Lecture Notes in Networks and Systems 495

Igor Perko
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World Organization of Systems and Cybernetics 18. Congress-WOSC2021

Systems Approach and Cybernetics: Engaging for the Future of Mankind

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Preface

Important world institutions, such as the United Nations (UN), the World Health Organization (WHO) and the Organization for Economic Co-operation and Development (OECD), are publicly recognizing the highly interconnected nature of our world and therefore the relevance of systemic thinking and cybernetics as leading knowledge foundations to deal with the complexity of economic, social and environmental issues. This recognition by major international agencies of the CyberSystemic nature of world problems makes it apparent that in the context of the World Organisation of Systems and Cybernetics more than ever, we need to debate and develop current ontological, epistemological and methodological approaches to understanding the future of humanity.

After our successful 17th Congress in Rome in 2017, WOSC agreed with the Russian Academy of Sciences (RAS) to hold its 18th Congress (WOSC 2021) in Moscow in 2020. Eventually, the COVID-19 pandemic at the beginning of 2020 made it necessary to hold only roundtables during that year and postpone the Congress to 2021 in the expectation that the situation would be favourable for an in situ Congress in September of 2021. Unfortunately, a Congress in Moscow was again impossible, and it was agreed to hold an online meeting from 27 to 30 September, which was reported on www.WOSC2020.org.

Cybernetic and systems scientists from all around the world and in particular of the Russian Academy of Sciences as the intended host of the Congress have made important contributions to key issues of human society over the decades. They have contributed to epistemological and methodological issues relevant to social organizations, communities and digital technology as well as to problems of space exploration, the fight against terrorism, self-organization for strategic projects and many more.

More recently, in the Institute of Philosophy of the Russian Academy of Sciences, they have been developing aspects of socio-humanitarian cybernetics and of self-developing poly-subject reflexive-active environments. Indeed, the RAS has been a most valuable setting to support further developments of these and other issues.

During the preparation and holding of the congress, its participants actively discussed the problems of increasing challenges and threats to humanity associated with the introduction of digital technologies and AI. There was a general opinion that there should be global coordinated actions of scientists for a timely response to these challenges and threats.

For specialists in systemic cybernetics, the task was initiated to become leaders in organizing problem-oriented scientific and practical communities (international clubs) for systemic socio-humanitarian analysis and expertise in the development and implementation of digital technologies and AI in social systems with a focus on ensuring the security and development of a wide range of social systems: individuals, communities and organizations, countries and civilizations. During the preparation and holding of the congress, its participants actively discussed the problems of increasing challenges and threats to humanity associated with the introduction of digital technologies and AI.

Our aim in WOSC 2021 has been to bring CyberSystemic scientists, and in particular younger researchers, together with senior managers and practitioners to debate pressing economic, social and ecological problems of humanity, at all levels from local communities to global societies.

For this purpose, the Congress focused discussions on four themes: firstly, philosophical and methodological foundations for the development of the systems approach and cybernetics; secondly, the cybernetics of society, ecology and governance; thirdly, subject, digital technologies and physical realities merging into a hybrid reality, and fourthly, the transdisciplinarity of systems sciences and cybernetics applied to the further developing of knowledge areas, such as education, medicine, economics and arts.

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Moscow, Russia — Vladimir Lepskiy
Moscow, Russia — Dmitry Novikov

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Part I
Philosophical and Methodological Foundations for the Development of the Systems Approach and Cybernetics

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Challenges and threats to the future of humanity are increasing pressure to develop and implement systemic approaches and cybernetics. We open the debate on their philosophical foundations, with particular emphasis on ontology, epistemology and methodology. Focusing on the specifics of the formation of self-developing poly-subject reflexive-active environments of hybrid reality. New ideas are needed concerning scientific rationality, the problem of the observer, transdisciplinary approaches and problems related to complexity, reflexivity and ethics. We must increase the convergence of civilisation and culture in the development of systemic approaches and cybernetics. Systems thinking and cybernetics should enable a rich social construction for an interrelated and coherent world.

WOSC 2021 invited congress participants to reflect upon critical crises situations, such as pandemics, climate change and social and environmental sustainability, threats and challenges of digital transformation and AI, from a systemic perspective with an increased awareness of the complexity of the contextual constraints imposed by the structural coupling of social agents in co-evolution with their ecosystemic chains. In this context of systemic thinking, we reflected on designing communication mechanisms, from the local to the global, for which cybernetics could be a major contributor. Social designing of communications and conversations, as well as the development of organisations with requisite variety have been proposed as tools to respond to our current crises situations.

Awareness of complexity offers opportunities to develop the functionality and coherence of societies. Meta-contextual aspects go beyond the interactions of organisational actors and environmental agents but need to consider their framing in cultural and meta-environmental interactions. This way participants could reflect on aspects of societal significance, such as ecological chains, constrained resources, as well as economic inequalities limiting fairness and justice. WOSC 2021 offered the opportunity to make inroads into the mechanisms shaping interactions, communications and relationships in complex systems, invoking people in communities, enterprises, government agencies, small businesses and families. In particular,

Congress participants had the opportunity to contribute empirical approaches, emerging from their practical experiences in the life-world of societal, ecological and economic situations. Epistemological and methodological debates about social boundaries, systemic structures and communication and interaction mechanisms could improve people's contributions to society.

General Artificial Intelligence in Self-developing Reflective-Active Environments

David Dubrovsky, Vladimir Lepskiy, and Alexander Raikov

Abstract **The purpose**—explain identify the features of General Artificial Intelligence (AGI), from the standpoint of scientific rationality stages (classic, non-classical, post-non-classical), and show its difference from traditional Artificial Intelligence (AI). The latter is currently implemented mainly with digital computers and implements the functions of recognition, forecasting and preparation of answers to simple questions. New conditions force us to consider AGI from the standpoint of functionalism, as a man–machine system, purposefully functioning in a self-developing poly-subject (reflexive-active) environment.

Design/Methodology/Approach—AI development paradigm should consider aspects of its immersion in the social and humanitarian environment and the innovative atmosphere. The new paradigm of AI development should reflect the unformalized cognitive dynamics of AI models and support the self-development of AI systems under pressure from the external environment. The methodology of creating AGI is based on the ideas of the subject-oriented and ontological approach, functionalism, the phenomenology of subjective reality, the convergent cognitive architectures, as well as the methods of creating a self-developing poly-subject (reflexive-active) environment. AGI becomes a hybrid, purposefully integrating the capabilities of a machine and a person.

Findings—General properties, value-semantic and intentional-volitional operational structures of the phenomenon of subjective reality do not lean itself on direct formalized and algorithmic representation in discrete computer systems of von Neumann architecture. The study of consciousness in the context of subjective

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reality made it possible to formulate the main systemic, structural, functional, and operational characteristics of human cognitive activity, which allows a new approach to the modelling of cognitive architectures that meet the tasks of building AGI. The characteristics of subjective reality cannot be fully represented in the paradigm of physicalism; that is, it cannot be represented only with the help of physical devices. The chapter proposes a non-reductionist way of taking this characteristic into account by considering the problem of consciousness in an ontological and epistemological context, which allows representing the processes of consciousness and cognitive activity of a person and a group of people indirectly and inversely.

Originality/Value—State-of-the-art cognitive architectures and traditional AI approaches practically ignore solving the problems of AGI. They are more focused on the formalized construction of a thinking model, identifying physical blocks and processes of mental activity. At the same time, for AGI, ontological, subjective and hybrid reality issues are of the most importance, especially in explanations of the activity of consciousness, unconsciousness, and causeless processes, which can act purposefully in conditions of goal uncertainty. AGI must help to describe the phenomena of subjective reality, which causes physical changes, explain the ability of goal setting, free will, the ability of self-management by the physical actions of an individual in a team, etc.

Research/Practical/Social/Environment implications—the chapter give rise to a new type of control, which differs from the traditional control in digital reality. The chapter's results made it possible to uniquely find the optimal measure of centralization and autonomy of control loops that can ensure the preservation and strengthening of the integrity of a complex poly-subject system functioning in a reflexive-active environment, the interpretation of which does not fit into the narrow framework of digital and algorithmic reality, and traditional AI.

Research limitations—the AGI approach based on exceptional methods of constructing subjective reality also has its limitations. For example, the approach we propose to explain the connection between the human brain, consciousness, thought processes and environment does not yet allow us to explain the information and cognitive processes generated by the effect of subjective reality nonlocality, which arises, e.g., at the atomic level of the human brain and should be considered when studying cognitive processes.

Keywords Artificial general intelligence · Scientific rationality · Cognitive semantics · Self-developing poly-subject (reflexive-active) environment · Subjective reality

1 Introduction

The structure of reality is the issue of growing attention of scientists. Deutsch's book (2016), for example, proposed to single out four main threads: epistemology with an indication of the ways of development of science, quantum mechanics with the

paradigm of many worlds, Turing's discrete theory of computation, and the universal theory of evolution. Most modern approaches and ideas concerning the structure of reality rest upon physicalistic descriptions. At the same time, new tools for cognition of the universe and consciousness, especially advanced artificial intelligence (AI), force the development of established views. More and more intentions try to reach out the structure of a hybrid, human–machine, reality (Perko 2020), the nature of subjective reality (Dubrovsky 2019), and the self-developing poly-subject (reflexive-active) environment that forms it (Lepskiy 2018).

Classical AI can recognize, predict short-term, and answer simple questions. AI can edit texts, solve mathematical tasks, make programs on a computer, help to synthesize medicines, materials, and food, drive cars and tractors, apply fertilizer to the soil, and feed farm animals. AI systems control drones, make movies, create poetry and fiction, and help uncover tacit knowledge in big data. These systems track people, ensure security, etc.

However, modern AI systems cannot think, understand, explain, and pose problems. The inability to explain breeds distrust of the conclusions drawn with the help of such systems. You can see that everything that modern AI does is more like automation than creativity. AI accelerates what can be described by an algorithm, logic. The development of AI systems is proceeding in a classically extensive way—mainly due to the acceleration of computer power and the use of heuristics implemented on digital devices. AI systems are also being used to improve understanding of the human mind.

A human can draw correct and at the same time uncaused conclusions, instantly evaluate the authenticity of a work of art, has intuition, can fall into a trance, he has a mysterious soul. The unconscious phenomenon characterizes it. The idea of consciousness is available. A person forms a subjective reality located on the "other side" of the computer and numbers. It is these aspects that are the subject for further development of modern AI, which develops in the direction of an artificial general (AGI), strong, super-intelligence.

The primary motivation for creating promising versions of AI (we will further refer to it as AGI) is: the lack of the ability of traditional (weak, narrow) AI to explain its conclusions, the strengthening of the possibilities for the malicious use of AI, the miniaturization of robots and aircraft (in the defence sector, agriculture, etc.), the hopelessness of solving many problems of strategic planning, national security, biology, physics, astronomy, etc. by traditional methods.

Developers of modern (weak, narrow) AI often rely on the ability to achieve success in imitating human creative intuition using cause-and-effect (causal) mathematical models with high computational speed. This assumption contains an insoluble contradiction, which does not always lead to a dialectical synthesis of the new. It is enough to read the abundant literature on the generation of insights, emotional intelligence, the unconscious, Eureka Effect, Gut Feeling, etc. It will be apparent that the causal approach to creating AGI is insufficient, although necessary.

This article develops the idea of subjective reality and a self-developing poly-subject (reflexive-active) environment as defining attributes of development AGI.

2 Background of Modern AGI Development

The current state of advanced AI, including AGI or strong AI, have been drawn from science, culture, and philosophy (Sundvall 2019). Hybrid AI is immersed into the Hybrid Reality where humans play the role of observers and create a cognitive component of the control system (Perko 2020). AGI, Artificial Super Intelligence, and Strong AI are considered synonyms in this chapter.

The topic of AGI with its multi-tasking and "non-axiomatic" basis in the world scientific community sounded relatively recently (Wang 2013; Wang et al. 2018). The birth of the term can be traced back to 1997 when the Deep Blue computer beat the world chess champion. Based on the concept of general intelligence, it was proposed to divide AI not into strong and weak but into general (capable of adapting to solving various problems and solving several problems) and narrow (capable of solving a specific task).

Of course, there is no clear definition and understanding. There are various nominations mentioned above for promising versions of advanced AI. AGI was more of a philosophical category (ISO/IEC CD 22989/2019). There are different studies; for example, hundreds of "cognitive architectures" have been created (Kotseruba and Tsotsos 2020); hybrid reality (Perko 2020), quantum, wave, cognitive and non-local semantics of AI models are being worked out (Raikov 2021a, b), etc.

Relatively few papers on AGI development issues have been published; for example, a query on the terms "Artificial Intelligence" and "Artificial General Intelligence" in the Elsevier database for 2021 shows, respectively, 24,704 against 102 publications. Particular attention in the study of issues of advanced AI is paid to the problems of non-formalizable aspects of consciousness, the possibility of covering the emotional layers of consciousness by the AI system, building an explanation component.

A considerable number of works are devoted to studying emotional intelligence (see, for example, Cooper and Sawaf 2000; Gigerenzer 2007). The area of emotions that can be observed and felt, and the area of the unconscious that cannot be formally represented, go beyond the descriptive possibilities of language and thinking. Most importantly, causal reasoning, trying to discover the cause-and-effect relationships of events. Even the kinesthetic abilities of a person have their own cognitive and expressive capabilities, which are not always prone to a formalized interpretation.

The study of the explainable AI imposes such requirements as creating conclusions with clear explanations, ensuring control of new objects (Chen et al. 2020), decision-making with good resolution to a layperson (Wang et al. 2020). There are aiming to open the "black box" to create accurate models and give a satisfactory explanation (Veličković et al. 2019), etc. A problem for decision-making systems is the understandability of AI models due to their lack of transparency. The article (Setzu et al. 2021) suggested a framework for considering non-logic explanations based on data observed by querying the "black box".

