WORKSHOP: NEW ROLES OF SYSTEMS SCIENCE IN A KNOWLEDGE SOCIETY[i]

Introductory provocation

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ABSTRACT

Knowledge is intangible raw material from which entrepreneurs make innovations. By using it for innovation, the modern western society dominates the entire world. It is called innovative, or entrepreneurial, information, knowledge society, etc. It is full of narrow specialists, which may be very deep and risk essential oversights, too. Hence, their specialization needs completing-up with other special insights in order to enable requisite holism. (See part 1). Requisite holism receives support from systems thinking. This has been an ancient, which can belong to bases of informal systems thinking. Modern trends of life require the latter in many ways because one sees that one-sidedness is very dangerous for all of us as individuals, organizations, and humankind. (See part 2). Therefore it is a pity than centuries of growing and useful narrow specialization have caused humankind to forget scientists advocating holistic thinking over recent centuries. (See part 3). The 20th century with its two World Wars and the world wide economic crisis between them (1914-1945) demonstrated the urgent need for holism and hence for systems thinking to receive a scientific basis – systems theory – against the current overspecialization. Still, over six decades of GST and Cybernetics, the narrow specialization has won the battle over Bertalanffian holism, and made it forgotten, or limited inside single traditional fields of science and practice, mostly. (See part 4). World-wide humankind's organizations found it necessary to renew systems thinking and to do so in a rather direct link / interdependence with (1) survival of humankind by peace – United Nation and Security Council, (2) by linking economy and care for nature – Sustainable Development, and (3) quality of life and work life by linking entrepreneurship, innovation, excellent quality, learning, and systems thinking, including (4) enlarging the notion of innovation from a technological novelty to every novelty that its customers experience as a source of new benefit. Invention (= new idea) cannot become innovation without systems thinking linking many different specialists in the same endeavor run by entrepreneurial persons in teamwork. (See part 5). Though, the current systems theory is neither uniform nor united, but diversified in five major streams. All of them are beneficial in their own right, but none is the only beneficial or useful one. (See part 6). Our conclusion about the new role of systems thinking in the modern society can hence be briefed as follows (with a slight economic flavor to the notion, see Part 7).

Key words: innovative society, interdependence, knowledge society, survival, systems thinking, systems theories, sustainable development, United Nations

0. THE SELECTED PROBLEM AND VIEWPOINT OF CONSIDERING IT HERE

The modern society lives more than any society earlier on intangible inputs into products, services, life style, etc. They result from enormous increasing in knowledge and its application, especially for innovations, which result from entrepreneurial humans' co-operation with many specialists. The available quantity of knowledge makes individuals one-sided specialists who risk oversights along with depth of their knowledge. It was systems thinking which has always helped people fight oversights. Its practice evolved into systems theory several decades ago. But it still fights for its survival, and so does (hence) humankind. An innovated perception of the link between the modern, innovative / knowledge / entrepreneurial / information, society is suggested.

1. BRIEFLY ABOUT KNOWLEDGE SOCIETY TURNING TO CREATIVE / ENTREPRENEURIAL / INNOVATIVE ONE

Humans have always depended on knowledge of all kinds, making them different from other living beings. Sometimes knowledge is quite self-sufficient. But never has the share of intangible inputs in products and processes been so big as today. Close to 150 years ago abolishment of guilds and of unity of government and church sharing power, as monopolistic obstacles to competition, made room for competition of producers and customers (= market) and of authors and implementers of ideas (= democracy): entrepreneurship and innovation has become the way of life. Knowledge, information, creativity, entrepreneurship, total/excellent quality, learning, growing surplus of supply over demand, consumerism rather than modesty, competition with no mercy, etc. are attributes of the modern innovative society. It lives on innovation, using knowledge, information, creativity, entrepreneurship etc. in order to offer excellent

quality and thus to survive in the contemporary competition. One-sided rather than requisitely holistic thinking, decision-making, and action causes failure rather than success of individuals, organizations, nations, regions, and even of the entire humankind. Holism receives support from systems thinking, which can be supported by systems theory. But systems theory consists no longer of a single version and notion (See: [1]). It is far from trivial [2].

