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About BCSSS:

In 2001, a century after Ludwig von Bertlanffy was born, a Bertalanffy Anniversary Conference was held at the Vienna University of Technology. Iryna Dobronravova was present and amongst those who suggested the establishment of a scientific society in honour of Bertalanffy. When three years later parts of Bertalanffy's library and professional correspondence were discovered, the time had come to found the Bertlanffy Center for the Study of Systems Science. The Center houses an archive related to Bertalanffy, which was extended by donations from Bertalanffy's daughter-in-law, Gisиle Bertalanffy, as well as literature from other systems theorists. It is an independent research institute that is funded by donations. Its aim is to advance systems thinking and systems practice through own contributions to the field.

Acknowledgement:

I'm very thankful to my colleague Professor Iryna Dobronravova with whom I share illuminating discussions in an outstanding research project on "Human Strategies in Complexity", carried out 2001–2004. Ideas presented here have their origin in the fruitful exchange of findings and opinions in the course of that project.

THE RATIONALE FOR COMPLEXITY THINKING AND EMERGENTIST SYSTEMISM

The rationale for thinking in terms of complex systems today is its fitness to help understand the global problems and alleviate, if not solve, them. The tenets of complexity thinking can be identified, drawing upon the path-breaking assumptions of Bertalanffy's General System Theory that revolutionises the way of thinking, the world picture, and the worldview of scientific disciplines.

Key words: *complexity thinking, emergentist systemism, global problems, Bertalanffy's General System Theory.*

1. The rationale for complexity thinking

We are living in an age of global challenges. Global challenges are global because they do not affect only local communities but humanity as a whole and because they cannot be tackled successfully by local communities only but need efforts by humanity as a whole.

Since the second half of the last century the dominant way of using technological, environmental and human resources has turned out to be increasingly incompatible with a peaceful and harmonious future of our worldwide civilisation. There are heavy impediments on the path to establishing sustainable international as well as intra-national relations that abandon the use of military force and other technological means that are detrimental to a flourishing life; to establishing ecologically sustainable relations to nature that prevent overuse of resources and their abuse as sinks for harmful waste; and to establishing sustainable relations amongst humans that guarantee all producers and users a fair management of whatever they produce and use in the cultural, political and socio-economic contexts of society. Now that local communities have grown interdependent, the careless handling of those resources is not tenable any more. Whatever negative effect a community had been able to externalise so far, will be reciprocated by other communities and, in the end, return as threat to the own community.

The crises of today are the heralds of a change never seen before – a possible and needful meta-system transition in which a supra-system is on the point of emerging, a true world society, humanity as a single whole, as a unity through diversity, the integration of differentiated interdependent social systems with a higher organisation.

That is to say, global challenges are a problem of complexity, since they represent complex problems that need complex solutions. There is a mismatch between the complexity a system is characterised by and the complexity of the problems faced by the system. It is cyberneticist W. Ross Ashby's Law of Requisite Variety that states that a system is dynamically stable if the variety (the number of states) of its control mechanism is not less than the variety of that system that is to be controlled. The system that is to be controlled can be the system itself. That means, when increased complexity puts the performance or maintenance of a system at risk, it can catch up and solve the problem by activating the collective intelligence of the co-systems it is made up of and raise the complexity of its organisational relations or by activating the collective intelligence of its co-systems and raise the complexity of the system in which they are nested in order to match or surpass the complexity that is faced. Intelligence is the capability of self-organising systems to generate that information that contributes in the best way to solving problems that occur to the systems

when maintaining themselves or improving their performance. Collective intelligence is emergent from the single intelligences of the co-systems on the level of the supra-system. In times of crises, systems are prompted to organise themselves onto a higher level to overcome the crises. The better their collective intelligence, that is, the better their problem solving capacity and the better their capability to generate information, the better their handling of the crisis and the order they can reach. Higher complexity not only signifies a higher degree of differentiation. At least as importantly, it signifies a new quality of integration. Only a new level of integration can deal with an intensification of differentiation.

