Piero Mella

The Holonic Revolution

Holons, Holarchies and Holonic Networks
The Ghost in the Production Machine

Pavia University Press

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Preface

> Quod est inferius est sicut quod est superius, et quod est superius est sicut quod est inferius ad perpetranda miracola Rei Unius.
>
> That which is below is like that which is above, and that which is above is like that which is below, to make a miracle of the thing that is unity (Smeraldine Table of Ermete Trismegisto).

A minor conceptual revolution has been under way for less than forty years now, beginning in 1967 with the publication of Arthur Koestler's *The Ghost in the Machine* – a phantasmagorical book in terms of the breath and variety of its content – which formally introduced the concepts of *holon* and *holarchy* (the hierarchical ordering of holons).

Koestler's idea is clear and simple: in observing the Universe surrounding us (at the physical and biological level and in the real or formal sense) we must take into account the *whole/part* relationship between observed "entities". In other words, we must not only consider atoms, molecules, cells, individuals, systems, words or concepts as autonomous and independent units, but we must always be aware that each of these units is at the same time a *whole* – composed of smaller parts – and *part* of a larger *whole*.

In fact, they are *holons*.

By systematically applying the *whole/part* observational relationship, or the equivalent one of *containing/contained*, the Universe appears to us as a hierarchy of *holons*: that is, as a *holarchy* where, at each hierarchical level, the holons undergo the effects of the structural or operational variations of the subordinate holons and in turn produce variations in the behaviour of the superordinate ones.

The entire *machine* of life and of the Universe itself evolves toward ever more complex states, as if a *ghost were operating the machine*.

The concepts of holon and holarchy have since been used, especially in recent times, by a number of writers in a variety of disciplines and contexts, and these concepts are rapidly spreading to all sectors of research. Physics (Capra 1982), engineering (Babiceanu *et al*. 2005; Dani *et al*. 2004)), robotics, biology (Shafaei – Aghaee, 2008), organizational studies, management science (Zhang *et al*. 2003; Ng *et al*. 1996), business administration and entrepreneurship (Chirn – McFarlane 2001), production and

supply chain systems (McFarlane – Bussmann 2000; Aktürk – Türkcan 2000; Amiri 2006). Connected to these ideas are those of holonic networks, holonic and virtual enterprises, virtual organizations, agile manufacturing networks, holonic manufacturing systems, fractal enterprise and bionic manufacturing (Chapter 5).

This short essay, written from an economic-business point of view, has four objectives.

The first (covering the first two chapters) provides the reader with a brief but precise *theoretical* framework for understanding the meaning of the new terms that increasingly come up in business literature (outside Italy as well) and which refer directly or indirectly to the ideas of holon and holarchy. Connected to these terms are those of holonic network, holonic firm and enterprise, holonic manufacturing systems, holonic production, bionic production, fractal enterprise, and virtual enterprise, to name but a few.

Since I have observed that often the term "holon" has been improperly used, without any reference to the original sources, leading to models and conclusions that are absolutely inappropriate, I feel it is useful to provide the theoretical framework within which these terms can be properly used, considering not only Koestler's definition but also the ideas of Ken Wilber, which are based on this notion.

I also feel it is useful to examine several fundamental classes of holarchies in order to show that the idea of a hierarchical order among classes of holons can be applied to a variety of contexts. In particular I have presented Koestler's *Self-organizing Open Hierarchical Order*, Wilber's *Kosmos* and Shimizu's *Autonomic Cognitive Computer* as applications that illustrate the concept of a holon.

The second objective (presented in Chapter 3) is to extend the notion of holon while respecting its original meaning, in order to apply it to organizations.

Starting from the definition of organizations as systems whose organs are composed of individuals or groups of individuals, I have attempted to demonstrate two interconnected aspects: on the one hand, that organizations are holons that derive from a holarchy of organs (from their functionalities), and on the other that organizations can be formed by other holon-organizations – which I have labelled *orgons* – that are connected in a holarchy that I have called an *orgonization*.

When we observe the functionality and the function of its organs we see that an organization can be thought of as a macro system whose purpose is the attainment of a macro objective. It immediately follows that it can be compared to an *Holonic Manufacturing System*, or to an *Autonomic Cognitive Computer*; that is, to a holarchy of operators at different levels – each included in the other, so as to form parts of ever smaller size – each capable of pursuing part of the macro objective.