2. BRIEFLY ABOUT MODERN TRENDS REQUIRING SYSTEMS THINKING

There are several trends in world-wide life using or requiring systems thinking, such as:

- United Nations are the widest organization of humankind and exist to work for holism in detecting and solving of the world-wide problems;
- Many other international organizations exist for the same basic reason;
- Sustainable Development is an important concept, which humankind has launched through United Nations and several other international organizations in order to solve the problem of survival of humankind: we all need interdependence of both our care for economic development and for nature, because both of them together, in synergy rather than in separation, support our survival;
- Since the times of enlightenment several centuries ago, humankind has been working for its economic development, including its development of knowledge, including science and its application; this development resulted in enormous amounts of new findings, discoveries, and innovations, as well as in a more and more narrow specialization;
- The unavoidable specialization has become exaggerated: along with deep and crucial insights it has caused many oversights, resulting in small and huge problems, all way to world wars, many other wars, profit (as motive) killing profit (as outcome) by causing huge medical, repair, nature renewal, etc. costs; all these trends required and require increasingly the international etc. bodies and people to act under the motto: **Think globally, act locally**;
- Science and its application resulted, among other effects, in humankind's capacity to master more and more complex, not only complicated, issues, all the way to the most modern computer-supported tools (1) able to bring data, messages, even information from other planets that are many million kilometers away from Earth, (2) able to enter human body, (3) cure diseases as never before, etc.
- Etc. Most of the great results of modern times result from combinations / synergies of
    - Deep, and hence one-sided, specialization, and
    - Bridges for co-operation between mutually different and interdependent specialists, based on application of (informal or formal) systems thinking.
- Systems thinking, rather than systems theory is a millennia old practice of the successful practitioners and scientists and artists, which has made and makes them different from the less successful ones. (All losers are more or less one-sided thinkers and actors.)
- The exaggerated specialization of the modern times caused the need for systems thinking to receive support from systems theory. It can teach humans to live consciously in the way that has always made a part of humans successful without possessing a theory as background of their success.

(For details see: [3]; [4]; [5]; [6])

3. TRENDS TOWARD HOLISM AND CREATIVITY IN OLDER TIMES – NOTION OF INTERDEPENDENCE

In the 19th century, there were authors claiming the humankinds' need to consider relations, interdependences, not parts of the world as independent entities only. Their background may have been consciously or subconsciously the ancient Chinese notion of interdependence called **yin and yang**, and/or the ancient Greek notion of interdependence called **dialectics**. Both mean interdependence. In the 19th century one has seen Idealistic Dialectics, Materialistic Dialectics, and several more notions and teachings about holistic thinking. [7]

One can reach several centuries back. Many know that there has been, centuries ago, e.g. Leonardo da Vinci. He is known as artist of supreme quality, but he was also a great researcher. One can find in him a pioneer in the fields of creative thinking, accelerated learning, and innovative leadership ([8]. Fig. 1; thanks to New Moment).

Still, specialization makes us people blind outside our specialization, and the huge amount of data, messages, as potential information, makes us selective. An individual can no way read one single percent of contemporary new publications. In other words, many of such important findings and notions remained poorly noticed. Their resurrection became necessary.

4. EMERGING AND LIMITED CONSIDERATION OF SYSTEMS THINKING TODAY

After the period of the two World Wars and the worldwide economic crisis between them (1914-45) and partly in their time, several groups of humans created several streams of responses to the problems requiring a resurrection of holistic thinking. General Systems

Theory and Cybernetics resulted. After a few decades of their successful penetration in science and practice, their authors found that the unavoidable specialization keeps making people too narrow and refuse holism, which the General Systems Theory and Cybernetics have suggested.

