

# **Systemic Thinking as a Gluing Material for Solving Earth's Nature's Problems Due to Mankind**

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## **Abstract**

The author orients notions and traditional concepts from systemics and cybernetics, their influence and practical value towards a global problem. Main instrumentation is the theory of general hierarchies, and more specifically, the fifth group of kinds of hierarchies – process hierarchies, discussed in a series of her publications during the period 1986 – 1997 and used by a number of Bulgarian mathematicians. The specific ‘gluing material’ is a matter-information model, ‘The Mosaic of Technologies’. It applies invariant characteristics (ICs) of process hierarchies to fuse natural ecological and environmental phenomena with economic laws and trends (1985 – 1988), as well as with social ones and humanity’s values, while preserving the model know-how for operations research and other quantitative mathematical methods. She successfully fuses conceptual knowledge from systemic and hierarchic investigations by established scientists made on all atomicity levels of hierarchies’ elements by choosing technology as a ‘mosaic stone’. The instrument of ICs from the theory of general hierarchies allows varying the investigated level of abstraction, (dis)aggregation or atomicity without damaging the model by changing types of a hierarchy thoroughly or locally. The money component of information modelling is linked up with its nine roles in human society and with the essence of the ECOSYS model (1988). A rigorous critique on the modern understanding on measures and solutions for ecological problems due to human doings, on wrong priorities for human and economic effort is given further details.

*Keywords:* ecology, feedback, general hierarchy, information, living systems theory, matter-information model, money, operations research, system, technology, value

## **Introduction – an Attempt to Summon Mankind’s Knowledge and Relate It to Systemic Thinking**

The paper makes an attempt to summon an inventory of mankind’s knowledge and skills related to the necessity to prevent the ongoing process of self destruction, to point out positive steps made in knowledge domains of science and practice and show how they can be extended and creatively merged. During the last several decades much thought has been devoted, much resources invested, much real betterment designed and here and there done, to show that it is possible at all. Now, time has come to arrange the thoughts, to re-arrange principles, priorities and design, to imply the best of organizational theory

and practice, to re-organise the efforts of sciences, humanities and arts, to do all this in concert supported by a science that emerged during the 20th century – the theory of systems.

“*Systemics* is an open set of concepts, *models* and practical tools useful for a better *understanding* and eventual *management* of complex situations of entities of any type. It would seemingly be advisable to replace expressions like *systems research, general systems theory, and general theory of systems or systems science*” (François, 2004).

Charles François’ *International Encyclopedia of Systems and Cybernetics* gives an extended definition of the concept *system*, as well as further 81 encyclopaedic articles titled by keywords or phrases for concepts and terminological constructs, containing the word ‘system’, and specifying its features with many citations from scientific sources of the systemics and cybernetics knowledge area. His conceptual basis may be a good starting surface for concerted actions to be planned and undertaken.

The synergy among Ecology, Environmental Control (E-EC) (Meadows and Meadows, 1992) on the one hand, and Systemics, Cybernetics and Informatics (SCI) – on the other hand, needs various capabilities for to take part in or constitute international, multi- and inter-disciplinary and action research teams or workgroups, in order to conduct requiring synergic relationships among different kinds of talents, cognitive styles, intellectual faculties and scientific, educational, industrial or social interests. Combined capabilities incorporate analytic thinking for focused creative conversations and team research, holistic and synthetic thinking, analogies generation in multi-focus knowledge domains and divergent thinking for a synergic relation between analytically and synthetically oriented research. Synergy itself is a systemic concept. Similar merging of conceptual bases from other knowledge domains put even more difficult challenges on the agenda.

Why do we ask a child to clean up the mess and restore her/his micro environment, but it seems so incredibly far fetched to require the same from a local, regional or global society? Sometimes, as pedagogues or parents well know: “... To ask someone to undo a wrong action at once, requires less effort or is even easier to initiate, than after some time passed to ask to clean up (somebody else’s) mess ...” Neither of the governments on Earth feels strong enough, or maybe competent, to put such a goal on the agenda. Regretfully, the lack of global understanding for or underdevelopment, or isolation of systemics, the limited, too narrow conception for innovative actions, the unpopularity of theory of general hierarchies (Kalaidjieva, 1985, 1979), as well as the controversy of both industrial and bureaucratic interests with Nature’s laws at present, let things worsen on.