However, the problem of explainable AI is not only the logical and technological provision of satisfactory explanations. The solution to this problem is closely related

to the non-formalizable aspects of the phenomenon of subjective reality (Dubrovsky 2019) with the contradictory epistemological and ethical choice (Kaul 2022), the immersion of artificial intelligence in the self-developing poly-subject (reflexive-active) environment of control systems (Lepskiy 2018), as well as ensuring the convergence of collective intelligence processes to achieve fuzzy set goals (Raikov 2021b).

3 Methodology Covering Subject Aspects of AGI

3.1 The Subjective Reality of AGI

The representation of consciousness is becoming increasingly crucial in AGI creation, and the issues of using the results of a phenomenological analysis of subjective reality, its value-semantic and operational structures come to the fore. In this context, AGI should have a high degree of autonomy and independent solution of a wide range of tasks in different environmental conditions. Figure 1 represents the AGI's component architecture, considering the subjective reality aspects.

In this regard, Turing's discrete methodology's limitations become more prominent, which excludes the use of the results of special studies of consciousness as a subjective reality. According to this methodology, the phenomenon "intelligence" is interpreted in a purely operational (computational) sense, excluding the role of consciousness. In this methodology, any cognitive or practical task is formulated

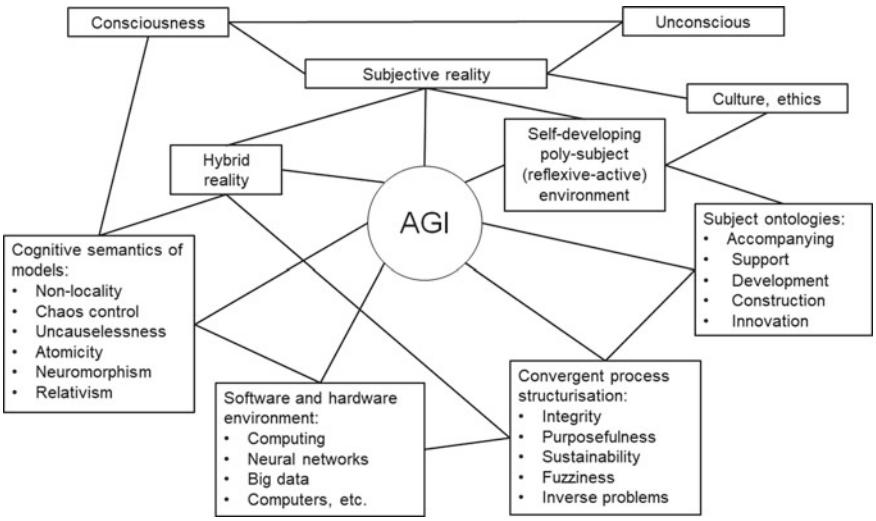

Fig. 1 AGI's component architecture (subjective reality aspects)

and solved by purely digital methods. Currently, creating AGI uses symbolism, connectionism, behaviourism, statistical, quantum, imitational, and even neuromorphic approaches (Huang 2017) that rest upon initial digital data representation. The paradigm of functionalism embedded in it remains valid, but it requires a broader semantic interpretation, considering its role in explaining consciousness in the context of subjective reality.

Some researchers are sceptical about bringing in the problem of consciousness, believing that it entails a lot of uncertainties, a kind of fog, that there is no point in elaborating a phenomenon of consciousness in traditional AI context, which only complicates the situation. And, perhaps, the deficit in the function of consciousness in promising versions of AI will be compensated by accelerating the computer, for example, using quantum computing. However, the core problem of computationalism remains the possibility of embracing any kind of consciousness. Raikov's work (2021a, b), for example, suggests doing it by using optical processing of analogue (non-digital) signals with complete spectra, considering non-local and relativistic effects of human brain neural behaviour on an atomic level, etc.

The focus of attention is increasingly on the problems of theory, methodology, interdisciplinarity, the concept of intelligence, thinking, cognition and consciousness, problems and hypotheses, explanation and understanding, the question of the relationship between empirical and theoretical knowledge, the nature of the relationship between artificial and natural intelligence. The primary role in their comprehension belongs to philosophers—specialists in the field of epistemology, the methodology of science, phenomenology, the study of consciousness in a broad sense, including those areas that are often referred to as the analytical philosophy of consciousness.

In this context, to build AGI, the specific properties and functions of consciousness inherent in the human thought process should be involved, which is impossible without considering the subjective reality, which includes human consciousness. At the initial stages of creating an AGI, this can be done under the condition of adequate isolation and description of operational analogues of certain states of subjective reality.

At the same time, when describing the operational analogues of such states of consciousness as "experiencing", "introspection", "thoughts", or "the image of oneself as part of the picture of the world", the classical approach to the development of AI encounters insurmountable difficulties. These concepts are complex, multidimensional, complementary in content, and cannot be described formally. Each of them includes an infinite set of analytical and synthetic operational actions in cognitive terms.

Studies of consciousness, taken as its subjective reality, make it possible to formulate the main systemic, structural, functional, and operational characteristics of a person's natural mental activity, which means that they represent an indispensable resource for modelling cognitive processes that meet the tasks of building AGI.

At the same time, the quality of subjective reality creates as yet unresolved theoretical difficulties in the problem of consciousness. They are related to the fact that physical properties can only be attributed to subjective reality if the subject is a physical machine, creating a reality. The question arises of how, without resorting to

idealistic postulates about the presence of a spiritual substance and without resorting to a physicalist reduction, to build a theoretically correct explanation of consciousness in a form accessible to understanding and operating by the AI system, given its apparent connection with physical processes.

It was proposed to use a non-reductionist method of solution within the framework of two main categorical plans: ontological and epistemological (Dubrovsky 2019). The former helps to solve issues of consciousness activity, as well as to explain the connection between the phenomena of subjective reality and the activity of the brain, the latter—to make the transition from the individual-subjective experience to poly-subject self-developing (reflexive-active) environment.

The concept of subjective reality means any conscious state, as opposed to unconscious processes. It covers both individual conscious phenomena of subjective reality and their types (sensations, perceptions, feelings, thoughts, desires, goal setting, etc.), and their holistic personal formation. The emergence of the psyche, which has the quality of subjective reality, led to the emergence of the concept of information management, regulation of behaviour and made it possible to solve the problem of effective self-organization of various organisms.

3.2 Poly-Subject Self-developing (Reflexive-Active) Environments of AGI

During studying AI systems in control processes, problems arise related to the break of paradigms that define ideas about AI without considering control aspects (Lepskiy 2021a). Classical AI paradigms consider AI not as a means included in the control activity, but as an object independent of the control loops. These paradigms of building AI systems have such sections as:

- morphological idea of AI as a model of the brain;
- a logical understanding of AI as a problem solver;
- neural network concept of AI;
- imitation—discrete similarity to human reasoning;
- neuromorphic—believing that the construction of a physical similarity of the brain will create AGI;
- perspective—computer modelling of human activity, emotions, thoughts and thinking, etc.

Of the above, we will explain only the neuromorphic paradigm, which quite boldly claims to be the creation of AGI (Huang 2017). In this work, it is proposed to use the method of "reverse engineering"—to build an AGI, literally copy the brain's neural structure, with the hope that the copy will reproduce its functions. This approach continues the evolutionary chain of development of AI methodologies—symbolism, connectionism, behaviourism and statisticalism—by creating on the same, logically formalized basis, a new version of weak AI: intuitionalism.

The listed paradigms contribute to the development of certain areas of AI development but make it challenging to use AI in management processes since they underestimate the specifics of the subject in the control loop. In particular, the conceptual aspect of management remains outside the brackets. A separate problem is establishing an interface between the technological, based on traditional AI paradigms, and the subjective, based on a person's mental and behavioural characteristics, aspects of control systems using AI systems. Control processes are based on their specialized paradigms (purposeful, reflexive, subjective, cybernetic, etc.), which put forward specific requirements for AI ideas and tasks in which it is advisable to use AI.

An analysis of the trends in the development of control issues from the standpoint of the development of scientific rationality (classical, non-classical, post-non-classical) allows concluding that they are primarily associated with the development of the corresponding subject management paradigms (Lepskiy 2018). Self-developing systems are at the centre of attention of control problems. The dominant subjective paradigm in control becomes the "self-developing poly-subject environment" paradigm. This paradigm is endowed with the properties of subjectivity, in which the subjects can interact through reflection.

Purposefulness, reflexivity, communicativeness, sociality and the ability to develop should be attributed to the basic invariant properties of subjects. The coexistence of subjects of natural intelligence and AI systems forms a hybrid environment, that is, the reality of the joint action of natural and artificial intelligence. In this environment, interactions of heterogeneous formations occur and their integration into integral types of constructions.

The essential property of the subject is reflexion. The interaction and integration of natural subjects and AI systems in a hybrid environment should determine the procedure for their reflexive coordination. The principle of "double subject" is of great importance to understand the specifics of self-regulation of reflexive activity. Its essence lies in the constant improvement of various types of activity (thinking, activity, communicative, reflexive) of subjects through interaction with partners who have adequate positions, organization based on the analysis of the activity of subjects of their twins, including "digital" (Lepskiy 2021b).

Considering the principle of a double subject in the organization of hybrid systems will allow the creation of systems with the inclusion of AI elements that do not go out of the control of their creators and adequately adapt to changes in the external environment. This corresponds to creating an AGI that considers the peculiarities of the self-developing poly-subject (reflexive-active) environment and subjective reality (Lepskiy 2021b). At the same time, the AGI systems being designed should create the necessary conditions to ensure accelerated convergence of participants' positions in decision-making (collective intelligence) regarding the goals and ways of action, even if the goals are not clear.

3.3 Convergent AGI

The convergent approach to creating AGI ensures speeding up collective decision-making in hybrid reality, including emergencies (Raikov 2020). Information structuring is performed during a collective conversation, e.g., a strategic meeting. It can help to reach a team's members consensus faster than usual. It helps to generate ideas in a self-developing poly-subject (reflexive-active) environment. The convergent technology assembles inverse problem-solving, topology theory, cognitive modelling, Big Data analysis, genetic algorithms, etc.

The dynamics of the collective decision-making processes combine the analytical and synthesis components. The former is divergent, and the latter—must be convergent. These processes cannot be fully formalized because they are caused by participants' emotions, experiences, desires, and thoughts, which well known the belief-desire-intention model can partially embrace (Umbrello and Yampolskiy 2021). These aspects restrict to speed up getting goals of collective decision-making and must be considered during using AGI for collective decision-making support.

The cognitive semantics of AGI models can represent the non-formalizable part of the collective conversation by creating a special cognitive space (Raikov 2021a, b). This space is based on the concept of a "non-formalizable event". It is the subjected phenomenon distributed in some mentally limited space and time. This space is created by considering the non-local (entanglement) behaviour of the human brain and body atomic particles. The thought or event has certain conditional fuzzy boundaries. Each event with its local and non-local characteristics depends on an observer, who tries to describe the thought-event, but cannot do it by a digital and logical means.

Creating cognitive semantics of the AGI model helps to represent the thought events in a single space. In this case, cognitive semantics supply non-formalizable subject or human phenomena by symbolic description described by logic, the laws of quantum electrodynamics, and the special theory of relativity. The category theory and topology theory using unified operators inverse problem-solving method ensure to implement transformations of thought-events and the purposefulness of collective decision-making considering the cognitive semantics of AGI models. The category and topology theories help to study the properties of the relations of objects without their logical structures. In this case, cognitive semantics of AGI models corresponds to the list of rules, such as follow (Raikov 2021a, b):

- the goals should be tiered and ranked by importance;
- the solving problem should be divided into a finite number of components;
- the mapping of the team's resource on the goals should be closed;
- every element of the team's resource should be associated and disjointed with neighbour one;
- the communication mechanisms should be developed;
- the cognitive semantics should be represented by team members participation with using ontological frames;
- AGI models should be verifiable by mapping on relevant big data.

These rules can be extended by considering non-local effects for creating cognitive semantics, which should consider subjective reality and immerse AGI models into self-developing poly-subject (reflexive-active) environment of the solving problem.

4 Summary

Traditional AI and new AGI are phenomena, most likely from different spaces. They are connected not only by the intention to accelerate the evolutionary trend of AI development but by a principle like the matter–antimatter ratio. It combines complementary aspects of technical AI and subjective AGI to create the phenomena heading to fundamentally new subjective and reflexive-active reality that is developing in a convergent way to get synergy and unusual power for humans.

Separate elements of AGI already appear at present. These elements combine methods for studying subjective reality, designing in poly-subject self-developing (reflexive-active) environments, epistemology, and phenomenology, solving inverse problems on conceptual spaces, thermodynamics, quantum and relativistic physics, biology, and optics, etc. This combination already helps "get close" to inaccessible layers of consciousness, overcomes the limitations of discrete calculations, helps to build the explanatory component of AI. Elements of AGI already make it possible to accelerate the collective agreement of decisions and quickly create team strategies.

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Socio-Economic Cybernetics Transformation Trends

Michail Kozlov

Abstract **The purpose**—It is proposed to consider high-order socio-economic cybernetics as the basis of a new socio-economic structure. Which with the economy of individual subject-oriented production (ISOP) will ensure the transition from a mass consumer society to a society of producers and consumers of custom-made intellectual products, and it can be defined as a creative society—a society of Creators.

An attempt is made to substantiate that the transition to ISOP changing the psychology of consumption in the spirit of post-nonclassical rationality. The rationality of consumption harmonizes the cognitive personality with the noosphere, and the use of evolutionary developments of living nature will contribute to the conservation of resources and energy. Since the new structure is impossible without the transformation of the political system, it is proposed to consider the transition to the polity of the Democracy of Creators, which is the convergence of direct democracy and a broad creative aristocracy.