Problems of complexity are dealt with by complexity thinking as we can term it today. Complexity thinking is key to tackle complex problems and thus key to tackling global challenges and guiding the transformation of the current state of civilisation into a new state that brings about a peaceful, environmentally sound and socially and economically just and inclusive world society. What are the tenets of such thinking in complexity?

2. Emergentist systemism

Founder of General System Theory, Ludwig von Bertalanffy (2015), was one of the pioneers approaching complexity. His historical achievement was the reconciliation of the contending strands in biology of Mechanicism (the reduction to laws of physics) and Vitalism (the belief in mystic forces) by general system laws that become manifest in the specific (re-)production of organisational relations through different elements on different evolutionary system stages up to the level of the human race. The cyclic systems dynamics that is, initially, set off by the co-action of agents producing organisational relations and is, consecutively, going on by these very organisational relations enabling and constraining the next round of agential co-action that might reproduce or transform the organisational relations – which represent the structure of the system –, is what is known by the term "self-organisation". The production of the structure by the agents is an emergent effect that cannot be reduced to the action of the agents. This holds for reproduction and transformation as well. In turn, downward causation exerted by the structure has emergent effects too, since it is not a pre-determined causation.

The legacy of Bertalanffy is threefold. General System Theory revolutionises

- the tools of science by a new way of thinking;
- the scope of science by a new picture of the world;
- and the aims of science by a new worldview (weltanschauung).

Tools, scope and aims are characteristic of any science. Methodology provides the tools of scientific studies; it is a framework through which

understanding of the functioning of the real world can be generated to serve its function during problem solving. Theory embraces the scope of scientific studies; it gives deep insights in the functioning of the real world – insights that can be functionalised for the solution of problems, by informing the practice about the way to a goal from a point of departure. Technology incorporates the aims of scientific studies; it directs theory towards practical application. Applications intervene in the real world so as to help solve problems. Problems stand at the beginning of any science because they form ends for any science. Problems are always social.

The strands of thinking that draw upon Bertalanffy's legacy can be labelled as "emergentist systemism", a systems approach that revolves around the term emergence (Wan 2011). Emergentist systemism is the best candidate so far to fulfil the requirements of complexity thinking.

2.1 Integrationism as systems way of thinking

Making the Mechanicism-Vitalism debate obsolete is the role model for a new way of thinking. The tools of science shall recognise "unity through diversity" when framing complexity. Complex problems need an epistemological approach that does justice to the complexity of reality from which systems phenomena emanate. In many cases, if not in any case, an assumption has to be made about which is the interrelation of phenomena of different degrees of complexity: how does the lower complex phenomenon relate to the higher complex phenomenon?

There are, in principle, three (or four) possibilities (Hofkirchner 2011) (see Table 1).

Table 1. Ways of thinking

		complexities	**identity and differences**
absolutism	**reductionism**	levelling down higher complexity	identity at the cost of differences (monism: uniformity not diversity)
	projectionism	levelling up lower complexity	identity for the benefit of one difference (monism: uniformity not diversity)
relativism: disjunctionism		disjoining degrees of complexity	differences at the cost of identity (dualism: plurality not unity)
systems way of thinking: integrationism		linking complexity degrees through integration and differentiation	identity and differences united (dialectics: unity through diversity)

First, there is an absolutistic way of thinking that gives priority to uniformity over diversity. It comes in two varieties:

(a) the levelling down of phenomena of higher complexity to phenomena of lower complexity; identity of the phenomena is established at the cost of differences; that is known under the label "reductionism";

(b) the levelling up of phenomena of lower complexity to phenomena of higher complexity through projection of features of the higher-level complexity onto the lower level; identity of the phenomena is established for the benefit of one difference; that's called projectionism.

The second way of thinking is a relativistic one. In contradistinction to absolutism, priority is given to plurality over unity. The disjoining of phenomena of different degrees of complexity establishes an equivalence of differences at the cost of an identity common to the phenomena. That's called disjunctionism.

