heinz von Foerster

"We are today in the midst of a scientific revolution!"

We've heard that before; so what else is new?

New today is that the ongoing profound change in perspective is not limited to certain specific fields, such as to astronomy by arguing about the correct choice of the center of the world; or to cosmology by arguing about the origin of the universe: was it a Big Bang, or is the universe in a perpetual dynamic equilibrium, and thus was and will be there always; or to biology by arguing about the genesis of humanity: was it a single act of creation or did we come about by evolution? . . . and so on.

No, the scientific revolution of today is not about deciding such questions which, by the way, are in principle undecidable; today's scientific revolution is about science itself. Not too long ago philosophers of science were concerned with the purpose of science, or with its meaning. Today we are more concerned with the purpose of "purpose' or the meaning of "meaning," that is, today we are concerned with the logical structure of notions that can be applied to themselves.

Why?

Simply because we see now the necessity of including the scientist in her or his science; otherwise an observer's report "I measured this . . . ," "I observed that . . ." remains uninterpretable as long as the enigmatic self-referential operator "I" is not yet epistemologically well established. The recognition of this task is one of the forces that propels today's scientific revolution: making scientists accountable for their science. In other words, ethics and epistemology will appear now as the two sides of the same coin.

What could be the logical, the mathematical, the conceptual tools with which to carry out this task?

From the glorious past of the evolution of science we have, of course, inherited an impressive arsenal of explanatory devices, modes of inference, and strategies of analysis and argumentation. "The Royal Path," "Der Konigsweg," "El Camino Real," along which most of these argumentations proceed, has been and still is the triadic notional of causality. "Triadic" because in causality we distinguish between first, a cause, second, an effect, and third, the "principle," the "operator," the "laws of nature," the "program," and so on, that carries the cause into the effect. Consequently, if we know these "rules of transformation," we can predict the effects from any given causes. For Pierre Simon Marquis

de Laplace this was the appropriate model of the universe: "If for a superhuman intelligence the present condition of all particles in the universe were known, nothing would be uncertain, and the future and the past would be present to his mind."

In the last three-quarters of this century, however, this sunny picture of the triviality of the world became, through arguments in logic, physics, and mathematics, successively clouded, until today its main features are irretrievably lost. What brought about the demise of this fundamental notion?

The first blow against causality was delivered by Ludwig Wittgenstein in 1923. In his *Tractatus Logico-Philosophicus* he introduces the concept of "elementary sentences (Elemntarsätze)," and discusses the limits of inference of such sentences. Here is Proposition #5.134:

> #5134: "One elementary sentence cannot be deduced from another one."

From this follows:

> #5.136: "There is no causal nexus to justify such an inference."

And finally the famous Proposition

> #5.1361: "We *cannot* infer the events of the future from those of the present. Belief in the causal nexus is *superstition*."

Werner Heisenberg recognized in 1927 that the act of observing a system is an intervention that alters the system in ways that cannot be inferred from the results of the observation. This is the essence of Heisenberg's "Uncertainty Principle" that limits the determinability of elementary events.

But the coup de grâce to causality was administered by those mathematicians who were fascinated by the problem of the analytic determination of the operational modalities of a given computer or, as it is referred to in the language of the experts, as the "machine identification problem."

The organization of these "machines" is usually of a form in which a program can call upon a variety of "sub-routines," say, computing a square root, or whatever, depending on the need for such computation given by the state of affairs at a particular moment in the overall operation of this machine.

Now, imagine yourself to be conversant and at ease with such computers and that an anonymous donor has given you for your birthday a fully programmed, ready to use machine, but without the manual of instructions. The problem for you now is to establish by experimentation the workings of the computer. This is the analytic problem, the machine identification problem.

The question is: how to solve this problem?

The answer is: there is no problem!

In 1957 Arthur Gill proved once and for all that the machine identification problem for non-trivial machines, that is, for those like ours whose modus operandi may change as a consequence of its previous operations, is in principle unsolvable! In other words, non-trivial systems are analytically undeterminable, hence unpredictable. Moreover, there is no way to establish through a finite number of experiments the triviality of a system we have not synthesized; hence, there is no way that would allow us to write down the rules of transformation, the "laws" of its nature. And ultimately, since we cannot write down these rules, causality becomes meaningless, because the centerpiece of causal argumentation, the transformation rule, is missing.

It is for the cultural anthropologist to tell us why there are people who wish that the world were a trivial machine. Bizarre! Perhaps it is the wishful thought to keep causality alive because when causality collapses, we seem to stand vis à vis de rien.

How can one rebuild the awesome structure of science without the cement of "causation," the cement that is supposed to hold the whole construction together?

It was a stroke of genius that guided Mauro Ceruti in his development of an appropriate epistemology for a new science, when he chose to demonstrate this development with the aid of a case of (almost) perfect asymmetry, that is, a case of (almost) complete transparency and interpretability of things past, and (almost) universal opacity and unpredictability of things to come: the case of biological evolution.

While in the orthodox perception and discussion of this notion we, the human beings who do the perceiving and the discussion, are eliminated by invoking causation either in its fuzzy form of "chance," or in its straight form of "necessity," Ceruti re-instates our responsibility into the new architecture of science by founding it not on chance and necessity but on constraints and possibilities.