Methodology—When analysing the problem under consideration, were used the works on the general theory of systems, the concept of V.S. Stepin on post-non-classical rationality, G.G. Malinetskiy and other authors on synergetics and prediction of the behaviour of complex systems, the works of V.E. Lepskiy and his colleagues on control systems in the context of post-non-classical scientific rationality and the formation of third-order cybernetics based on self-developing reflective-active media. Additionally, works on Decision-making theory, Political science, Sociology, Behavioral economics, Ecological economics and the Ecosystem economy were considered.

Findings—The transition to ISOP will stimulate the formation of a new socio-economic structure, to which will correspond the socio-economic high-order cybernetics. It will rely on a collective mind, built on decentralized human interaction based on subject-oriented intelligent information technologies, and is aimed at providing each subject with creative independence in the development and adoption of collective decisions.

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In the spirit of post-non-classical scientific rationality, considering the pluralism of views and different positions of members of society, the new structure will lead to more harmonious cognitive competition and the formation of constructive ethical norms of interaction in society.

The reliability and robustness of state decisions is significantly increased due to the formation of a collective decision-maker who, using Blockchain technology, will quickly make decisions in real-time.

The system, in the spirit of multivalued logic, will constantly go through 3 cyclic stages in the form of probes, estimates and generation of a new more optimal system using positive feedback, then stabilization due to negative feedback at the achieved level of multi-parameter optimization, and then improvement within the framework of a new dynamically changing social homeostasis.

The proposed solutions based on a wide planning horizon correspond to modern conditions and trends in socio-economic development, including decentralization based on new principles and the reasonable formation of a new environmental reality.

Originality—The socioeconomic cybernetics under consideration is based on the paradigm "cognitive subject—decentralized interaction system—cognitive subjects". In such a system, each subject is approached from the standpoint of the requirements of the polity Democracy of Creators, considering it as a cognitive personality.

Research implications—According to the author, the work may be useful to researchers in the field of analysing the work of complex social self-organizing reflective-active systems.

Research limitations—The author considers general approaches that, with further analysis, can be supplemented and adjusted.

Keywords Customer-centric smart economy · Human-intelligent instrument interaction · Democracy of creators

1 Introduction

Modern socio-economic relations are largely based on mass production, distribution and dissemination of cultural standards. Mass production allows you to quickly meet the needs of the population in the products necessary for its existence. The products are characterized by a high degree of standardization and uniformity, which contributes to a significant reduction in manufacturer's costs and production intensification, and brings great profit. At the same time, elations of the subject-object type dominate in the established society of mass consumption. The subject is the manufacturer of mass products, and the objects are a multitude of consumers, which fits well into the classical paradigm of the system of relations in society.

A distinctive feature of such a society is the rapid turnover of the purchased products, which have not lost their consumer properties, but already have a more fashionable and popularized analogue in the media. Thus, the cult of consumption of

mass products was formed. And for this massive experiment, mankind is paying with mountains of garbage of out-of-fashion goods. However, a person needs a Meaning of his life that goes beyond consumption. In King Lear, Shakespeare, translated into Russian by Boris Pasternak, there is a philosophical phrase "Reduce all life to necessities, and man will equal the animal," which reflects the irrationality of human essence.

For a number of good reasons, the system of socio-economic relations that has been formed is approaching a turning point in its development. On the one hand, automation, leading to a sharp reduction in jobs. And there is an assumption that the owners of robots can refuse to keep unnecessary workers, and the world of the future will be reduced by 99% of the population that has become superfluous. Existing predictions that advanced artificial intelligence (AI) systems will lead to a technological singularity. The growing shortage of resources and negative forecasts for the near future on their depletion, growing inequality in society. Degradation of ethical norms and a decrease in the level of motivation. All this creates a critical situation for humanity. On the other hand, scientific and technological progress contributes to the introduction of innovative technologies covering all spheres of human activity, such as 3D printing and NBICS technologies. Robotization and the use of special robots (cobots) for collaboration with a human user will free people from monotonous, physically difficult and unhealthy jobs. This can create a foundation for humanity to improve.

Noting the inextricable connection of the financial and economic system with scientific and technological progress, in (Boldachev 2016) it is concluded that the crisis of the modern economic system is inevitable and the possibility of technological support of a new form of agreement the production and consumption. And one can hope that the coming passage of the bifurcation point will lead to a socio-economic structure in which the majority of society will be comfortable. Humanity will once again solve the emerging problem of employment and strengthen the motivation for its development. Otherwise, the dominance of the superelite, further degradation of society and, as a result, decision-making for us will be a strong AI. But then it will be another story.

2 Formation of a Post-industrial Socio-Economic Structure

Considering the trends in the development of modern technologies and the changing needs of social development can conclude that this will inevitably lead to decentralized production and consumption and the formation of a customer-centric smart economy. What makes the method of mass production an anachronism and allows you to switch to individual subject-oriented production (ISOP) (Kozlov 2018). The emerging situation will make it possible to form a new socio-economic structure focused on the transition in relations with consumers to an active "subject-subject" paradigm. Such a transition will create conditions for solving the totality of problems accumulating in society. This will significantly reduce inequality and provide an

opportunity to provide employment for the entire working-age population. In such a society, creative activity, providing the most complete psychologically comfortable state of each individual, in combination with the developing technologies of individual production, will make it possible to create each product as a work of culture.

The transition to ISOP will change the psychology of consumption. A person will use only those things that are convenient. Unlike modern consumer goods, which, without losing their consumer properties, quickly change to new ones, since they already have a more fashionable and promoted analogue in the media, things made to order will be appreciated by the owner. People get used to things that are comfortable to use. They become truly dear to their owners and the so-called "ownership effect" arises, well described by one of the founders of behavioural economics, the psychologist Nobel Prize laureate (Kahneman 2011). These things can serve for many years, if necessary, repairing and modernizing them, based on operating experience and new requirements. ISOP correlates well with emerging economic trends such as cyclic, green, creative and networked economies. The totality of their provisions is aimed at ensuring the living comfort of each subject of society on the basis of his individual needs. In the spirit of post-non-classical scientific rationality (Lepskiy 2018), the rationality of consumption will harmonize a person with the noosphere, and the use of evolutionary developments of living nature will contribute to resource and energy conservation.

The formation of a wide class of individual producers will increase the cognitive abilities of society and stabilize it. Members of the society will have their own stable worldview based on developed conservative ethical principles and are less susceptible to external influences. This will allow decision-making with a broader planning horizon, which will naturally create an effective foundation for the future. The human need for competitive self-expression can be a powerful stimulus for the development of society. People have different talents, and the variety of their applications will make it possible to fill the entire volume of social needs in a new historical era.

The transition to a new socio-economic structure is impossible without the transformation of the political system. This will cause resistance from different and often opposite forces. The proponents of globalization will be extremely disadvantageous in the transition to ISOP.

To maintain economic well-being, transnational companies will use an established, widely developed ideological and political system to preserve the invariability of socio-economic relations.

Considering the reasoning of Aristotle about the ideal polity of society, in Kozlov (2018) considers the transition from imperfect representative democracy as a political state structure to the state in the form of the Creators' democracy, which is the convergence of direct democracy and a broad creative aristocracy. Under such governing the determining factor should be the political dominance of the producers of goods and services needed by society. For the transition to the polity of the Creators' democracy, it may be necessary to carry out a constitutional revolution by the forces of the

democratic majority, which would consolidate the principles of decision-making in society.

With the development of technologies, the risks of a decrease in the level of reliability of the decisions made, associated with a decrease in the time for the decision-making (Kozlov 2019). And with the polity of the Creators' democracy, the problem is removed by the formation of a collective decision-maker who, using Blockchain technologies, will promptly make decisions in real-time, significantly increasing their reliability and robustness.

With such a political structure, both liberal ideas and ideas of the need for state regulation will be combined. This approach, in contrast to the paternalistic theory of Nudge (Thaler and Sunstein 2008), can be called the implementation of the socio-economic policy of wise paternalism, which is based on a combination of the ideas of Keynesianism, neo-libertarianism, behavioural and socioeconomics. And the polity of the Creators' democracy presupposes the observance of four principles: a wide planning horizon when working out a development strategy; minimal state intervention in current processes, only when overcoming the boundaries of certain social homeostasis; ensuring maximum comfort for all members of society; maintaining a balance in combining traditional values with innovative action by the method of probes and estimates (Kozlov 2018).

In the spirit of post-nonclassical scientific rationality, considering the pluralism of views and different positions held by members of society, the new socio-economic structure will lead to more harmonious cognitive competition and, by changing the genetic memory of individuals, it modifies the matrix of emotions, consolidating the positive ethical norms of interaction in society. This will create a multifaceted collective irrational mind that will effectively confront new challenges. It will strengthen the cognitive abilities of each subject and provide both the individuality of the individual and its comprehensive connection with society. In such a society, creative activity, providing the most complete psychologically comfortable state of each individual, in combination with the developing technologies of individual production, will make it possible to create each product as a work of culture.

Decentralization and ISOP will cover all spheres of human activity. From the procurement and processing of raw materials, energetics, the production of the final product, to service, education and individually adapted digital healthcare. And it will help improve the environment, increase the comfort and safety of human existence.

3 High-Order Cybernetics

The need to move from classical cybernetics to higher-level cybernetics when interacting with self-organizing, adaptive systems, will be considered at the beginning with a simple but convincing example. In the context of post-nonclassical scientific rationality and the cybernetic approach, the joint evolution of nature and man can be considered. And, in particular, to analyse such a burning topic as countering the COVID-19 pandemic. Based on the analysis of evolutionary processes, viruses can

be attributed to open self-regulating systems that seek to adapt to the environment that ensures their existence. Permanent mutations occurring in strains of coronavirus lead to the emergence of new strains and changes in their properties, which increase the replication capabilities of the virus and the ability to resist vaccines.

Based on the high adaptation of the coronavirus to the environment, in the fight against it one should move away from the traditional views of classical 1st order cybernetics, which considers the relationship of the subject-object type, where the subject is understood as the observer, that is, we, and the object—variations of coronavirus strains. Additionally, we should move on to the concepts of cybernetics of a higher order, considering the subject-subject interactions, in which the subject—the strains of the coronavirus are an active self-organizing system, acting based on what the second subject allows him—a certain local attractor of people with which a fuzzy set of virus strains contacts.

Let's take the example of collective precellular intelligence in coronavirus. The virus cannot reproduce on its own. To do this, he needs to use the cells of the body. And scientists from the Hebrew University of Jerusalem have discovered that the coronavirus can control the metabolism of cells in the lungs and prevents the body from burning carbohydrates, as a result of which the cells accumulate large amounts of fat that the virus needs to reproduce. Scientists have begun to use this identified feature to combat coronavirus (Ehrlich et al. 2020). Apparently, their changing genetic memory is actively involved in such adaptation of virus strains.

Considering the paradigm of relations, the subject (local attractor of people)—a rapidly reflexive subject (coronavirus), it is necessary to build a strategy for combating COVID-19, moving away from an ineffective, in this case, passive strategy for developing group immunity to a wise, proactive strategy of action. This strategy is designed to prevent the development of the COVIT-19 pandemic through the use of modern information technologies Big Data, Data Mining, Data Science, methods of decision theory and predictive analytics, modelling processes based on evolutionary algorithms, primarily on very effective genetic algorithms, as well as using achievements of subjectively-oriented digital healthcare.

Proceeding from the fact that vaccination does not completely solve the problem of counteracting the constant phenotypic changes in the coronavirus, it may be necessary to change the strategy of such counteraction in the system of relations between subjects (community of people)—subjects (population of coronavirus). Departing from the law of the materialist dialectic of the unity and struggle of opposites, move in the dialectic of their relations to the position of the unity and interaction of opposites. Assuming that the coronavirus in the form of constantly mutating clones will persist, it becomes necessary for humanity, from the standpoint of wise paternalism, to "tame" the coronavirus, directing the evolution of its strains along the most harmless path for people. Applying, to obtain such genetic variants, various means of biotechnology and other necessary methods.

From consideration of the problem, which can be attributed to the problems of biological cybernetics, second-order cybernetics, let us move on to socio-economic systems. For the interaction of complex active, self-developing systems operating

under conditions of partial information uncertainty and unclear conditions, multiparameter control algorithms are needed, considering a variety of rather vague factors. In many cases, the problem of such interaction can be viewed as an ill-posed problem. Given the dynamically changing parameters of such a problem, it has to be constantly solved at the level of an approximate model, often using simulation methods. This also applies to such a multifactorial problem as the functioning of the post-industrial socio-economic structure.

The considered post-industrial socio-economic structure can be attributed to a self-regulating cybernetic system of a high order. This system, in the spirit of multivalued logic, will constantly go through 3 cyclic stages in the form of probes, estimates and generation of a new more optimal system using positive feedback, then stabilization due to negative feedback at the achieved level of multi-parameter optimization, and then improvement within the framework of a new dynamically changing social homeostasis.

Socio-economic cybernetics can be classified as a high-order cybernetic system. It is largely correlated with third-order cybernetics based on the paradigm "subject-meta-subject (self-developing poly-subject environment)" (Lepskiy 2018). Socio-economic cybernetics, using collective intelligence, is based on the paradigm "subject—decentralized system of creative subjects", uses Blockchain technology in the interaction of its elements.

It is desirable that in the society under consideration the development of individuals proceeds according to the mechanism of genetic development worked out by evolution, for which one can generally speak of the presence of some kind of intraspecific restriction. This intraspecific restriction allows the species to limit the dominance of its individual individuals and somewhat harmonizes society.