A third option is that way of thinking that is the proper systems way of thinking. It negates relativism and absolutism as well and links phenomena to each other through integration and differentiation of their complexity degrees. The union of identity and differences yields unity through diversity. That's integrationism. That is, the phenomenon with a lower degree of complexity shares with the phenomenon with a higher degree of complexity at least one property, which makes them, to a certain extent, identical, but the latter phenomenon is in the exclusive possession of at least another property, which makes it, to a certain extent, distinct from the former. So both phenomena are identical and different at the same time.

Thus conceptualising complexity in a systems perspective drawing upon Bertalanffy's General System Theory means ruling out reductionistic, projectionistic, and disjunctionistic ways of thinking and framing the phenomena through the deliberate equilibration of integration and differentiation.

Systems are conceptualised as a unity that is made up by the diversity of its elements.

2.2. Emergentism as systems world picture

Bertalanffy's focus on organisation that makes systems distinct from each other and brings forth evolutionary levels posits a new picture of the world. An ontology is provided according to which complex problems are pictured as complex because they take part in an overall interconnectedness of processes and structures that are constituted by self-organising real-world systems. Those systems bring about evolution and nestedness (hierarchy) as emergent features of reality.

The world is pictured along a multi-stage model of evolutionary systems (Hofkirchner 2013) (see Figure 1).

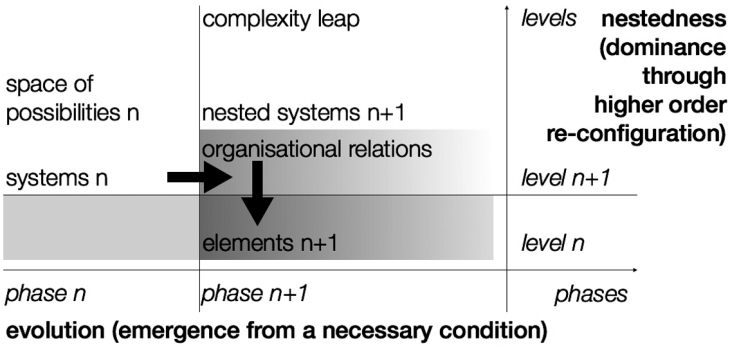

Figure 1. Multi-stage model of self-organisation

Systems evolve during a phase n. Spontaneously, at a certain point of time a leap in quality emerges and one possibility out of the space of possibilities that are rooted in the reality of the systems during the phase n (which form the necessary condition for the transition to phase n+1) is realised such that new organisational relations emerge. Those organisational relations realise a higher order in that they nest the old systems n as elements n+1 of the new systems n+1 during the phase n+1. Thus they form another level n+1 above the level n that is being reontologised, reworked, shaped through reconfiguration. Emergence is followed by dominance of higher levels.

Emergentism is an important ingredient of systems theories. It helps understand events and entities that function according to less-than-strict determinacy, which means that the mechanisms of the real world are not machine-like. The systems picture crosses all disciplines because it extends to all reality.

Thus the scope of sciences includes the specifics of the state of unity-through-diversity of the self-organisation of any system.

Emergentism provides an ontological superstructure for the epistemological integrationism. Integrationism can integrate because evolution lets new features emerge.

2.3. Synergism as systems worldview

Acting in the face of complex problems is based on praxiological assumptions about the interference with self-organising systems. Known mechanisms can be furthered or dampened according to what the goal shall be.

Bertalanffy never tired of writing against the dehumanisation of man. So it goes without saying that his General System Theory is not value-free science but rather a new weltanschauung since it inheres universal human values. The aims of sciences shall help cope with the future of civilisation and the knowl-

edge of the conditions of self-organisation can help develop civilisation in a humane direction.

The situation of the evolution of human civilisation can be described as Great Bifurcation (see Figure 2).

