Principia Ecologica:
Eco-Principles as a Conceptual Framework for a New Ethics in Science and Technology

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Abstract: As a result of contemporary environmental problems, scientists are focusing their interests on developing a greater understanding of nature. Described in this paper is a view of life and the environment as a case of complex systems analysis; this analysis results in a series of general principles which are manifested in life and bioprocesses. These 'eco-principles' will be very useful as guidelines for the eco-restructuring of technology as well as the reorientation of human activities towards a sustainable lifestyle which includes the economy, society, management of industry, the university and even the church. The goal is a society which will be in harmony with the laws of nature ('Principia Ecologica').

1. INTRODUCTION - 'L'art de l'ingénieur'

It is no longer the aim of engineering activities and technological developments to fulfil man's physical requirements by the unconsidered manipulation of nature. Engineers now have to effect developments in harmony with technical, economic, social and ecological systems.

The eco-principles ('eco' is derived from αίκος, Greek for house or habitat) presented in this paper reflect natural principles and will, when applied in the future, lead to the ecological (cybernetic, holistic) world view which will replace the 'old' mechanistic, reductionistic paradigm, expressed in Descarte's Principia Philosophiae (1644) and in Newton's Principia Mathematica (1687). The new paradigm exhibits a more comprehensive problem solving capacity as it integrates the different problem areas: ecology, the economy and society, resulting in Principia Ecologica. This new ecological, holistic, open-ended and dynamic approach can be characterized by five transitions:

1) from parts to the whole (holistic);
2) from structure to function (process dynamics);
3) from objective to empirical interactive science (subjectivity);
4) from 'fundamentals' to network knowledge (cognition);
5) from truth to models (approximations).

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This new paradigm requires an agenda as summarized in the following propositions based on a new ‘eco-ethics’:

1) eco-principles are derived from a systemic analysis of bioprocesses in the ecosphere;
2) ‘indices for sustainability’ must be applied to technology.

The application of these principles result in ‘Eco-Tech’ as the new technology paradigm and the ‘Eco-Social Market Economy’ as the new lifestyle.

2. ECO-PRINCIPLES - The Guidelines

The largest living system that we know with some accuracy is extant on our planet. The perception of the earth in all its beauty - “a blue and white globe floating in the deep darkness of space”, as described by astronauts - was a profound spiritual experience that forever changed the relationship of humans to the earth they inhabit. The surface of the earth can be regarded as the environment necessary for life. In many ways, the earth as a living system is like a tree; there is just a thin layer of living tissue around its perimeter but it differs from the tree in that it does not reproduce itself. The thin layer of the biosphere, i.e. the eco-productive area, is what we need to protect and renew. However, there are some drawbacks to the better understanding of nature because it is highly complex and difficult to quantify.

2.1 Learning by Listening to Nature - The Way

Complexity is a dominant feature of nature and of bioprocesses, in particular, where interactions between a variety of phenomena influence the whole process. For many centuries we, in western society, have strictly followed an approach which can be seen as an attempt to reduce complexity by discovering the component parts and their interactions (‘reductionistic view’). The background for this was the belief that the laws of physics governed all phenomena. This approach was successful until recently when disagreements accumulated in the areas of quantum physics, biology, sociology, psychology and other fields. Due to the complexity of these different disciplines, the application of reductionistic thinking and modelling failed. A simple causal nexus could not be posited in complex situations; a new systems approach was needed. A great advantage of the systems approach is that the same concepts can be applied at different levels, which often leads to important insights.

According to this new mode of thinking, the problem solving capacity is greater when using formal relationships on the macroscopic level often with the aid of analogies; this can be called the ‘formal macroapproach’.

The new mode of thinking can be applied to different fields:
(i) to understand the functioning of our planet Earth;
(ii) to understand natural cycles in the anthroposphere, i.e. eco-tech design and performance;
(iii) to understand the interactions between production processes and their environments, i.e. industrial ecology;
(iv) to enhance the understandings and actions needed for eco-restructuring of societies and organizations.

The basis of such understandings lies in the Theory of Self-Organization.

2.2 Theory of Self-Organization as a Theory of Living Systems

This theory which stems from investigations in biology and physics emerged fully during the last two decades. A significant property of living systems is