This permissible value of the dominance of individual individuals can be mathematically represented in the following form:

$$\Delta R_{ij} \le \left| \sum_{s=1}^{N} \left\{ W_{st}\left(q - q_{mt}\right) \right\} p \right|^{\frac{1}{p}}, \qquad \Delta R_{ij} = \Delta R, \quad \forall_{i,j}$$

where ΔR_{ij} is the permissible value of dominance between individuals i and j, $\Delta R$is the value of the intraspecific restriction, q_s is the multi-point estimate of the s-th parameter characterizing the individual in question, q_{mt} is the estimate of the average discrete statistical distribution of parameters for the sample of subjects of this type at the t-th step of the change states, N is the number of parameters, w_{st} is the estimate of the weight of the parameter s for a given period t, p is an indicator characterizing the type of metric, the choice of which affects the permissible ratios of deviations of the parameters.

The estimation of the q_s parameters can be made based on linguistic variables using the 9-point Saaty scale, and as q_{mt} we can take a robust estimate based on a representative sample of subjects of this type, in the simplest case, the median.

If there is a limitation on the deviation of the set of parameters of an individual ΔR_{ij}, it is possible to form his individual parameters q_s in a fairly wide range. Thus, it is possible for the human species to avoid the singularity and, since the value of q_{mt} is not constant in time and changes with each t iteration, then evolutionary development is not limited. Thus, the evolutionary trend in the development of mankind will continue. To some extent, the given formula can be a mathematical model of a multi-parameter Overton window.

The collective intelligence formed in this way must be decentralized and can function according to the principle of blockchain technology. So, no one will be able to exert a dominant influence on him. It is present everywhere and is not specifically controlled from anywhere.

Since new information will be generated by individuals all the time and it will be exchanged through feedback loops of collective communication, a collective mind with emergent properties will be maintained.

It is important that at the same time, in such a decentralized system of the collective mind, the protective properties of the apperception system of individuals are preserved, and sometimes selectively strengthened. Leibniz introduced the concept of apperception as a conscious subjective perception of information. It largely depends on external factors and the internal state of the individual's body, and the mental health of a society can be assessed by the apperception of its citizens.

4 Transition to Comfortable Human-Intelligent Instrument Interaction

One of the most important factors that the transition to individual creative work will lead to is the provision of people with a comfortable life activity.

Robots perform standard operations faster than humans, and when choosing whether a person needs to compete with a robot or allow these nimble assistants to perform a lot of routine work, the answer is clear. And it should be highlighted what can be the advantage of man over AI. The irrationality of a person's thinking expands his horizon of consciousness, allowing, with an insufficient information base, to solve incorrectly posed tasks, effectively overcoming the barriers of the unknown. The irrationality of his behaviour, when using probes and estimates, is close to a heuristic, very effective genetic algorithm for solving optimization problems. This architecture of consciousness, combined with collective intelligence in society, ensures the universality of thinking when responding to a wide range of emerging situations and allows a person to easily adapt to changes in environmental conditions.

Perhaps the AI is prepared for the role of the swift-footed Achilles, who, according to Zeno's aporia, cannot catch up with the slowly crawling turtle. The cobot will repeat what a person has mastered, going through individual operations in its development in a short time. And having surpassed his in this, it will become a very effective assistant

in the form of an intelligent instrument. The robotization of many operations will fundamentally change a person's life, bringing its pace to the natural one, and will allow one to devote oneself to creativity, which is directly related to conscious activity and requires much more time than performing routine work.

The evolution of human-intelligent instrument interaction can lead to the creation of an individual intellectual assistant and advisor (alter ego), with whom there can already be a relationship at the subject-subject level. The alter-ego endowed with a matrix of artificial emotions, performing the functions of an interface with the outside world, will expand the owner's access to the necessary subject-oriented information, providing anti-spam and anti-trolling filtering, and will accumulate and process it (Kozlov 2018). Its perception of information can correspond to his master's apperception.

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Sloppy Science, Shortcuts, and COVID-19: A Set of Systems Lessons

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Abstract Trust in science is undermined when science is sloppy. Slodderwetenschap ("sloppy science") is a carelessness characterized by a willingness to tolerate scientific shortcuts and the lack of needed questioning of assumptions which that tolerance enables. When scientism (the fetish-like belief of all that is labeled as "science" is good) combines with Slodderwetenschap, the mistakes and shortcuts which characterize the sloppiness can carry over into decision making. The public, the media, and relevant decision-makers were all too often misled by the many instances of sloppy science and scientism encountered as the world dealt with the unfolding of the COVID-19 pandemic. Bad decisions with huge costs were the result. COVID-19 demonstrated that good science seldom comes from taking shortcuts or relying on "truthies" (items that "feel" true regardless of actual validity). Good science, instead, demands that we continually ask what about a given factoid, label, category, or narrative affords it meaning—and then to base further inquiry on the assumptions, contexts, and constraints so revealed. This article opens a discussion into what the past two years of dealing with COVID-19 have taught us about the dangers and practices of sloppy science.

Keywords COVID-19 · Science · Ethics · Systems

1 Introduction

The global spread of coronavirus disease 2019 (COVID-19) has been mirrored by the diffusion of misinformation and conspiracy theories and the motivations of preventive

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measures like vaccination, social distancing, and face masks (for example, as a political ploy). These beliefs have resulted in substantive, negative real-world outcomes. (Agley and Xiao 2021).

During the COVID-19 pandemic, discordant and conflicting information, including both genuine scientific controversies and medical misinformation, have made a coherent public health response difficult. … The coronavirus disease (COVID-19) pandemic has created new threats to trust. This may have been inevitable when facing a novel pathogen that defied [the public's] preconceived expectations (e.g., spread from asymptomatic carriers), leading to rapid advances in scientific understanding of the disease and frequently changing recommendations for prevention and treatment. However, the pre-existing distrust in science was exacerbated by conflicting messages, questionable treatments reported in research publications, concerns about political interference in public health recommendations and decisions regarding the efficacy of therapeutics, and pseudoscience and conspiracy theories (Baker 2020).

While science is to thank for bringing vaccine protection to the fight against COVID-19, sloppy science and scientism (Milgrom 2020; Muller 2021; Ogbunu 2021) (for our purposes, we define scientism as the near religious-like belief that anything labeled as "science" must be "truth") contributed much to the public's distrust of how the pandemic was handled—a distrust likely to carry over into all of science. (Luna et al. 2021).

COVID-19's many unknowns—its virility, transmission mechanisms, the effectiveness of therapies, etc.—created challenges for both decision-making (regarding public policy) and the public's understanding and interpretation of those policies. Chief among these unknowns was the novelty of asymptomatic transmission and the inability of many decision-makers to fully grasp the severity of a problem capable of exponential growth. The ever-shifting state of "knowledge" concerning the transmission, treatment, and suppression of the disease led to many a public dispute over the idea of "truth" (Sarmiento et al. 2020). One of COVID's lasting impacts is the general public's heightened degree of distrust of both "science" and "experts" (Couée 2020; Solomon 2021). Much of that distrust can be directly traced to sloppy science or, as the Dutch call it, Slodderwetenschap (Levelt et al. 2012).

The notion of slodderwetenschap was introduced to the world by the Stapel Affair in the Netherlands (Levelt et al. 2012). In this affair, the carelessness of the scientific community and its willingness to tolerate scientific shortcuts allowed Diederik Stapel, a prominent researcher, to forge fake datasets so that he and his students could produce scientific articles with nice, neat, near-perfect results. At the time, Stapel was the head of the psychology department at Tilburg University. It was not Stapel's fraud that the Dutch science community labeled slodderwetenschap. Instead, the term was leveled at the community of scientists, administrators, journalists, politicians, article reviewers, grant providers, and others who tolerated Stapel's sloppiness in the name of results.

Slodderwetenschap is at heart a disregard for process in the name of "preferred results." This kind of sloppiness is not just about science ideas or how science is practiced. It also involves those who report on and describe science to others and those

who make decisions based upon the sloppy science practice, results, or reporting. The past two years of the COVID pandemic have created a set of very interesting lessons for the science community. This chapter looks at the role of sloppy science and what that means for how we go about scientific inquiry in almost all endeavors.

COVID-19, like other public health issues, requires an explanation longer and more complex than the media will allow. With COVID-19, the general public and our political leadership were unprepared for a pandemic disease that had a huge number of asymptomatic carriers. Because people who were contagious often displayed no symptoms, our normal understandings about how to behave no longer worked. We looked to public officials and the media for guidance. Guidance which was, in retrospect, often wrong.

Cyberneticians will recognize the "wrong guidance" problem as one of a lack of requisite variety (Ashby 1968; Boisot and McKelvey 2011) combined with the all too human predilection for the "least action principle" (Lissack and Meagher 2021). We desire to take the simplest and quickest path—a desire that conflicts with a recognition that the world is uncertain, the risks we face poorly articulated at best, and the demand for trade-offs so large that it exceeds our cognitive capacity. Control and communication (the original subject of study of cybernetics) work best in stable environments, and its lessons are often aimed at creating such stability. The past two-plus pandemic years do not fit within that paradigm.

COVID-19 threatens our sense of "stability" not only with disease but also with innumerable unknowns. The longer COVID-19 stayed with us, the greater these uncertainties became. Last year, when the body of science agreed on certain parts of the virus structure, we still had yet to understand the way it spreads from human to human (Zhou et al. 2021). If the public is given an incomplete story with a conclusion that is not backed by science, they see no need to fill in the gaps with research because, to them, there are no gaps (Hughes 2012; Milgrom 2020). When our public health officials willingly participate in such a charade, all they are doing is undercutting long-term trust in science itself. Sloppy replaces rigor.

It is critical to note that the science can be sound, but its promulgation sloppy. Sloppy science is both the practice of science without attention to detail and rigor and promulgations made on a similar basis. Shortcuts are taken and used in place of attention to nuance and to due diligence. Alternative choices are ignored—perhaps due to their disruption to the already assumed conclusion or sheer laziness (Lissack and Meagher 2021). Desired results are proclaimed as "true" because of political pressure, financial incentives, the fear of more people dying, or the cloud of fame that comes from finding the cure (Barry et al. 2020; Caulfield et al. 2021).

2 Three Examples

If sloppy science was merely an abstract phenomenon, the concerns expressed herein would be much less troubling. But, sloppy science has pervaded our world—from

prominent public health officials and the media to the corporate boss trying to determine when and how workers can return to the office. With each of the three examples below, bad or sloppy science was accompanied by sloppiness in promulgation and in reaction.

Hydroxychloroquine. Hydroxychloroquine was pushed as a cure for COVID-19 on the basis of sloppy science. Many in the medical community warned that hydroxychloroquine's supposed efficacy was being pushed on the basis of a poorly designed study and anecdotal evidence. Yet, the hope for a silver bullet cure resonated with journalists, decision-makers, doctors, and scientists. Given one paper on hydroxychloroquine, both the media and policymakers reacted as if the small-scale study involved was conclusive. Rigorous science would mostly disprove the hydroxychloroquine treatment as effective against COVID-19, only months after it first soared in public expectations. Perhaps most troubling, the shortcut of "there exists a cure" manifested itself as a viral meme, the failure of which led to an erosion of the public's trust in science and scientists (c.f. Fiolet 2021; Paul 2020).

Masks. The strong emphasis for and against masks was made without consideration of key variables, including the roles of aerosols, the concentration of exposure, ventilation, and others. Nor was any policy rationale communicated to the public properly so that citizens would understand why they were being asked to do x. Many decisions were hastily made regarding mask-wearing without proper science or proper logic. In February 2020, there was a lack of RCT studies for facemask effectiveness against aerosol transmission, masks were being used in every hospital that had them, but still, the messaging to the public was: masks don't work. The CDC recommended that citizens not wear masks, but healthcare workers should. What about homemade masks? Cloth masks? Etc.? The CDC failed to explore such nuanced labels. Masks don't just have to be an N 95 to help. Even though the CDC changed its recommendation in April 2020 to urge mask-wearing, it was much too late. Lives could have been saved had more dialogue been undertaken. Even now, the general public is confused. Vaccines may help prevent hospitalization, but they do little to stop transmission from mucus membrane carriers. While it is getting better educated about the role of ventilation, the media seems ignorant of the link between mucus membranes and COVID-19 (c.f. CDC 2021).

Surface Transmission. The sloppy science surrounding COVID-19 led to an obsession with fomite transmission. For months there was a focus on sanitizers and avoiding surfaces. Not only did this cause unnecessary anxiety, but this obsession took the focus away from the danger of aerosol and airborne transmission: the main causes of COVID-19 infections. As COVID-19 spread, the media and public officials contributed to an over-focus on sanitization as a "preventative.". Much deeper explanations were required than "deeply clean surfaces and wash your hands." The media wasn't ready to convey that message, nor were they willing to admit to viewers that scientists didn't have all the answers. In Hong Kong, COVID-19 samples were collected from touch sites at a Buddhist temple, the site where an outbreak occurred. Then, the *New York Times* reported this as a huge fomite outbreak. The jump to conclude that surface transmission was the culprit was hasty and unsupported by evidence. The prospect of aerosol transmission was ignored. No one bothered to

distinguish between the viability of the virus and its contagion. It was simply sloppy science (c.f. Murphy 2020).

3 Why is Sloppiness Happening Now?

COVID is happening in an era that is devoid of any dedication to rigor. We live in a results-oriented world. Ends are cited to justify means. Outcomes are deemed more important than processes. The "sentence first—verdict afterward" world of Lewis Carroll's Queen of Hearts (1865) has become part of our present reality. In much of our lives, we assert the simple in lieu of the complex, the direct in lieu of the nuanced or the subtle, the label or category in lieu of recognizing the portfolio of choices that label/category represents (Lissack 2016c). Simplicity has its allures but can be very misleading. We live in a world that is more complex than our minds/brains are able to process. Our limited cognitive equipment forces us to deal with only selected aspects of any given piece of that complex world at each instant (Miller 1956; Lissack and Meagher 2021). Understanding is a product of choices that we are forced to make when seeking to overcome the mismatch between the relentlessly rich, interwoven complexity of the world and our minds' limited ability to cope with it all.