A comparison shows that the systems hierarchy concept, denoted sometimes as ‘mathematical hierarchy notion’, is a special case of the general hierarchy concept. Some scholars tend to stretch out the scope of the concept ‘hierarchy’, in order to cover the whole meaning of the ‘general hierarchy’ and overcome its “later” historical emerging. *However, by stating that systems hierarchy notion is a special case of the general hierarchy concept the levels of abstraction of the concepts would match the conventional terminological rules.* As a consequence, the systems hierarchy notion used at present can be denoted as ‘*systems hierarchy*’ or ‘*systemic hierarchy*’ or similar keyword phrases explaining the concretisation of the special case by appropriate attributes.

## Difficulty of Design Complexity and Prerequisites

Nature's problems due to mankind are scaled by journalists, ecology enthusiasts, politicians and many scientists as major, less important or minor. Another scaling is from global to local impact. These and similar scaling aspects are not directly applicable to the style of design to cope with complexity. Recurrence frequency of problems is significant, but not exclusively. A more complex, polythematic scaling aspect should be appropriate. I think that in the pre-design and general design phase scaling is of low priority, a foreground hard work would be to fit efforts to systemic effects. Solving the problems, i.e. *recreating Nature and living in sustainable balances with Nature*, is the goal urgently imposed on humanity. The difficulty consists in the design complexity – and here again systemic thinking has supportive methods and tools. An inventory of prerequisites to this goal is attempted below, in order to take account, to outline successful mutual efforts in knowledge domains far apart from each other. They are described as steps.

One step to challenge design difficulties is marked by modelling and control of processes supported by (hierarchical) systems and general hierarchies (Kalaidjieva, 2001, 1997, 1985), more specifically – by process hierarchies mediating to apply quantitative methodologies. Qualitative analysis and design and quantitative methods are applied repetitively. Hierarchy investigations concerned mainly organisation and structure of business and economic units, later it focused on markets (Williamson, 1975), but stayed much too long in the frame of monohierarchies in all. Another step in the right direction was to characterise and coin the concept of invisible economy – the economically valuable intellectual and information processing in all spheres of management and society – on the example of the British economy in the late 1980-ies (Liston and Reeves, 1988). It focuses on the context of world trade, international service industries, education and training dimensions, resulting challenges and conclusions. It is oriented towards national wealth and only indirectly contributes to international economic and innovative networking. One more step did the conceptualising of the global web, the new web of enterprise, the perils of vestigial thought and the diffusion of ownership and control (Reich, 1991).

Systems research plays both the roles of a specific knowledge domain and a methodological, instrumental knowledge related to synergy among Ecology, Environmental Control, and here I added earlier, Re-Generation or Re-Creation (E-EC&R). In addition to the contemporary general framework of disciplines for problem-oriented research and practical monitoring focused to preserve Nature, I need to emphasize that *time has come* to design action research and step-by-step planning for a forgotten duty of mankind – to re-generate Nature, where it was harmed. Moreover, re-generation and re-creation open a *wealth of innovative variety*, which can truly minimise material and social consequences of human activity. Innovations have been investigated largely from the viewpoint of economic optimising as methodology of economic development, prosperity and wealth (Maier and Robinson, 1982; Reich, 1991), less in concern with Nature's or Earth's problems (Meadows and Meadows, 1992). Far less innovation research and design has focused on systemic consequences of innovations as single 'mosaic stones' of modern consumption society. M. Kalaidjieva introduced this way of thinking applied on environmental problems in a series of papers at national Bulgarian and international conferences during the period 1985-1997. Some attempts

were made to merge economic-ecological modelling by mathematical processing, however the choice of parameters was oriented for central control planned economy (Bashalhanov and Baturin, 1988), i.e. all cases of polythematics and polyhierarchy would be neglected as early as during the semantic pre-design.

The requirement to include regeneration and recreation is seemingly making things more difficult and probably this was the reason to avoid them whenever possible, even if illogical. Actually, it closes control cycles, feedbacks in the mosaic of technologies (explained later here). A good way to encourage this sequence of thoughts and to learn a wealth of experience was Nature and particularly living beings, living systems both in the biological and social context (Miller, 1978; Swanson and Miller, 2001). Choosing technology as ‘mosaic stone’ allows to:

- Define levels of atomicity of elements in different kinds of hierarchies – investigated, lectured and coached by Len Troncale since 1984 (Brier et al., 2002; Troncale, 2002), and
- Place them in the conceptual frame of foundations of information science (Brier et al., 2000), among others by using the concept of money-information (Swanson, 1993).