7 DA VINCIAN PRINCIPLES	*What is it?*	Look at your own mind map from the perspective of the 7 Da Vinci principles
1 Curiosita	An insatiably curious approach to life and an unrelenting quest for continuous learning.	Am I asking right questions?
2 Dimonstrazione	A commitment to test knowledge through experience, persistence, and willingness to learn from mistakes.	How can I improve my ability to learn from my mistakes and experiences? How can I develop my independence of my thought?
3 Sensazione	The continual refinement of the senses, especially sight, as the means to enliven experience.	What is my plan for sharpening my senses as I age?
4 Sfumato (Literaly "Going up in Smoke")	A willingness to embrace ambiguity, paradox, and uncertainty.	How can I strengthen my ability to hold creative tension to embrace the major paradoxes of life?
5 Arte/Scienza	The development of the balance between science and art, logic and imagination. "Whole brain" thinking.	Am I balancing Arte and Scienza at home and at work?
6 Corporalita	The cultivation of grace, ambidexterity, fitness, and poise	How can I nurture the balance of body and mind?
7 Connessione	A recognition of and appreciation for the inter-connectedness of all things and phenomena. Systems thinking.	How do all the above elements fit together? How does everything connect to everything else?

Figure 1: How to Think like Leonardo da Vinci

L. von Bertalanffy wrote in his seminal book [9]:

> »Systems science ... is predominantly a development in engineering sciences in the broad sense, necessitated by the complexity of »systems« in modern technology ... . Systems theory, in this sense, is preeminently a mathematical field, offering partly novel and highly sophisticated techniques ... and essentially determined by the requirement to cope with a new sort of problem that has been appearing.
>
> »What may be obscured in these developments – important as they are – is the fact that systems theory is a broad view which far transcends technological problems and demands, a reorientation that has become necessary in science in general and in the gamut of disciplines ... It ... heralds a new world view of considerable impact. The student in »systems science« receives a technical training which makes systems theory – **originally intended to overcome current overspecialization** (bolding ours) into another of the hundreds of academic specialties. ...« ([9], p. VII). »It presents a novel »paradigm« in scientific thinking ... the concept of system can be defined and developed in different ways as required by the objective of research, and as reflecting different aspects of the central notion.« (Ibidem, p. XVII) ... »General systems theory, then, is scientific explorations of »wholes« and »wholeness« which, not so long ago, were considered to be metaphysical notions transcending the boundaries of science.« (Ibidem, p. XX) ... ».. »Systems« problems are problems of interrelations of a great number of »variables«.« (Ibidem, p. XX) .. ».. models, conceptualization and principles – as, for example, the concept of information, feedback, control, stability, circuit theory, etc. – by far transcend specialist boundaries, were of an interdisciplinary nature..« (Ibidem, p. XX)

- Note: Interdisciplinary nature denotes here something belonging to several disciplines rather than something resulting from mutual impact of them. Thus, it is poorly delimited from the notion of multidisciplinary. Three dictionaries at our disposal do not include either of the two words [10]; [11]. [12].
- (This fact itself speaks of the »uncommon sense« Bertalanffy has been speaking for (See: [13]): he was fighting the current practices, because they were dangerous and still are so. – Comment ours). Let us return to Bertalanffy!

> »What is to be defined and described as a system is not a question with an obvious or trivial answer. It will be readily agreed that a galaxy, a dog, a cell and an atom are *real systems*; that is, entities perceived in or inferred from observation, and existing

> independently of an observer. On the other hand, there are *conceptual systems* such as logic, mathematics (but e.g. also including music) which essentially are symbolic constructs; with *abstracted systems* (science) as a subclass of the latter, i.e. conceptual systems corresponding with reality. However, the distinction is by no means as sharp and clear as it would appear. .. the distinction between »real« objects and systems as given in observation and »conceptual« constructs and systems cannot be drawn in any commonsense way.« ([9], p. XXI-XXII)

Elohim [14] quotes Bertalanffy requiring people to behave as citizens of entire world rather than of single countries and consider the entire biosphere rather than its local parts only; this is a precondition for humankind to survive. – This quotation is close to the Bertalanffy's criticism of reductionism under the name of systems science:

> »Physics itself tells us that there are no ultimate entities like corpuscles or waves, existing independent of the observer. This leads us to a »perspective« philosophy for which physics, fully acknowledging its achievements in its own and related fields, is not a monopolistic way of knowledge. Against reductionism and theories declaring that reality is »nothing but« (a heap of physical particles, genes, reflexes, drives, or whatever the case may be), we see science as one of the »perspectives« man with his biological, cultural and linguistic endowment and bondage, has created to deal with the universe he is »thrown in«, or rather to which he is adapted owing to evolution and history.« ([9], p. XXII)

This quotation is expressed as »sustainable development« as well (see: [15]).