We take up only those actions and solutions that have an immediate effect on the situation, and always as they have been framed for us. We act based on the simplifications we choose, regardless of appropriateness. By acting on our interpretations, we consider ourselves as having made sense out of a situation. This creates a virtuous/vicious cycle. How we make sense, in turn, affects what we see. The very words and symbols we each use to describe our situation predetermine what we can perceive. Perception then generates narrative, which generates perception, and so on. All good in a world that is mostly "known" and somewhat "stable" but at risk of spiraling out of control when known and stable disappear and messiness replaces them.

Science was supposed to be known and stable. COVID-19 has shown the world the messiness of the scientific process. What was being proclaimed as knowledge, truth, or breakthrough on one day was often disavowed as unreliable the next. The public saw scientific carelessness and a willingness by scientists to tolerate sudden seemingly inappropriate reversals in what were otherwise portrayed as "facts." The public, the media, and political decision-makers are captivated by results. When scientists legitimately and transparently refer to their studies as, for example, works in progress, tentative, findings not yet to be relied upon, or raising of additional questions, the response from the public is often to reject that science rather than to accept it at face value. We—the public—dislike messy, incomplete stories. But most science only makes progress in messy, incomplete ways. Slodderwetenschap, alternatively, offers a tidy, superficial completeness that seems to provide cognitive comfort.

Our modern society's focus on efficacy and efficiency has led to a focus on the evaluation of results. But, as COVID-19 has made all too clear, efficacy and efficiency are rather meaningless concepts when dealing with unknowns, in-articulables, emergence, and exponential growth. We do not go through life overwhelmed by the apparent complexity continually confronting us. Instead, we make choices about what to deal with, what to see, and what questions to ask. We have two main methods of dealing with cognitive constraints in our effort to cope. First, we limit the information we pay attention to according to what we believe—perhaps falsely—we can cognize. Second, we look for relationships amongst the things to which we attend. (Lissack and Meagher 2021) Because the human cognitive limit is five to seven unrelated items (Miller 1956), asserting relationships allows us to limit cognitive load and pay attention to more things.

These choices can all fall under the label of "simplifying." We all too often choose to assert the simple over the complex, the shortcut over engagement. And then, we act. Often, wrongly. We call this problem the proliferation of the 3 T's: (1) *truthies*, (2) *TLDR* (too long did not read), and (3) *TCUSI* (too complex, used shortcut instead). The 3 T's haunt modern life. Science, regrettably, is no exception.

3.1 Truthies

Truthiness was coined in 2005 by Stephen Colbert as: "Truthiness is 'What I say is right, and (nothing) anyone else says could possibly be true.' It's not only that I feel it to be true, but that I feel it to be true. … truth that comes from the gut, not books" (Colbert 2005). Expressions of truthiness are called "truthies."

More generally, truthiness refers to the quality of preferring concepts or facts one wishes or believes to be true rather than concepts or facts known to be true (American Dialect Society 2006). Consider some COVID-specific examples. Many a time, what works with a specific context, under defined constraints, and with a sample described as x, fails when the context is changed, the constraints are relaxed, or the population is better described as y. Andrew Cuomo thought he was relying on "sound science" when he ordered that recovering COVID patients be transferred to nursing homes. What may have been "sound science" regarding recovering victims of auto accidents proved very deadly to the residents of those same nursing homes. Cuomo relied on the wrong truthy.

> Early in the pandemic, there was less appreciation for the importance of ventilation systems and the use of face masks, which can dramatically affect the safe levels of occupancy… in enclosed spaces, tiny airborne pathogen-bearing droplets emitted by people as they talk, cough, sneeze, sing, or eat will tend to float in the air for long periods and to be well-mixed throughout the space by air currents. There is now overwhelming evidence that such airborne transmission plays a major role in the spread of COVID … Simple rules based on distance or capacity limits on certain types of businesses don't reflect the full picture of the risk in a given setting. In some cases, that risk may be higher than those simple rules convey; in others, it may be lower. (Bazant and Bush 2021)

Surface transmission was, again, the wrong truthy.

3.2 TLDR

The short attention span of students (and of many of us in general) has led to the phenomenon of TLDR (too long did not read). In its simplest form, TLDR is used to express that a piece of text is too long to be worth reading. The very notion begs the question: How does one know the "worth" of a piece before actually reading it? Indeed, the judgment gets made based on truthies about the author, the title, the medium, and the context. It becomes, in essence, all about the shortcut. The "science of COVID," as seen by the public, was a hodge-podge of false starts, inaccurate claims, poor decisions, and frequent overreach. When what was proclaimed as knowledge, truth, breakthrough, etc., one day, was disavowed as unreliable the next, all that the public can see is carelessness and a willingness to tolerate inappropriate scientific shortcuts by the scientists themselves. Rigorous science (and its use in policy-making) has little place for the "thinking fast," the distinction of which earned Kahneman (2013) fame. But, TLDR is the very epitome of thinking fast.

Many of our COVID-centered policy decisions relied on outdated and ultimately incorrect singular models, which, despite better alternatives being available, were relied upon because they were "familiar." If one assumes that exposure to COVID on surfaces matters, then one might examine why it matters. Indeed, models of how long virus material could "survive" on a surface were diffused extensively during the first six months or so of the pandemic (van Doremalen et al. 2020). But, the models did not examine "contagion"; they examined "survivability (of the virus)." Contagion was an unexamined second effect not included in the singular models about "survival of the virus molecules." Subsequent research rigorously demonstrated that the contagion effects of virus materials found on surfaces were extremely tiny, despite the likelihood that the material could remain "alive" for many hours. (Goldman 2020) Contagion is what matters. It took over a year before guidance based on the "wrong assumption; wrong outcome" survivability models was withdrawn. That guidance—itself a form of TLDR—imposed a huge cost on society—ultimately for no reason.

3.3 TCUSI

This brings us to the third T: TCUSI (too complex, used a shortcut instead). Simplification as a process may increase efficiency … but at the price of context and fit. When things are complex, they embody ambiguity and uncertainty. They possess multiple meanings, each asking to be acknowledged. To ignore multiple meanings and ignore context is to assume a stasis to the world which seldom exists. Such a stasis assumes that opportunities are predictable, context is controllable, and the

emergence of the new is non-existent. Our present world does not match these over-simplifications. Prediction, at best, is only possible in the short term. Boundaries are always shifting. Identities are unclear. In the complex world of today, continuity is but a fragile, temporary, and illusionary notion; the assumption of predictability does not hold. But, all that is overwhelming. Shortcuts, by contrast, as so simple.

When COVID first appeared on the world stage, there was an immediate effort to limit how dangerous it was portrayed to be. As that portrayal became more and more inaccurate, hoped-for "miracle" cures began to take center stage. At first, the public was told, "masks do not help" (Diamond 2020), then masks became necessary (Chernozhukov et al. 2021). At first, lockdowns were spurned (Greyling et al. 2021), and then they too became necessary. (Farsalinos et al. 2021) At NO point during the evolution of the pandemic did relevant public officials admit "we do not know." Instead, half-truths, guesses, and even frauds were displayed as the "latest knowledge." Decisions were made, and policies expounded based upon the sloppy science of scientists, journalists, and other decision-makers. The rigor that should have been inspired by "we don't know" was replaced by a false certainty because of scientism. It was here that the Slodderwetenschap of the entire community converged—the idea of the moment which resonated with the "right" sub-crowd (amongst the scientists, journalists, and decision-makers) became the "science" of the day.

The problem of the 3 T's applies to science, to media reporting, and to policy/decision making as well as to life in general. The risk we face is that the explanations shortcuts and the 3 T's offer about the world are wrong, and so are the actions/decisions based upon them. Users of the 3 T's are convinced that they already "know" and thus that critical thinking interferes with their being "efficient." This is the false efficiency that underlies homeopathy. If the "shape" of the "truth" is present, that presence will remain regardless of how diluted the solution is (Most call this quackery.). We cope by simplifying—but we keep running into cognitive walls. We may smile when the simplifications of others fail them, but then we realize that our own simplifications are not working either.

As the proliferation of sloppy science continues, so does the distrust in science in general. All of this creates a huge chasm of doubt. Do the vaccines work? Don't they work? Push to take them when? How often with a booster/without a booster? Should we be wearing masks? When? Why should we have an economic lockdown? Should we be social distancing? Should our children be going to school? Should the elderly be kept at home? Not knowing clear answers to these things creates ample doubt. And that doubt feeds on itself. Witness this set of comments in response to a Wall Street Journal editorial titled "Partisan Science in America" (Morson 2021).

Reasonable people don't "trust science". Reasonable people trust rigor and debate. Reasonable people understand that there are almost no absolutes in "science".

Science is never settled and must be open to unending debate. "Follow the science" means accept what I tell you as true, or else.

Back in the day, an idea was stated as a "definition of the problem." This was followed by an appropriate set of conditions and assumptions necessary to estimate a solution. The answer was then clearly clothed in the conditions and assumptions.

When a conclusion is stated as science without the assumptions, the presenter is dishonest!

Everything we've ever learned at one point, was proven either wrong or incomplete by something we learned later. About 10% of what we think we know is made obsolete each year. Almost all of it is overturned within a decade.

Science is NEVER 'settled.' New and better information is obtained by continuously questioning the old information. Anyone who doesn't do that is not a scientist.

What science really is–being unsure, and willing to admit it, and willing to keep testing. Most people only ever get the book version.

Science is a conversation—not "settled". It is to learn, not force behaviour or thought.

Science isn't a dusty book, or a mathematical computer model, filled with unassailable facts. Science is a process where everything is questioned, and the questioning never stops.

Pretending the methodology of science is some kind of abstruse concept is exactly what's wrong with 'scientists' who seem to think they are the priests of some hieratic sect which cannot be questioned by the uninitiated and unwashed masses.

The continued repetition by the media and public officials to "trust the science," despite the "science" seeming to shift day-by-day, made the ascription of such trust all the more problematic. There was no stable science to trust. Predictions failed. Controls failed. The media joined with the general public in spreading wildly differing truthies—each of which seemed to resonate with some, yet very few of which actually resonated with provable facts or even with cogently explicable hypotheses.

4 Fixing this Mess

When the black box of sloppy science cannot quell the doubts, all that happens is fear, uncertainty, and confusion. The challenge for the next crisis is how to earn back that trust. Our goal must be to take the steps necessary so that the public can once again regain its faith in science. To do so means we need to bring back the notion of rigor. We need to bring back the continual asking of questions—in particular, questions that reveal assumptions, alternate (perhaps discarded) choices, and that which allows the cognitive shortcuts taken to represent whatever it is the shortcut taker understands.

From a systems perspective restoring rigor raises epistemological questions. For those who are of the belief that systems are real, rigor demands that the scientific questions, processes, and related results make explicit reference to the system(s) of which they are a part. For those who instead take a pragmatic constructivist (second-order cybernetic) view whereby membership in one or more systems is a descriptive quality ascribed by an observer, the Gregory Bateson "differences that make a difference" criterion applies. The use of a systems-level descriptor or reference will matter

if that use makes a difference in the scientific questions, processes, and related results or how they are described to observers.

The present authors are of the second point of view, and as such, believe that the system-level problems associated with Sloppy Science take the form of an environment or habitus (Bourdieu 1977) that works not only to tolerate the 3 T's but to implicitly encourage their use. Habitus describes the socialized norms or tendencies that (1) guide our behaviour and thinking (2) are either embodied in the environment or deeply embedded in our thought patterns, and (3) we take for granted as "given" when we attempt to make sense of the world. Habitus takes the form of lasting dispositions or structured propensities to think, feel and act in ways that then guide us in our behaviour, thoughts, and emotions. It is that lasting disposition towards toleration/encouragement that "makes the difference," and it is our belief that progress in this arena demands that such tolerance/encouragement be repudiated whenever possible.

Sloppy science often is the result of a singular unarticulated and unexamined decision that it is proper and reasonable to make use of one or more shortcuts in the conduct of the science or in its explication. Slodderwetenschap includes science itself, the reporting of science (be it in scientific journals or in the general media), and the reliance by decision-makers on either such science or such reporting. When a scientist (or someone who is reporting on or simply cognizing science) opts to use shortcuts (i.e., a non-evidence- or data-based assumption) in a context which instead demands a more thorough exploration of nuance, constraints, assumptions, and alternatives—sloppiness ensues. The chosen shortcut may well appear to be "correct" within a narrow set of constraints, but often it loses its alignment with truth/accuracy as those constraints are relaxed, non-conforming assumptions are encountered, or the applied context changes. Scientism adds to the problem by prematurely encouraging the expression of these sloppy shortcut-based items as "facts" so long as they are labeled as "science."

Sloppy science—in the conduct of science itself—resists cogent explication and coherent explanation. And, once that "science" is available to other actors (decision-makers, elected officials, members of the general public), scientism 'takes the baton' and propagates both reporting of supposed "science" as well as bad decision-making based on sloppy foundations. The aphorism "Traditional science is all about finding shortcuts" (Henle 2011) is too often misinterpreted. Science is about finding shortcuts that work, not just using those which may be convenient.

When the choices made are not explicated, are hidden by jargon, are treated as "obvious assumptions," or are accessible only to an expert, the science performed cannot be examined for alternatives, and the researchers involved cannot be questioned re the effects which might ensue if different choices had been selected. Jargon, of course, also creates opportunities for fraud. It is all too tempting for both researcher and observer to skip past the necessary step of questioning the choices made and instead asserting that the "science/policy/knowledge/actions speaks for itself." The key to good science, good policy, good research, and good decision-making is to avoid such temptations. The "devil" lies not in the details—but in an overt refusal to explicate each and every one of them.