A further step using the atomicity instrumentation is to find locally adequate sensors for early warning data input for an investigated system and its balancing. Primary information received from chosen sensors type(s) as input to perceptual-motor arches (François, 2004, cit p. 449, item 2520; Kalaidjieva and Swanson, 2004; Kalaidjieva, 1999) within a local system and its links, interactions with others have to point out causes, substances and process initiating agents for harmful consequences, destroying ecological natural balances and the capacity of Nature to regenerate itself.

Some knowledge domains to consider in concert with ecological problems from the viewpoints of Systemics, Cybernetics and Informatics (SCI) are: globalisation; natural and human resources; conceptual infrastructure of SCI; control systems; information systems development and management, human, education and management information systems; economic, financial and social systems, development and emerging economies; applications of SCI to science; psychology (cognition, spirituality, etc.), biology, medicine, chemistry, physics, astronomy, engineering, virtual engineering; computing techniques, (image, acoustic, speech signal processing, etc.), emergent computation, etc. This enumeration is by no means exhaustive.

*Integrative study* is another keyword for research gluing all these domains applying systems thinking. A country vitally needing, developing and supporting systems science is The Netherlands. The Systeem Groep Nederland (Dutch Systems Group) was one of the three founding members of the global systems community’s scientific professional organisation – the International Federation of Systems Research (IFSR) – together with USA and Austria in 1980. IFSR has now nearly 30 member societies ([www.ifsr.org](http://www.ifsr.org)). This went on in parallel with establishing numerous systems research institutes, college and university chairs, but almost not intersecting with the emerging national and international ecological ones. There are integrative studies fusing environmental health science and knowledge technology for the purposes of global assessment.

## Values and Local Invariants

Ecology investigations have difficulties to disseminate challenging scientific results, because historically seen they were, and to a certain extent still are, prevented by economic narrow focuses. Below is included an extract of an article presented 1993 in Amsterdam at "Problems of Values and (In-)Variants" that raised turbulent discussion in the global systemics community. It focused highlights on opening ways "to make the world a better place to live in" by a model balancing ecology, environmental control and economy (ECOSYS) (Kalaidjieva, 1988a; 1993) enhanced by social values to the '*Mosaic of Technologies*'. This was the first chance to disseminate it after being prevented 5 years long and later many to come.

Values of traditional concepts change and need to change. The idea that

**"Pollutant = Waste Material = Useless Product = Potential Resource"**

- was ideologically illegible on one side of the Iron Curtain and too obvious on the other side of it. The mathematical information process calculus model introduced was opposed, until the general hierarchy concept (GH) was accepted (Kalaidjieva, 1996). The subsequent production stages in this model shape branching processes, i.e. GH of the 5th group – process hierarchies.

One more step for understanding the state of affairs has to be made for a successful optimising the model – to re-think *humanity's values and priorities* (Kalaidjieva, 1990a; Kalaidjieva, 2002a). But before it is presented here, some notions have to be introduced.

The information technology ECOSYS model expanded for social issues, originates from the necessity to control all material products of human activities for content, quantity and further processing. It has mathematical and information processing background (Kalaidjieva, 1988a; 1993). It distinguishes among values (and their conceptual focuses or backgrounds) in use for economic industrial technological processes, their aggregating or disaggregating using data from production or administration management and control. The methods of aggregating and disaggregating are opposite to each other and aim at flexible systemic thinking, understanding, modelling and calculating optimal local conglomerates (systems), thus converting them for further uses into (local) "invariants". It was named '*mosaic of technologies*' for the important role innovation can play for environmental and ecological betterment of Nature and society in an E-EC&R-model. It became the founding idea for the Memorandum to the World Summit on Sustainable Development – Johannesburg elaborated and voted at the 46<sup>th</sup> ISSS Distributed Site in Varna, August 9–15, "2002 RIO + 10, Sofia and Stockholm + 30, INTERECO 2002: "*Ecoglobalization — Sustainable World*" (Memorandum, 2002).