Similar thinking can be discovered in Einstein's ideas (from [16]):

- Common sense is a set of prejudices, which we have collected before our age of 18. (p. 9)
- To approach a topic always in the same way and, at the same time, to always expect different results, is the most reliable sign of madness. (p. 21)
- Difficult problems we work on cannot be solved, if we stay on the same level of thinking than in the time of making them. (p. 31)
- The main characteristics of our time seem to be perfection of methods and confusion of intentions. (p. 35)
- Things should be as simple as possible, but not simpler. (p. 41)
- If we knew what are we doing, we could not speak of inquiry. (p. 53)
- The most incomprehensible fact of our world is that the world is comprehensible. (p. 56)
- Imagination matters more than knowledge. (p. 63)
- We must develop child's curiosity, and than direct this child to areas that are important for society. (p. 65)
- When mathematical laws speak of reality, they are unreliable. And when they are reliable, they do not speak of reality. (p. 117)
- I have no special talent. I am just passionately curious. (p. 121)
- Realism is only an illusion, but a very persistent illusion. (p. 123)
- The point is not that I am clever. I just persist longer with problems. (p. 141)
- The secret of creativity is the question how to hide one's sources. (p. 148)
- If you want to become a model member of a sheep herd, you must first become a sheep. (p. 167)
- Two thinks are endless: universe and human stupidity; and I am not totally sure about the universe. (p. 167)
- It is important that we never stop asking questions. (p. 195)
- Actually, very few people watch with their own eyes and feel with their own hearts. (p. 198)
- Curiosity has its own special reasons to exist. (p. 200)
- Who reads too much and uses brain too little, will some day become lazy and start to think. (p. 201)
- All things that count cannot be counted. Not every thing counts that can be counted. (p. 213)
- Objectively, there are absolutely no limits to what humans with devotion can grab from Truth. (p. 231)
- Very few individuals are capable of expressing their views, which differ from prejudices of their social environment, and remain unconcerned. Most individuals cannot even formulate such views. (p. 10)

Conclusion: systems thinking is much older than systems theory, and a basis for success.

5. MODERN OFFICIAL REQUIREMENTS FOR SYSTEMS THINKING

We are now living in times in which the most innovative 20 % of population live much better in terms of physical health, technical support to quality of work and living, than the routinized ones. Globalization may help all of them have a better life, or support neo-colonialization of the less innovative ones to the benefit of the more innovative ones. Examples abound in daily

press: innovation and systems thinking are means against neo-colonial subordination or for it.

Innovation has several theoretical, practical, and official links to systems thinking:

- Innovation is, by definition, neither every novelty, nor a technological novelty only, but every novelty found a new source of benefit by its customers. From the authors' and owners' viewpoint this reads: **innovation = invention + commercialization**.
- Innovation is therefore, a very complicated (= details oriented) and complex (= relations oriented) issue. It requires all - deep knowledge, creativity, entrepreneurial spirit, and broad co-operation – in synergy due to their interdependence. In other words: **innovation results from (invention X holism X entrepreneurship X management X co-workers X culture of creativity and co-operation and interdependence X suppliers X customers X competitors X socio-economic conditions X natural environment X random factors and good luck).** (X denotes interdependence).
- Both above statements require systems thinking, one-sided specialist can no way cover all the necessary knowledge, ethics, and conditions. **Interdependence** is a crucial attribute to bridge professional differences, both in values and in practice.
- Thus, interdependence is at least equally important as **isomorphisms**, which used to be exposed as the most crucial way from the unavoidable specialization to the equally unavoidable holism. Isomorphism carries findings from one field to another rather than makes them co-operate inter-disciplinarily.
- Notion of holism, which is limited inside a single profession or scientific discipline, is helpful, but insufficient. It does not support inter-disciplinary co-operation.
- There is neither a chance for a total holism to be attained, nor is holism inside a single specialization enough, usually, except as a phase of the entire process. Thus, a middle way is what we call **the law of requisite holism or a dialectical system: a network of all essential and only essential viewpoints / professions / systems** (as mental pictures of the topic under consideration from a selected viewpoint) [17].