We need to reassert that science is not about answers but is instead about questioning. It is being open to saying, "I don't know. I don't yet understand. Come on this journey with me." Good, rigorous science needs to be viewed as a process and its outcomes—and not merely as some set of results absent a description of how they came to be. Good science seldom comes from taking shortcuts, and even more rare is good science, which emerges from shortcuts taken which cannot be explained.

Scientific understanding happens when the scientist/researcher is capable of cogent explication of the process which allows the shortcuts used to categorically represent the problem at hand and its many entailments. This means careful explication of assumptions, presuppositions, contexts, and constraints (Lissack 2016a, b). It means being able to articulate how and why alternate choices were not made. It means being able to explicate a chain of meaning from the first unexpected observation to the deployment of a model on the way to a practical application. Good science happens when the researcher is able to offer a coherent cogent explication of (1) the choices made that afford the conclusion reached its specific meaning, (2) the conditions under which that conclusion can be generalized, and (3) what linkages the conclusion offers for expansion to/application for/ exploration of adjacent possibilities.

We cannot have the false truths or the black boxes of sloppy science work to destroy what has been the twentieth and twenty-first century's greatest achievements. Science and technology have done wonders for mankind. Sloppy science, fear, doubt, all of those can work to destroy the promise of more wonders to come.

It is critical that we work to restore our trust in science itself. That trust can happen when we once again approach science from the perspective of always asking questions—and reteach the public that science is a process of asking, not the proclamations of those "answering."

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Digital Earth and Hybrid Crises of XXI: Remedy and Disease?

Eugene Eremchenko and Alena Zakharova

Abstract **The purpose**—To briefly discuss the essence of the Digital Earth and its civilizational consequences in the scope of cybernetics and semiotics and the context of the variety of modern "digital" initiatives of nowadays. To present the Digital Earth as a new geospatial paradigm, to point out its philosophical, cybernetics and social implications. To unveil semiotics roots of hierarchical governance architectures and how the Digital Earth triggered the development of subject-oriented net-centric architectures. To unveil the semiotic "non-digital" conundrum of the Digital Earth. To discuss the ambivalence of the Digital Earth as a decision-making environment and how it can be used to prevent the new hybrid crisis typical of the twenty-first century.

Design/methodology/approach—The design of the work is focused on the task of revealing the general civilizational implications of the scientific geospatial revolution and is based on the dialectical approach. The general methodological basis of the work is system-centred, interdisciplinary and integral (H. Selye) approaches, which reveal the origins of geospatial approaches deeply rooted in human culture. Semiotic and cybernetic approaches are also used. The method of identifying and rationalizing paradoxes as well as retrospection are used extensively.

Findings—The Digital Earth is presented as a paradigm of the new geospatial revolution. Its semiotic foundations are shown, the concept of the "zero sign" in semiotics as a factor determining a qualitative leap in the principles of governance, and the typology of visualization methods is proposed. Based on semiotic and cybernetic approaches, different digital initiatives are analysed, and a semiotic definition of the digital economy is given. The practical involvement of the Digital Earth in the formation of a new architecture of the struggle for global dominance is shown, and an explanation of the phenomenon of the "end of art strategy" is proposed.

Originality/value—The scientific novelty of the proposed work is based on the author's original works, partly debated and partly already included in the official

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body of knowledge about the Digital Earth, summarized by the International Society for Digital Earth (ISDE). From a methodological point of view, the novelty of the work is based on the use of innovative approaches for this interdisciplinary field.

Research/practical/social/environment implications—Digital Earth as a geospatial approach directly impacts decision-making practices and command and control architecture on global and governmental levels. Additionally, Digital Earth due to its semiotics properties should contribute to the development of systems approach and cybernetics, which will be adequate to the challenges and threats of the twenty-first century. Based on this approach, criteria for assessing innovations in social systems using digital technologies and artificial intelligence could be developed.

Research limitations—due to the global spatial and very wide temporal context of the research, it's limited mainly by its methodological framework and clash of the scientific paradigms in the geospatial realm. Due to the high level of involvement in current geopolitical and sustainable development agendas and the self-interest of the group involved, research may be limited by subjective factors. Thus, there is a need to develop a methodology aimed at overcoming the limitations.

Keywords Digital earth · Cybernetics · Situational awareness · Semiotics · Scientific paradigm

1 Introduction

The COVID-19 pandemic of 2020 was a civilizational milestone, initiating a severe crisis. The long-term effects of that crisis are hardly foreseeable today, and the ways of overcoming it are debatable. The unprecedented collapse of the global economy unveils a deep crisis of civilization itself, rooted in ineffective decision making, wrong goals and distorted worldview. A clear sign that this vision is common is the widespread and growing popularity of the concept of sustainable development (Sustainable Development Goals 2021)—a declaration that drastically contradicts the visible downward civilization trend. Sustainable development is more a dream of a 'lost paradise' of effective and competent world governance than a scientifically based and methodologically supported initiative. The reality is not as optimistic as declarations, though. The crisis is worsening and no remedy can be developed without investigating its true nature.

The crisis of 2020 struck the global system which includes natural, technological, and social components. Therefore, the genesis of the crisis must be investigated by cybernetics as an interdisciplinary research area concerned with "control and communication in the animal and the machine" (Wiener 1948). Thus, it inevitably addresses decision-making issues. At present, there are two basic approaches to explaining the genesis of the crisis—technological and scientific. The technological trend links expectations to technologies, especially digital technologies, that are supposedly able to overcome the crisis without changing the current civilisational

horizon and goals, only by sustaining established governance and decision-making practices. There is also the opposing view, which suggests that the origins of the modern crisis go much deeper, and recovery needs to reconsider our worldview, scientific models and fundamental values.

In this study, we propose to discuss one of the vital prerequisites of this crisis—the lack of situational integrity rooted in the inability to create a unified situational image for all scales simultaneously using maps. Governance is fragmented into unconnected tiers in which uncoordinated information circulates. In this situation any management architecture inevitably begins to produce mutually contradictory and counterproductive solutions. A solution to the above problem is possible with the Digital Earth concept (2009 Beijing Declaration… 2009), which makes it possible to form a single large-scale independent information environment and thereby eliminate the isolation of decision-making on different tiers. The concept of the Digital Earth is widely recognized as a new geospatial paradigm with paradoxical properties and is capable of influencing the fundamental components of the modern scientific worldview. Thus, its comprehensive study is desirable.

2 Background

The global crisis study is interdisciplinary and is the result and development of several main scientific disciplines and research programs.

Firstly, it is cybernetics and specifically the hierarchical model of cybernetics proposed by Stepin and his school (Stepin 2000). It is essential to test and investigate the decision-making factor in the global civilisational framework as a cybernetic phenomenon.

Secondly, it is the concept of Digital Earth, a three-dimensional geocentric framework of our planet with distinct holographic properties and breathtaking possibilities, foreshadowed in the 1990s (Gore 1992, 1998). Its most prominent and well-known example is Google Earth, launched in 2005. Digital Earth is a geospatial visualisation based on remote sensing from space. The periodically updated Digital Earth Vision offered by the International Society for Digital Earth (ISDE), as well as the first comprehensive manual (Guo et al. 2020), are used in this work.

Thirdly, the use of semiotics as the "study of signs" (Todorov 1973) is mandatory, because the novelty of the Digital Earth essentially refers to its surprisingly new property—a radical simplification of the semiotic structure with the rejection of well-developed and well-known systems of signs. Henceforth, the information context of the system is set not by cartographic signs, but by images, remote sensing data.

Fourthly, the crisis must be analysed considering the digital economy and digitalisation in general, since the digital turn is one of the key factors in its genesis.

The concepts of situational awareness, sustainable development, net-centricity and neogeography, which are being actively developed nowadays, should also be mentioned as a background to this study. The theory of scientific revolutions (Kuhn 1970) should be mentioned in particular, as the Digital Earth is often associated with

a “geospatial revolution”, the new scientific paradigm in the perception of space and thus affecting the entire scientific worldview.

3 Methodology

In this study, due to the holistic nature of the task, we introduce the extensive use of the integral method, successfully applied by famous biologist Hans Selye (1907–1982) in the discovery of stress (general adaptation syndrome), and potentially productive in research in the realms of cybernetics, biology and geosciences. The essence of this method is to identify common, non-specific features of various manifestations of a single holistic phenomenon to discover its fundamental features (Selye 1964). It complements the opposite differential and comparative research methodology. Together, they make it possible to identify the nature of the complex phenomenon under study and develop a typology of its particular manifestations. Another methodological basis for the proposed work is the use of the semiotic method. The semiotic method is involved because the modern crisis is related to digitalization, and because Digital Earth is based on a significant shift in the use of signs in management. Whereas previously the development of management was carried out by the creation of ever more sophisticated sign systems, Digital Earth has demonstrated exactly the opposite approach. For the first time in human history, progress was made by abandoning the use of signs and moving instead to the use of remote sensing data. This trend can be interpreted in two ways, either as a return to using the simplest, most iconic signs instead of the more sophisticated cartographic signs, or as a rejection of the use of signs at all. Understanding these unexpected features of modern management systems allows us to better understand the features of the global crisis brought about by digitalization.

3.1 Understanding Digital Earth

Thus, situational awareness is not possible with the classical maps, which have become a bottleneck for decision support and limit the effectiveness of the decision making. A different geospatial environment is needed. Therefore, the envisioning of the new geospatial approach with miraculous properties, coined ‘Digital Earth’, in 1992 and 1998 (Gore 1992, 1998) and its successful implementation in 2005 has been widely appreciated throughout the world and recognised as a revolutionary step (Guo et al. 2020). It should be noted that the emergence of the Digital Earth has been long-awaited and foreseen many times as the miracle horizon of cartographic development. Future Digital Earth has been described with striking accuracy since at least the middle of the nineteenth century (Baturin et al. 2020, pp. 735–736).

According to the first and most recognised definition, the Digital Earth is a “multi-resolution, three-dimensional representation of the planet, into which we can

embed vast quantities of geo-referenced data" (Gore 1998). However, this definition now should be clarified. The Digital Earth is not simply a stack of a few maps of different scales. It is an "impossible map" that consists of all continuous scales and all possible directions of sights simultaneously.

The scale could be modelled within a very wide continuous dynamic range (about eight orders of magnitude even in the first implementations) and not limited. Moreover, it allows simulating interactively any required viewing aspect, not limited by a narrow set of map projections (Fig. 1a, b). It is the global volume of time and space opened for the collection of vast volumes of any possible localized data.

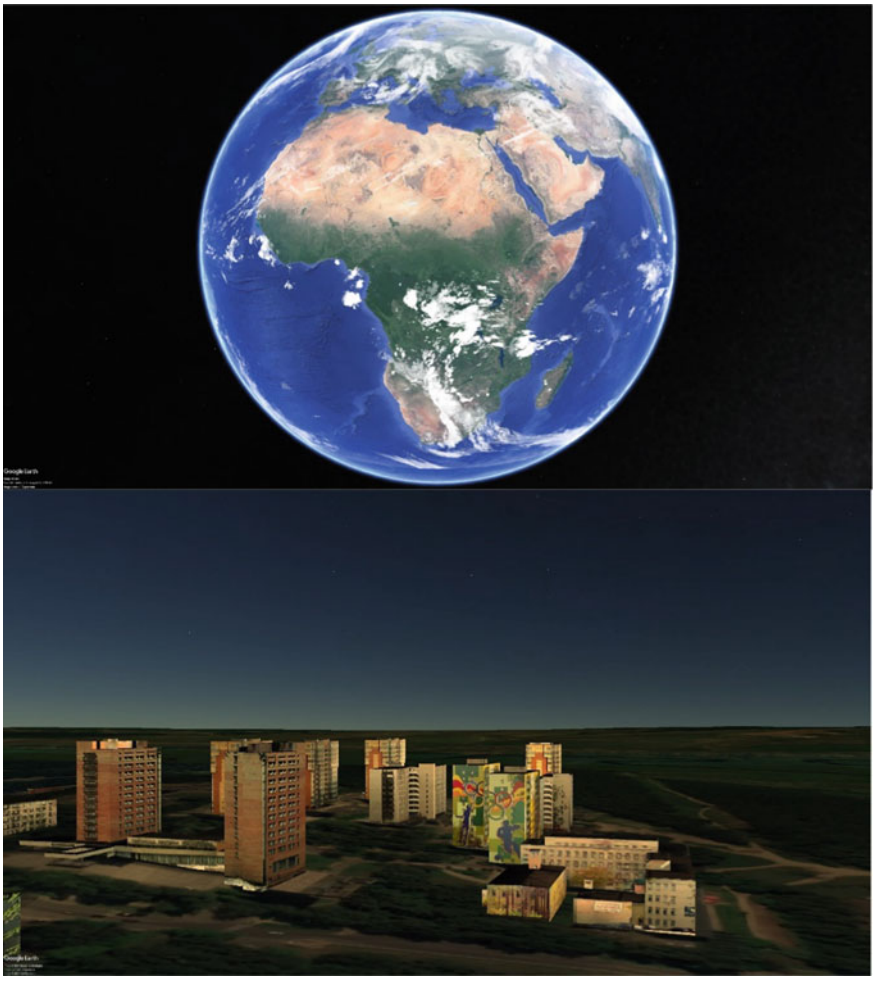

Fig. 1 From top to bottom: Unified representation of the geocentric space in Google Earth using the same sign-free, scale-free and projection-free dataset: **a** global extent (*Source* Google Earth); **b** local extent (part of Protvino, Russia). (*Source* Authors, Neogeography Group, Google Earth)

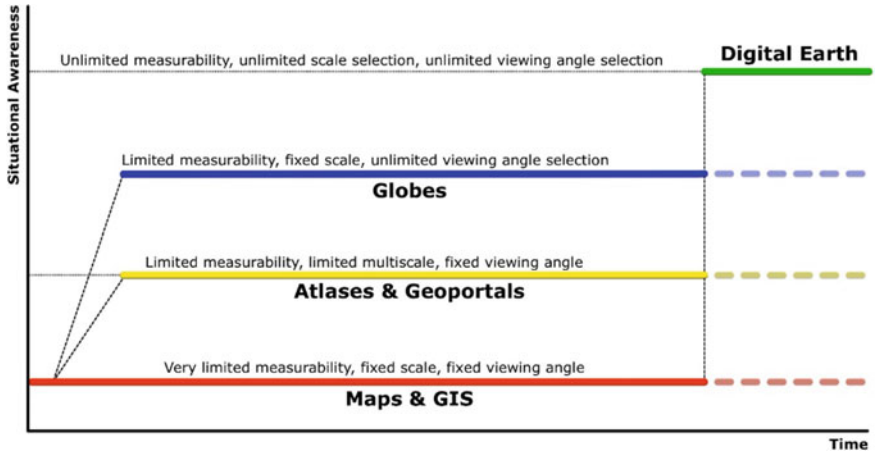

Fig. 2 Simplified representation of the roadmap of the quantum evolution of geospatial visualisation approaches (*Source* Authors)

Even more, the Digital Earth can even simulate perspectives that make no sense in terms of classical cartography—for example, the bottom-up direction of sight. The user of the Digital Earth sees behind a computer screen a precisely reproduced globe with its topography, obeying any commands—it can zoom in and out, rotate, tilt, etc. Any information can be added to it, including that represented by signs, but space imagery is ideal for conveying geospatial context. The use of an integrated approach makes it possible to identify what all geospatial visualisations have in common and create a typology containing three types and reflecting the logic of the internal development of the geospatial method: (1) maps and GIS, (2) atlases and geoportals; (3) globes, (4) Digital Earth (Baturin et al. 2019) (Fig. 2).