Features of the general hierarchy concept are used for analysing complex objects both by observer and user. Some different meanings of 'value' are studied in context. The sequencing of closing systems' structures in a single 'mosaic stone' and revealing their structures again requires and results in *iterations of qualitative and quantitative GH hierarchy analysis*. Observation is n-dimensionally constrained. Observer and user are bound in a productive loop by the feedbacks of process repetition illustrated on 1- and 2-dimensional schemes of 'investigation & application'. Common sense of failure is due to over-simplifying models. The techniques of analysing hierarchies by invariants may be

shown on a variety of examples: priorities, network of market relations in 5 variants and the mosaic of technologies itself, money as measurement unit, value, stimuli, etc. They were presented in the Amsterdam paper to show how concepts from different theories can be fused to become an applicable basis for design and action. Keywords in alphabetical order were: complex object, contents of a phrase, dimension of analysis, feedback, function, invariants, observer, sequencing, user and value. A concise example of the network of market relations in 5 variants (Table 1) and on the mosaic of technologies are displayed below.

**Table 1. General Hierarchy of Market Relations investigated as a polyhierarchic polythematic skeleton of a repeated process, i.e. as a general process hierarchy**

Invariant Characteristics	General Hierarchy of Market Relations
Hierarchic Direction:	Time axis
Aspect of Decomposition:	Processing of resources – split in 5 variants of simple aspects, which are taken account of simultaneously in parallel
I variant	Processing of materials (intermediate) products or services, etc. – material flows
II variant	Supply and demand trade flows based on contracts, before and after being materially processed – down to the end user. The barter exchange creates negative material flow connectedness, which then at some point changes its direction into the positive one, when it is sold on its run for money
III variant	From import to export of goods and services (cross-border trade) including medical, veterinary, customs, etc., checking and taxing; the smaller the country, the more open its economy to international exchange of goods and services, the greater is the profit from and need for international co-operation, the greater its dependence on co-operative relations
IV variant	Money or other exchange or payment units' flows – they follow the opposite direction of the connections in the GH, i.e. they are inverted, negatively calculated and, similarly to the profit vs. penalty flows, may distort the economic performance picture, special precautions are taken into account by means of complicated accounting procedures, which are still lacking the needed transparency
V variant	Labour as weighed node-interval for the act of resource processing, as employment of persons with sets of skills and knowledge, etc.

Element:	Resource, product, service, money (payment unit), labour, etc.
Connection:	A payment, exchange, single production stage, the meeting of a demand by a supply
Node:	Good, ware or service
Algorithm of Decomposition:	The technology of detailed splitting the hierarchy, developing the sets of sub-nodes, registering among others the polyhierarchy occurrences of sub-nodes, for the next lower subsequent level or step– different for each of the 5 variants, then combined in concert for one or two or several of them for different parts or domains in the GH, i.e. registering the rules for polythematic decomposing
Polyhierarchy:	One and the same kind of good or service can be implemented or used in different single exchange act, but only one good or service is sold in one act (besides information goods), the same demands can be met by different goods or services – these are some of the possibilities for the property of polyhierarchy to emerge in these relations
Polythematics:	Each of the variants can be understood as a simple aspect as a part of a complex aspect of decomposition, in fact though each of the variants may have special peculiarities making it to appear further more complex under other viewpoints
Measure:	Prices, quantities of substances and materials, volumes, contents or scopes of services, values for quality, relevance to the needs and many more quantitative measurement values

### **The ‘Mosaic of Technologies’ – A Model for Ecological, Economic and Social Balancing Control**

One ECOSYS industrial process may be shown in the usual way of illustrating processes. It is constructed after the first variant of the aspect of decomposition in Table 1, can however be enlarged in its complexity to incorporate the other variants, as well as the different meanings of money for the fourth variant of the aspect of decomposition as its sub-variants too. The Mosaic of Technologies (studied as a network-hierarchy before GH was published 1996), becomes very complicated when calculating values for quantities for each material separate.

The variants from Table 1 are simple aspects of decomposition being parts of the complex one. A calculating task can be (stepwise) reduced to a less number of simple ones or expanded by specifying more detailed and further breaking them down, and then choosing a combination for a resulting complex aspect.

For instance, technologies can be classified detailed according to: a) Type of good, ware or service – material discrete, material with continuous type of amount, non-material

documental information, factological, intellectual, etc., quantitative or verbally descriptive, b) Type of price – usual market as established, or as designed in project, hypothetical, single product specifically to negotiate with a customer, short production series specifically to negotiate with a narrow customer circle, c) Type of customers – buying products for traditional life supporting purposes, for medical and life saving, life quality betterment, for catastrophe incidents (fire, flood, communication break down, earthquake, mountain or sea rescue, etc.), for the betterment of labour productivity, product quality, production environment, for enhancing knowledge, skills, rating or prestige of the customer in business or on the labour market, for entertainment, recreation, sports and tourism, for entrepreneurship and business initiative, for public service, public order, defence (inclusively from criminal, terroristic or low instincts violent behaviour hazards) and general political activities, etc., d) Type of services – transport or transfer of goods, labour employed in material or non-material (culture, education, science and innovation, management and office communication, etc.) production, and e) Type of configuration and complexity – number of inputs, inner and outer links and outputs (Kalaidjieva, 2002b).