European Union (EU) has officially recognized the crucial link between: the (1) future of Europeans as people living well on innovative application of modern knowledge, (2) entrepreneurship as the motor of the high-quality European future, (3) innovation as the basic tool of entrepreneurship and future, (4) systems thinking as a precondition for innovation, entrepreneurship, and Europe to have a chance for a bright future [18]. EU did so to be able to compete with USA, Japan and others. (USA seems to be getting unhappy about her own level of creativity and innovation, as well. (See: [19])

Indirectly, at least, many international organizations, including United Nations, claim holism as well. In modern law, democracy is found unavoidable; it does not mean only political parties double-checking each other in power and opposition in politics, but it rather means a practice of interdependence and co-operation everywhere. Requisite holism is supposed to result.
The definition of the dialectical system / requisite holism [20], [17] tells us that: for the **requisite holism** to be achieved:
1) Both specialists and generalists are needed;
2) So are professionals from all and only essential professions / disciplines;
*3) And so are values, expressed in the ethics of interdependence and practiced in a creative team-work, task-force, session(s) based on an equal-footed cooperation rather than top-down one-way commanding***.** Mutually different specialists make such teams.

But not all systems theories work in this direction.

6. FIVE BASIC STREAMS OF SYSTEMS THEORY

There is no longer the General Systems Theory and general Cybernetics, but many of them. A holistic systems theory has **disintegrated and developed** into a number of *separate approaches* (see: [21]; [22], for details):

(1) The ones putting system equal to object, which is OK in theoretical mathematics, but fictitiously holistic in Bertalanffian sense, in other cases: the view is reduced to one single viewpoint / profession / scientific discipline alone;
(2) The ones defining system as a mental picture of the object, thus admitting their own specialization and unavoidable lack of holism, but not admitting the resulting need for interdisciplinary creative cooperation. The result is focus on complicatedness rather than complexity, inside their own specialties;
(3) The ones defining system as a mental picture of the object, thus admitting their own specialization as well, but also interested in inter-disciplinary co-operation;
(4) The ones working on systems theory as a general theory of holistic thinking, decision making, and action, rather than mathematically;
(5) creative co-operation. This stream includes making an impact over humans, rather than offering them

tools for them to use in whatever way and for whatever purpose.

Our application of Figure 2 to 17th EMCSR [1] showed the following shares: stream 1 = 15%, stream 2 = 44%, stream 3 = 16%, stream 4 = 17%, and stream 5 = 8% (approx.).

On such a basis, we suggest systems theorists to work with specialists of other disciplines toward a **modern common sense** replacing the narrow specialization with a network of narrow specializations and capacity of interdisciplinary co-operation aimed at requisite holism. The left column in Figure 3 expresses this suggestion briefly [25].

Stream No	*Background*	*Viewpoints / professions considered*	*Complicatedness Or Complexity*	*Single discipline or interdisciplinary co-op.*
1	Mathematics as topic	One, theoretical mathematics	Both potentially	Both potentially
2	Mathematics as tool for quantitative analysis	One by authors' choice, aimed at research of components inside a single viewpoint	Complicatedness, for details about components alone	Single discipline, self-sufficient, no interdisciplinary co-operation
3	Mathematics as tool for quantitative analysis	Several by authors' choice, aimed at research of relations between viewpoints chosen	Complexity, for synergies between components and disciplines	Several disciplines in interdependence, systems thinking as a bridge between them
4	Philosophy as tool for qualitative analysis	One by authors' choice, aimed at research of components inside a single viewpoint	Complicatedness, for details about components alone	Single discipline, self-sufficient, no interdisciplinary co-operation
5	Philosophy as tool for qualitative analysis	Several by authors' choice, aimed at research of relations between viewpoints chosen	Complexity, for synergies between components and disciplines	Several disciplines in interdependence, systems thinking as a bridge between them

Figure 2: Five streams of current systems theories, a generalized summary

Systems / Systemic / Holistic Thinking	*Un-systemic / Traditional Thinking*
Interdependence/s, Relation/s, Openness, Interconnectedness, Dialectical System	Independence, One-way dependence, Closeness, A single viewpoint / system
Complexity (plus complicatedness)	Simplicity or Complicatedness alone
Attractor/s	No influential force/s, but isolation
Emergence	No process of making new attributes
Synergy, System, Synthesis	No new attributes resulting from relations between elements and with environment
Whole, holism, big picture	Parts and partial attributes only
Networking, Interaction, Interplay	No mutual influences