Digital Earth allows us to see the reality around us exactly as it appears to the observer in the real world, free from cartographic and any conventional signs—and thus becomes the ultimate medium for organising inter-subject and subject-object interactions in a post-non-classical paradigm (Stepin 2013). The new striking properties of Digital Earth are rooted in the visible rejection of the mapping signs as an ultimate tool for the representation of the geospatial context. This is undoubtedly a revolutionary step, as throughout history, "cartography always and everywhere used signs, collecting them into the corresponding sign systems" (Solomonic 2021). And even more, now all information is thought to be represented by signs. This fact gives rise to a problem addressed to semiotics.

3.2 Semiotic Conundrum Behind the Digital Earth

According to the existing vision, information can only and exclusively be conveyed by signs of different types. Images are usually referred to as a special type of signs—iconic signs, the simplest (or one of the simplest) type of signs. It is widely believed that the evolution of signs from simple to more complex was the main way of civilizational development, and mapping as the oldest information system in the world initiated this process in prehistory. For example, even the most ancient high-quality topographical map of Çatalhöyük, created circa eight thousand years ago, long before the invention of letters, implements all the fundamentals of the cartographic principle and uses well recognizable and readable cartographic signs, similar to the ones used today (Mellaart 1967; Schmitt et al. 2014).

Hence, a conundrum emerges. The development of mankind has taken the form of the collection and proliferation of information, and the evolution of information systems throughout history have been driven by the invention of more and more advanced signs. However, the latest quantum leap in informatics, the Digital Earth, contradicts the logic of information systems development, because it has been achieved by abandoning the use of signs, or at least bouncing back to the primitive iconic signs instead of the invention of the most perfect and abstract ones. This conundrum can be resolved by assuming the existence of carriers of information outside of signs—the so-called "zero signs", or "non-signs" (Eremchenko 2020). Such an assumption does not affect classical semiotics but makes it possible to draw a clear boundary between signs and hypothetical non-signs and to investigate the latter. The existence of "zero signs" outside the realm of classical semiotics follows organically from the artificial nature of signs and from the need to avoid the violation of the "law of parsimony". The "zero signs" should include the images, like remote sensing data, obtained by technical means with the minimum degree of subjectivity. It is also interesting that the term "Digital Earth" does not quite correctly reflect its essence it is a dialectic turn of "Digital-less Earth", reconstructed through digital technologies following its hierarchical model of cybernetics based on post-non-classical scientific rationality (Lepskiy 2019).

Digital Earth's stunning situational awareness capabilities and its tremendous interdisciplinary capabilities have been quickly appreciated by users in a wide range of areas (Lepskiy 2013). Digital Earth becomes a testing ground for the reconstruction of fundamental milestones in early human history, deeply rooted in the human unconscious—for example, understanding the genesis of signs. Digital Earth has become a uniquely powerful "microscope for society," opening up the possibility to study social phenomena and processes by observing their dynamics in space and time. Its unique feature is the ability to study social processes without observer intervention in them, which is critical to the study of subject-object and object-object cybernetic processes. Thus, Digital Earth implements in practice the cybernetic subject-object approach and makes it possible to qualitatively improve the quality of decision making.

4 Results

4.1 Global Crises and Situational Awareness

Crisis prevention requires smart global governance and, consequently, the comprehensive decision making based on the clear vision of the global situation within the planet-wide geospatial context—i.e., the smart replica of the Earth that represents the current situation and the geospatial context in its integrity, as much as closer to a real-time, comprehensively and accurately, with best possible resolution and in a most natural way to avoid wrong decision making and mismanagement. The decision-making environment should meet the principle of situational awareness that includes two statements: "the perception of the elements in the environment within a volume of time and space, the comprehension of their meaning and the projection of their status in the near future" (Endsley 1995). There are two vital requirements in this definition: (1) perception should be provided "in the environment within a volume of time and space", and (2) understanding the elements of the environment through physical sensations (perception).

The first one requires the existence of a unified, non-fragmented image of the system (Zakharova et al. 2021), immersed in the "volume of time and space", therefore the system should be encapsulated within a spatial–temporal framework. Unfortunately, it is impossible to create such a framework using mapping for fundamental reasons, because any classical geospatial products (maps, globes, atlases, GIS, etc.) necessarily split the holistic and versatile real-world into different and incompatible scale-dependent and projection-dependent replicas—maps of different scales, that inevitably contradict each other due to the fractal nature of geospatial entities revealed by the discovery of the so-called 'coastline paradox' (Mandelbrot 1967).

The second one requires a direct perception of the environment through physical sensations, not mediated by signs. This requirement is also not achievable with maps or with other informational systems. The idea of creating an information system that does not use signs seems, at first glance, impossible. However, we are witnessing the dialectical transition of "negation of negation" in action. Originally, before the invention of signs, the environment was perceived by the subject directly through the senses. Later, signs appeared as the negation of direct sense perception. And now it is already possible to use computers to process and visualise images perceived directly through the senses. The subject has returned to the original mode of perception, but on an entirely new technological level through the dialectical transition of "negation of negation".

4.2 Global Crises and Digital Earth

A fundamental consequence of Digital Earth is to improve management by eliminating distortions in information systems. Such distortions are an inevitable consequence of the use of sign systems in governance. Incorporating the sign-less representation of the environment allows us to bypass these limitations.

In turn, this property of the Digital Earth has made a quantum leap in the architecture of governance inevitable. Throughout history, humankind has used a tiered approach to governance, based on the hierarchy of vertical levels of decision making (for example, global, strategic, operational, tactical levels, etc.). That approach originated in the scale and projection dependence of sign-based geospatial tools—maps and their derivates. Tiered governmental architectures were reproduced in all cultures until recently, but with the advent of Digital Earth, this obstacle has been overcome. At least one new type of warfare, cyber warfare, has already been established, which exploits the holistic vision of the global battlefield as a critical factor in defeating the adversary using its hierarchical control system as the main vulnerability.

The dismantling of complex command and control systems is one important consequence of the inclusion of Digital Earth in the global control loop. Digital Earth is only an instrumental entity in the context of societal governance and can be both a cure-all and a source of new dangers because it can become a kind of "organizational weapon" (Lepskiy 2018) and can be used to achieve global domination by implementing qualitatively new scenarios of confrontation. In other words, Digital Earth as a new governance paradigm has the potential to revitalise global confrontation and reignite the global crises by highly effective decision making that achieves goals with fewer resources. Additionally, it could be used to organize sustainable development for mutual benefits. Digital Earth is neither a remedy nor a disease, but a radical new worldview paradigm that forms a bifurcation point for future human development.

Digital Earth has enabled a new class of study of complex processes of an unknown nature—such as the COVID-19 pandemic. It was the first pandemic in history to be recorded with unprecedented spatial and temporal resolution. This offers the prospect of a better understanding of the nature of pandemics (and diseases as well) through the study of their dynamics with new cognitive tools and methodologies—such as fractal analysis—and within the framework of a subject-oriented approach (Lepskiy 2020). It can be assumed that it will play a role in better understanding the nature of these catastrophic global processes. It is worth mentioning that, for example, a comparative analysis of pandemic dynamics at the interscale level has not been conducted so far due to the lack of suitable geospatial tools.

The crisis initiated by the COVID-19 pandemic (and presumably the future crises of XXI as well) is hybrid and originated from poor, responsive world decision making based on distorted worldview due to instrumental reasons and, therefore, should be further investigated. The crisis is an inevitable consequence of current decision-making methodologies inspired and implemented by geospatial instruments as well as economics. Economics and cybernetics pretend to study the same realm or very

similar realms and involving semiotics help to reveal the relations between cybernetics and economics. The semiotic paradox of the Digital Earth allows us to resolve this contradiction. Economics should be defined as the simplest possible control approach based on a single and discrete scalar indicator (cost) to control complex systems. The crisis nature of economic governance is already well recognised, but there is no common ground on how to overcome it. In general, overcoming the crisis is credited to the so-called "digital economy". However, the meaning of this term remains unclear. It is widely interpreted as increasing the number of similar scalar "money-like" indicators—e.g. ratings—In addition to the economic indicator, as well as the data transfer rate acceleration. This is an attempt to "quench the fire with gasoline" and it will inevitably disrupt world system governance. Instead, Digital Earth makes it possible to resolve the growing crisis of the governance by incorporating into the decision-making approach not only scalar signs, as economics did, but also the use of sign-less data carriers based on "zero signs" that allow for an amazingly accurate and reliable reconstruction of the situation for decision-making.

5 Conclusions

Digital Earth suggests an alternative to the hierarchical governance approach in crisis solving, based on the use of a variety of classical semiotic tools as well as unsigned representations of the environment. The unsigned representation is necessary because geographical objects cannot be represented by any signs for fundamental reasons (coastline paradox). A smart decision-making environment should include rich content unmediated by signs like Digital Earth does. Digital Earth is naturally complementary to the basic needs of today's Sustainable Development Goals (SDGs) and connects seamlessly with Big Data.

Even now, the Digital Earth has significantly changed our visions of management and the architectures of global governance. Further study of the Digital Earth and its semiotics from a post-non-classical cybernetic perspective as a decision support environment is seen as an important, relevant, potentially fruitful task with obvious fundamental impacts. Also, the geospatial revolution is a call to delimit the boundary between signified and non-signified media in semiotics.

The geospatial scientific revolution resulting from the emergence of the Digital Earth is unique in the scale and variety of its fundamental and applied implications. Unlike the previous scientific revolution in physics, which occurred a century ago, it affects all aspects of the modern scientific worldview without exception—although cartography, for example, survived the revolution in physics without even noticing it. This peculiarity of the Digital Earth makes it especially necessary to discuss and critically analyse its fundamentals, to deploy its principles, and to systematically implement the Digital Earth so that it becomes a cure for crises rather than worsening them.

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Strategic Management of Peruvian Natural Gas Using Soft System Dynamics Methodology (SSDM)

Ricardo Rodríguez-Ulloa, Silvio Martínez-Vicente, and Isaac Dyner-Rezonzew

Abstract **The Purpose**—The present article shows how a soft system dynamics model was used, dynamically and interactively, as a tool for the management of strategic "soft" issues existing in the Peruvian natural gas problematic situation.

Design/Methodology/Approach—For doing it, Soft System Dynamics Methodology (SSDM) was applied. SSDM was created at the Instituto Andino de Sistemas—IAS (Peru), in the period 1992–2000, and arose as a result of the fusion of two well-known systemic methodologies: Soft Systems Methodology (SSM) developed by Prof. P.B. Checkland from Lancaster University (UK) and System Dynamics (SD) developed by Prof. Jay W. Forrester from MIT (USA).