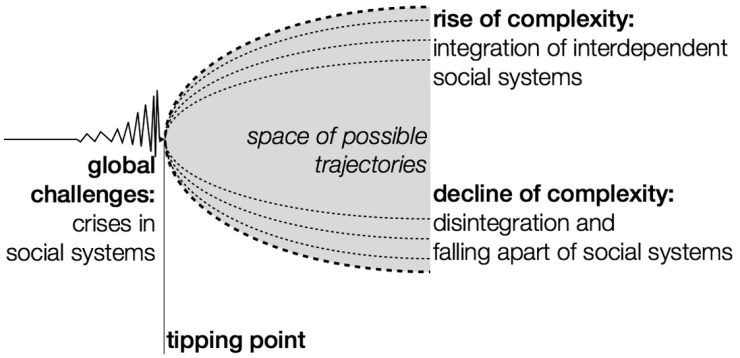

Figure 2. The Great Bifurcation

Amplification of parameters marks the advent of multiple crises. At any time self-organisation takes place that might realise one of possible trajectories. Those moments are tipping points. Two extremes span the space of possible trajectories. There is the possibility of jumping onto a level of higher complexity on which the interdependent social systems can integrate. And there is the possibility of falling back onto levels of lower complexity on which the systems disintegrate.

Integration means a jump in complexity, which means the emergence of a new synergy regime. Self-organising systems have as raison d'etre the provision and production of synergetic effects (Corning 1983). If the organisational relations are not able any more to provide and help the elements produce synergy, the system will break down. Hindrances of letting synergy emerge are called frictions. Any social system is a social system by virtue of organisational relations of production and provision of the common(-good)s, that is, the commons is the social manifestation of synergy (Hofkirchner 2017). Hindrances of the commons supply are frictions that are systemic dysfunctions due to the suboptimal organisation of the synergetic effects. The global challenges are frictions. Any meaningful technology is oriented towards the alleviation of frictions and the advancement of synergy.

Meaningful technology is technology endowed with meaning by the participation of those affected in an integrated technology assessment and design process (that is, design builds upon assessment) for the reflection of the expected and actual usage of technology. The assessment and design criterion

is social usefulness, that is, the reflection of both the adequacy to the purpose (utility; operational knowledge: know-how) and the purpose itself (the function technology serves; orientational knowledge: know why and what for). The purpose is advancing the commons.

Synergism, the orientation towards synergy for every real-world system and towards the human value of the commons in the case of social systems (which is a worldview since it is value-laden), is the praxiological superstructure for emergentism. Synergy emerges, emergence brings about synergy.

3. An idea whose time has come

Integrationism, emergentism, and synergism altogether are the essential features of complexity thinking the implementation of which has the potential to kick civilisation's development in the right direction.

Emergent systemism uses tools that generate scientific knowledge through a method of equilibrating integration and differentiation as way of thinking for a proper understanding of how complexity grows. It has as its scope the functioning of emergent real-world systems in the interconnectedness of their evolution and their nestedness, the scientific knowledge of which is a world picture that is needed for alleviating frictions. And it aims – by its world view – at providing scientific knowledge for solving problems of frictions in the functioning of real-world systems, in particular, in processes of the provision and production of the commons in social systems through meaningful systems technologies that support the re-organisation of social systems in order to safeguard sustainable development and rule out self-inflicted breakdowns.

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***Вольфганг Гофкірхнер*. Підстави для складнісного мислення і емерджентистський системізм**

Підставою для мислення в термінах складних систем є його здатність допомогти розуміти глобальні проблеми та пом'якшити, якщо не розв'язати їх. Принципи складнісного мислення можуть бути ідентифіковані в контексті переламних припущень Загальної теорії систем Берталанфі, теорії, яка революціонізувала стиль мислення, картину світу та світогляд наукових дисциплін.

Ключові слова: *складнісне мислення, емерджентистський системізм, глобальні проблеми, Загальна теорія систем Берталанфі.*

***Вольфганг Хофкирхнер*. Обоснование для сложностного мышления и эмерджентистский системизм**

Обоснованием для мышления в терминах сложных систем является способность такого мышления помочь понять глобальные проблемы и смягчить, если не разрешить их. Принципы сложностного мышления могут быть идентифицированы в контексте переломных допущений Общей теории систем Берталанфи, теории, революционизировавшей стиль мышления, картину мира и мировоззрение научных дисциплин.

Ключевые слова: *сложностное мышление, эмерджентистский системизм. глобальные проблемы, Общая теория систем Берталанфи.*

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