Fig. 3: The Basic Seven Groups of Terms of Systems Versus Non-systemic Thinking

On this basis, **holism** tends to be both close to the Bertalanffian definition of holism and workable. Holism is therefore a dialectical system with four interdependent attributes:

- **Systemics** (attributes of the whole, but not of its single components), complexity, synergies.
- **Systematics** (attributes of the single components, but not of the whole), complicatedness, details.
- **Dialectics** (attributes of relations that form the attributes of the whole, by causing emergence, resulting in synergy), interdependence, and resulting interaction.
- **Materialistics** (attributes ob the observer, decision maker, and/or actor, called also realism), the smallest possible deviation of models from reality.

(Mulej, in [26]). See Figure 4, too.

These attributes have been sought from the very beginning of cybernetics and (the general) systems theory, but have lost battle to the unavoidable narrow specialization of the contemporary times. Many seem to find them too demanding [26].

Though, the alternative to systems thinking is one-sided thinking with no links between disciplines and no links between details, resulting in blindness and oversight, hence in disaster, e.g.:

- Only one single percent of patents become innovations, practiced and yielding benefit.
- Only a very small percentage of new companies survive five years.
- More people die in traffic than in war, although wars after the 2nd World War have killed fifty million, and more people died in wars in last 90 years than in previous five centuries. One must add people in medical trouble due to one-sided diets, life styles, etc.; among them many die or cause enormous cost and loss of necessary funds.
- One-sided concepts of economic development are threatening that glaciers will melt too much for life conditions and humankind to survive.

(For details see: [15]; [28]; [29]; [30]; etc).

Actual attributes of real features		*Considered attributes of thinking about real features*
Systemic	Complexity	Consideration of whole's attributes that parts do not have
Systematic	Complicatedness	Consideration of parts' attributes that whole does not have
Dialectic	Basis for complexity	Consideration of interdependences of parts that make parts unite into the new whole
Requisite realism / materialism	Basis for requisite holism of consideration	Consideration that selection of the systems of viewpoints must consider reality in line with the law of requisite holism for results of consideration to be applicable

Figure 4: Dialectical system of four basic attributes of holism of thinking

7. CONCLUSIONS: IN A KNOWLEDGE/INNOVATIVE SOCIETY SYSTEMS THINKING IS A PRECONDITION OF SURVIVAL; IT CAN BE APPLIED ALONG WITH/UNITING MANY UNAVOIDABLE NARROW SPECIALIZATION, MAKING THEM REALLY USEFUL

All such and similar facts and trends require knowledge of systems thinking to be used along with many specialists' knowledge types in interdependence. The old excuse that people are not willing and able to co-operate was recently refused: only 20% are free riders, 63% wait and react, 17% are co-operative by nature [31]. Conclusion: if the most influential persons, such as entrepreneurs, managers, and politicians, i.e. opinion makers, apply systems thinking along the streams 3 and 5 (see Figure 2), teamwork of mutually different specialists can take place. Overspecialization, to which Bertalanffy referred half a century ago with full right and as a visionary, can make room for specialization to go hand in hand with systems thinking (see Figure 3, left column). Thus, the existing knowledge and other preconditions for inventions to become innovations (see Part 5) can be used for results briefed in Figure 5.

In business, and every individual is a kind of a business-person, the following conclusion might result (see F. 5):

◙← Survival, existence, evolution, growth, and development ←
← competitiveness in markets and other life processes ←
← investment capacity in organizations ←
← offering the »systemic quality« to consumers ←
← innovating (= creation of new benefit from new ideas/inventions/suggestions) ←
← social and organizational culture supportive of inquiry, inventing and innovating x (fresh knowledge and creativity and co-operativity and entrepreneurship of humans at stake) ←
← innovated and innovative, entrepreneurial management, using systems thinking ← ◙

Figure 5: Systems thinking as a basis of survival in modern times

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