In this sequence of reasoning a further break down of the aspect of decomposition may implement the different roles money can play in different relevance of measurement (Kalaidjieva, 1988b; 1990b):

- Money as an exchange unit,
- Money as value (measurement) unit including material processing production, etc. values, substituting quantitative measurement in other units and qualitative measurement expressed as price – as consumer money,
- Money as a value unit including social, moral, intellectual, cultural, etc. values expressed as price and or capital – as consumer money,
- Money as a value unit including social, moral, intellectual, cultural, etc. values expressed as price and or capital – as investment money,
- Money in the role of stimuli for economic development – as investment money,
- Money in the role of stimuli for environmental support expressed as price and or capital – as investment money,
- Money in the role of stimuli for social and intellectual development expressed as price and or capital – as investment money,
- Money as an information and mathematical basis for economic indicators and for definition of foreign currency exchange rates,
- Money as a tax system linked with a credit system, both depending on (periodical) expert evaluation aiming to summarise many of the previous (eventually not very successfully), etc.

The good news is the possibility to stepwise aggregate (up-roll) or disaggregate (down-roll to the detailed primary registered data) ‘stones’ of the Mosaic of Technologies. A calculation can be (stepwise) limited – as local, geographic, (stepwise) nested, etc., or of product, service or action(s) line(s), etc.



## **From Neolithic Towards a Modern Re-Creative Human Behaviour onto Nature**

Scientific researchers needed almost 20 years to prove the viability of the model, to investigate the knowledge resources for its functioning, to disseminate their results among those, who would be able to make it work, to invent computer, communication and information technologies for its performance, to convince practitioners, politicians and governments of the necessity to care for Nature and social health. While reorganising a research institute's department for a Monitoring System for Air Pollutants, some future problems came into the lights:

- Market economy relations foster innovative attitude in all subjects of society, but market incentives do not match Nature's recreation needs;
- Companies' management databases are of little help for global calculus procedures, data have to be uncovered also indirectly, however
- Companies are interested in calculating within their scope of activity, in order to optimise their relations with governmental and public authorities, investors or investment funds, as well as with other companies concerned, i.e. to
- 'Bind' unused residuals on both input and output sides of each 'mosaic stone' on different levels of aggregation by means of innovative actions;
- Governmental regulations amass quite good set of data, but eventually proclaim them secret (!);
- Transparency of information has been achieved on the bases of democratic laws, but is still insufficient for genuine and overall (pollution) care; yet
- Data do not fit a concerted conception and have to be post-processed,
- Health and genetic problems have awoken a sensitivity to ecological health of Nature, but the
- Resources of the economy are not exhausted, i.e.
- A novel attitude to economic and social accountancy and money supply is needed in concert with the E-EC&R-model (the present methods are too inexact up to incorrect, due to former difficulties to calculate manually or by means of poor technical equipment),
- Modern computing is used to a minimum, while computer industry is dreaming on snoozing in multi-media illusions,
- A similar concerted effort is needed on the side of science and education, in order to support management and practitioners in business
- For innovation by means of innovative actions in concert with the E-EC&R-model.

There are a plenty of unused resources, and optimising the model would partially free some resources and create new ones in effect. It may come to the point to touch the monetary systems vision on the new scale of priorities of humanity's values:

**Nature & Ecology  $\leftrightarrow$  Economic Model  $\leftrightarrow$  Social Wellbeing & Safety**

The idea for this sequence of priorities has not been consciously understood since the Neolith. It gradually emerged in human consciousness during the last two centuries, but has been (actively) opposed for the recent decades. During the last 10 – 15 years

humanity stepwise understood its self-harming self-made artificial systems chaotically emerging and eventually collapsing (Meadows and Meadows, 1992; and many, many others).

Systems thinking – before and while modelling, processing or doing whatever – can, I am deeply convinced, help to a shift of human behaviour onto Nature from Neolithic towards a modern re-creative one.

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