When there is a larger objective to achieve, rather than add levels to the org*a*nization we can form an org*a*nization of org*a*nizations, that is an org*o*nization with unique characteristics.

The third objective is to show (Chapter 4) how holons can be connected not only in the typical hierarchical structure – the holarchy – but, by stretching somewhat the original

meaning, also in a reticular structure in order to form *holonic networks* in which the vertical ordering (above and below) is replaced by a horizontal one (before and after).

Within the *holonic networks* the holons maintain their autonomy and their whole/part relationship, which together characterize holarchies. However, for this reason the dominant feature is their horizontal systemic interconnections; each holon becomes a node of input-output interconnections between holons that come before and those that come after in the structure.

I have thus discovered that even holonic networks can be made up of orgons that form *orgonic networks*.

Since *holarchies, orgonizations, holonic networks* and *orgonic networks* are present everywhere – in firms and between firms, as well as in the economic system of which they are a vital part – it is useful to present a general survey.

Among the many types of holonic networks, I have chosen to examine the main sources of inspiration for those production systems referred to as the *Holonic Manufacturing Systems*, comparing these to those defined as *Bionic* and *Fractal Manufacturing Systems*. I have also considered the numerous *forms of Inter-organizational Networks as well as the Holonic and Virtual Organizations*.

The fourth objective (Chapter 5) is perhaps the most ambitious one, since I have tried to extend the holonic vision to the global production-economic system, or *Production Kosmos*.

Globally we are witnessing the continual and accelerated economic progress of mankind. There is an increase in the quantity and quality of needs that are satisfied and those still to be satisfied, and in the aspirations achieved and yet to be achieved. The increase in productivity and quality is unstoppable, and appears to guide the other variables in the system.

It is natural to ask who activates and governs such phenomena. The answer is that they are self-generated and self-organized in the context of *reticular holarchies* and *orgonic networks* formed by production enterprises – or production organizations – that comprise the integrated process of global production.

On a continental scale, it makes sense to consider production in terms of *networks* of *orgons* in which, by choice or not, every firm that produces final consumption goods is linked at several levels to a number of other suppliers of materials, components, machines and other structural factors. We can easily observe that the large continental production networks – in North America, China, Japan, India and Europe – are not yet integrated but are becoming larger and increasingly connected, while other local networks are developing in other countries.

In order to understand how things are evolving in a context where there is a connection between firm and production organization we need a conceptual framework that does not limit our observations to the single production units, searching therein for

the laws of survival, but one which, at least in principle, is able to explain how the large orgonic networks internally produce self-organization and self-development.

The theory of systems provides two particularly interesting approaches: one that considers firms as *adaptive systems* that operate according to local rules and that spontaneously and inevitably generate production networks understood as *complex adaptive systems*, and that which considers production organizations as *holons* that, given their arrangement in a *multi-level holarchy*, generate the production networks in which progress appears as the inevitable consequence of the *holarchic* ordering of the Economic-Production Kosmos.

This essay considers the second approach, presenting the holarchic model of the analysis of production networks. It assumes that in an economy based on knowledge, where the limits of time and space are tenuous, production must increasingly refer not to a single firm but to a system of firms (a super-organizational network) or to operational units (inter-organizational network) conceived of as an operative, information or cognitive network.

It truly appears there is a Ghost in the Machine, whose invisible hand produces growing levels of productivity and quality, increases the quality and quantity of satisfied needs and aspirations, and reduces the burden of work, thereby continually increasing the level of progress in the entire Kosmos.

It is useful to conclude with a bibliographical note.

The conceptual revolution begun in 1967 has not yet led to a relevant number of monographs. On the other hand, there is a substantial bibliography containing journal articles, papers presented at congresses, and opinions and documents from discussion forums. The Internet has been crucial for gaining access to recent material.

In the citations I have indicated the page of the reference only for monographs and articles. Those citations from the Internet, even though in quotation marks, do not contain the page reference but only that of the author and of the URL of the site they were taken from.

NOTE. This book is the English version of «La Rivoluzione Olonica. Oloni, Olarchie e Reti Oloniche. Il Fantasma nel Kosmos Produttivo», published in Italian by Franco Angeli, Milan, 2005. The first four chapters are more or less unchanged, with the exception of some updated information and expanded treatment. Chapter 5, on the other hand, has been entirely rewritten to bring out more clearly the logic of the Production Kosmos.

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