Originality/Value—The main particularity of the approach is that it applies a phenomenological-hermeneutic and nominalist approach in contrast to the usual realist practice of System Dynamics Methodology (SDM) when system dynamics models are built. Additionally, in its later version, done in the period 2014–2015, precisely as a consequence of the present study, SSDM goes further than Soft Systems Methodology (SSM), considering, when analysing complex situations, the intervention of human and non-human stakeholders, breaking in this way, the anthropocentric approach of SSM, that only considers as stakeholders, human beings and/or human groups in its application. For considering no-human stakeholders, SSDM uses creativity techniques coming from Synectics, a creativity approach developed by G. M. Prince and W.J.J. Gordon, thus non-human stakeholders can be considered in the study, as representants of the flora, fauna or the environment (land, water, air, covid-19 virus, etc.) from whom their "weltanschauungen" must be considered as it is done with human stakeholders. The idea of considering non-human stakeholders

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came from the traditional thinking practised by ancient Peruvians who believed that the mountains, the rivers, the sun, the moon, the land ("Pachamama" in the Quechua language), were living beings, to whom human beings can "communicate" and establish a "living" relationship with them. This approach, using Synectics, has been extended to work with representants of the flora and fauna as important stakeholders to be considered in SSDM interventions as it was in the present case study, where the "pink river dolphin" was representant of the Peruvian fauna and the "caoba tree" (Mahogany tree) was the representant of the Peruvian flora. Additionally, it is important to mention that SSDM is composed of 10 stages and uses three "worlds" for collecting, in a hermeneutic manner, the soft and hard data, and for doing the analysis and synthesis of a problematic situation being studied in a specific case. These "worlds" are: (1) The Real World, (2) the Problem-Oriented World and the (3) Solving-Oriented World. Besides, it is important to mention that SSDM is oriented to implant viable changes in the eco-social systems in the real world. For doing that, it also applies, since 2011 onwards, Wilson's variant of SSM, called Issue Based and Primary Task Analysis (IB&PTA), which is used in this experience, for obtaining consensual conceptual models that can satisfy the expectations of the stakeholders (human and non-human), considering as well, in its later version, the analysis and management of diverse kind and level of power that stakeholders (human and non-human) can exert in the problem situation being studied. For all mentioned previously, SSDM can be considered a multi-methodology and a multi-paradigmatic approach to adopt a critical position concerning the issues of a particular situation being studied.

Findings—The article explains how, following the 10 stages of SSDM, including within them, Wilson's variant, it is possible to study complex situations like the Peruvian natural gas problematic situation, considering diverse hard and soft problems, as well as diverse stakeholders (human and non-human), their worldviews (weltanschauungen) and their power exerted for directing the future of the Peruvian natural gas. Thus, SSDM was used to analyse the hard and soft problems integrally and to get a systemic, dynamic, interpretive, causal and hermeneutic view of the problematic situation and from there it allowed to elaborate viable dynamic intervention policies for the mentioned problematic situation. These policies should be culturally feasible and systemically desirable for the diverse human and non-human stakeholders, with the support of critical systems thinking (CST).

Research/Practical/Social/Environment implications—SSDM can be considered as a tool for the analysis, design and strategic transformation of eco-social systems of any size. Thus, it can be used to conceive and implement complex eco-social changes with the guarantee to do them in a viable way, looking for culturally feasible and systemically desirable no-zero sum changes to implant in eco-social systems in the real world with the help of extended soft systems thinking, synectics, critical systems thinking and the support of system dynamics models to visualize past, present and future scenarios.

Research limitations—Finally the chapter mentions the implications and limitations encountered, in diverse aspects, when SSDM was used, like issues related to cultural and ethical considerations and restrictions that should be taken into account in

systemic methodologies when doing interventions in complex problems, the weltanschauungen and the management of stakeholders' power needed to be taken into account to get policies which allow to implant viable strategic changes in eco-social systems, the possibility for obtaining consensual conceptual models, using soft approaches need the use of creativity and imagination, the ethic orientation of the policies to be developed and applied is a very important issue to consider, to obtain non-zero sum strategic changes to be implanted in the real world, considering human and non-human stakeholders (clients, actors and owners).

Keywords Soft Systems Methodology (SSM) · System Dynamics (SD) · Soft System Dynamics Methodology (SSDM) · Issue Based and Primary Task Analysis (IB&PTA) · Strategic management · Natural gas · Peru · Pollution · Power · Stakeholders · Critical Systems Thinking (CST) · Synectics · Weltanschauung

1 Introduction

Energy currently constitutes one of the most crucial points in economic growth and development for societies. Any activity that human beings carry out involves the use of some kind of energy and in that sense, if someone wants to study the growth and development of a country, the cornerstone under which it is essential to start turns out to be the study of its energy infrastructure.

This has been the concern of the Supervisory Agency for Investment in Energy and Mining of Peru (Osinergmin), which convened a consultancy work oriented to develop a dynamic model to establish guidelines for action, in the long-term activities concerning Natural Gas (NG), with a horizon to 2040.

The Instituto Andino de Sistemas—IAS, from Lima—Peru, was chosen for the development of this work, and what is shown onwards is a summary of this experience.

Peruvian reality is extremely complex and its low competitiveness as a country is due to several aspects that have to do with soft variables like "government bureaucracy", "restrictive labour regulations", "corruption", "lack of infrastructure", "political instability" and "crime" (Perú cayó cuatro puestos en ránking de competitividad mundial 2015).

These soft variables are usually not considered in the majority of strategic studies, when models are developed, such as those developed and used in System Dynamics (SD).

By contrast, in the present study, the later developments of Soft System Dynamics Methodology (SSDM), done since 2011 onwards, were used to examine the Peruvian Natural Gas (NG) problematic situation, considering both quantitative (hard) and qualitative (soft) variables, as will be seen later.

2 Background

Soft System Dynamics Methodology (SSDM) (Rodriguez-Ulloa 1995, 2002; Rodriguez-Ulloa and Paucar-Caceres 2005; Rodriguez-Ulloa et al. 2011); was created at the Instituto Andino de Sistemas—IAS, in the period 1992–2000, in an action research work done through academic research as well as consultancy interventions developed at national and international level.

SSDM has 10 stages and is the outcome of the synergistic combination of two methodologies widely used in the systemic world: Soft Systems Methodology (SSM) (Checkland 1981, 1999; Checkland and Scholes 1990; Checkland and Poulter 2006; Rodriguez-Ulloa 1994; Wilson 2000), created by Prof. Peter B. Checkland, at Lancaster University (UK) and System Dynamics (SD) (Forrester 1965), (Sterman 2000), (Goodman 1988), (Morecroft 2007), created by Prof. Jay W. Forrester at the Massachusetts Institute of Technology—MIT (USA).

SSDM eclectically incorporates philosophical frameworks, steps, concepts, techniques, methods and technologies from both methodologies, but in turn, it adds as well, new stages, philosophical considerations, concepts, techniques, methods, technologies and ways of use of both, SSM and SD, as a result of this merger. Figure 1 shows an overview of SSDM.

SSDM manages three worlds for conceiving change: World 1: The real world, World 2: The problem-oriented world, World 3: The solving-oriented world.

World 1 is comprised by Stage 1: Unstructured Situation, Stage 2: Structured Situation, Stage: 5: Comparison Stage 4 versus Stage 2, Stage 6: Cultural and Feasible Changes, Stage 9: Implanting culturally feasible and systemically desirable changes. World 2 is comprised of Stages 3: Problem-oriented root definitions

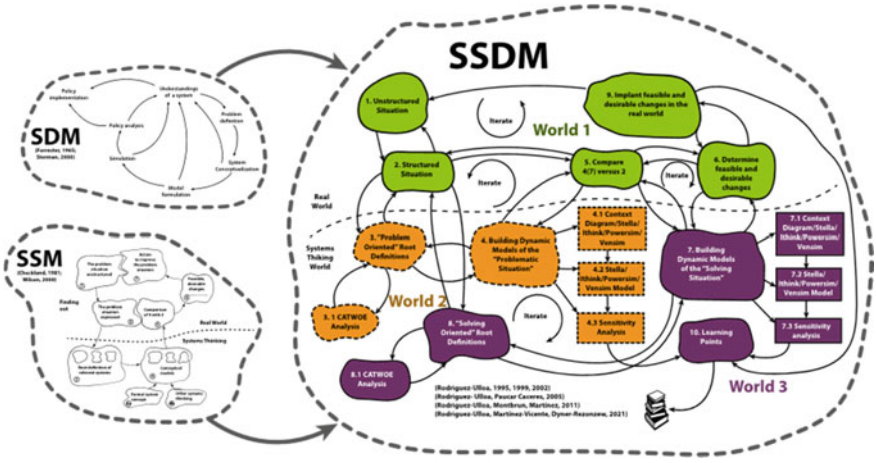

Fig. 1 Soft System Dynamics Methodology—SSDM deploy (Rodriguez Ulloa 1995, 2002; Rodriguez-Ulloa et al. 2005, 2011)

and CATWOE (Clients, Actors, Transformation, Weltanschauung, Owners and Environment, in Soft Systems Methodology (SSM) (Checkland 1981, 1999)) Analysis and Stage 4: Problem-oriented conceptual models and Problem-oriented system dynamics models. World 3 is comprised by Stage 7: Solving-oriented conceptual models and Solving-oriented system dynamics models, Stage 8: Solving-oriented root definitions and CATWOE analysis. A detailed explanation of its stages and how they were applied can be found (Rodriguez-Ulloa et al. 2011), however in this experience, done in the period 2014–2015, was the first time where SSDM was applied using the Issue-Based & Primary Task Analysis (i.e. Wilson's SSM variant) considering human and non-human stakeholders, with the support of Synectics (Gordon 1961; Prince 2012).

SSDM is a systemic framework to orchestrate and implant viable changes in eco-social systems. For proposing viable changes, it uses the Issue-Based and Primary Task Analysis (IB&PTA), an SSM's variant proposed by Prof. B. Wilson (Wilson 2000; Wilson and van Haperen 2017) to obtain a confirmed and validated primary task model (i.e. a confirmed and validated consensual conceptual model) which hopefully satisfy the aspirations and wishes of stakeholders (i.e. clients, actors and owners) existing in the problematic situation being studied. Besides, in its late developments, since 2015, SSDM began to consider stakeholders beyond human ones, breaking the anthropocentric approach of SSM and, thus, considering non-human stakeholders, as well, in the analysis. Thus, representants of the flora and fauna were considered as important stakeholders to be taken into account in the present case study, then the *pink river dolphin* (in extinction) was selected as representant of the Peruvian fauna and the *caoba tree* (*mahogany tree*) (in extinction) was selected as the representant of the Peruvian flora.

Figure 2 shows an overall view of the IB&PTA (Wilson 2000, Rodriguez-Ulloa et al. 2011; Wilson et al. 2017), used for obtaining a consensual conceptual model considering diverse human and non-human stakeholders in this case study.

For considering non-human stakeholders, SSDM applies ancient Peruvian thinking, seeing pieces of the environment (i.e. land ("Pachamama" in the Quechua language), rivers, mountains, air, flora, fauna, stones, etc.) as "living beings" (Zaffaroni 2011), with whom it is possible to interact, communicate and do things together. SSDM considers this kind of stakeholders to have a degree and type of power which influences how the events can develop in a specific problematic situation. Synectics (Gordon 1961; Prince 2012) was considered as the suitable approach to get into the inner side of the non-human stakeholders and metaphors like to "see the strange as familiar" or "see the familiar as strange" were applied to build root definitions and conceptual models of non-human stakeholders in a creative and interpretive way.

An interesting issue to mention is the bridge established in SSDM between a Conceptual Model (CM) used in SSM and the Context Diagram (CD) used in System Dynamics Methodology (SDM), where each Human Activity System (HAS) that conforms to the Conceptual Model (CM) is considered as a Module of the Context Diagram (CD) used in SDM, considering the logical interconnections existing in the CM as the basis to consider the flux of information, materials or energy when Modules are interconnected in the CD used in SDM. Later, developing each Module

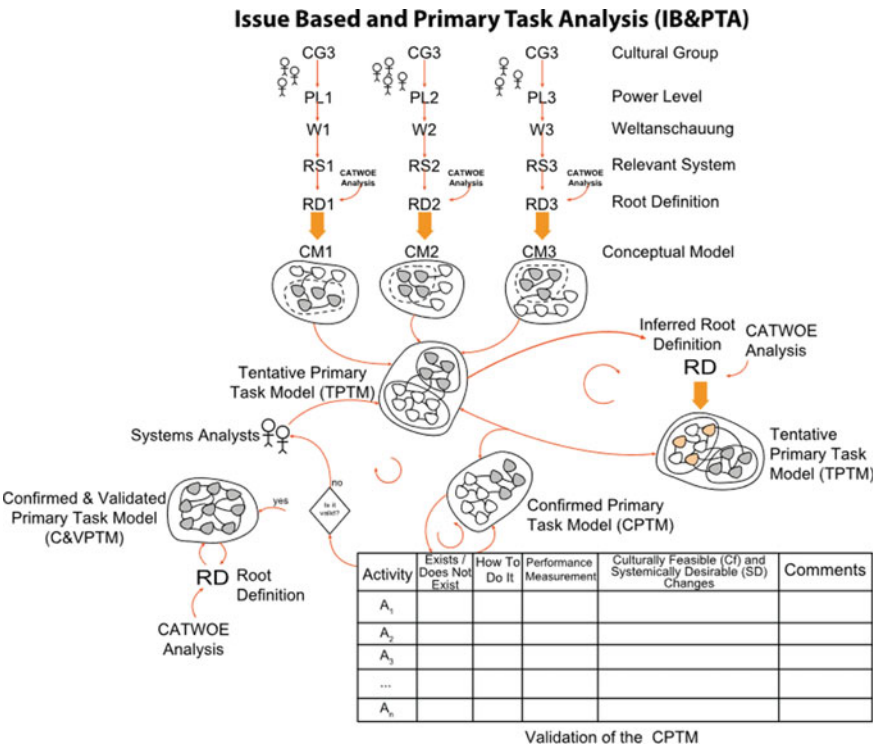

Fig. 2 Deployment of Issue Based and Primary Task Analysis—IB&PTA (After Wilson 2000)

can be obtained the Causal Loop Diagrams (CLDs) that can be converted into Stock and Flow Diagrams (S&FD) to be used in system dynamics modelling to simulate the overall model behaviour along time.

In brief, it can be said that SSDM is a methodology to do analysis, design and viable transformation of eco-social systems of any size, because it considers the aspirations and desires of stakeholders (human and non-human) in a creative and culturally feasible way, taking into consideration, as well, the required resources in a systemically desirable manner, thus, guaranteeing a viable change in a specific problem situation.

3 Application of the SSDM in the Natural Gas (NG) Problematic Situation in Peru

To achieve this purpose, SSDM considers the vision, interests, type and level of power and purposes of stakeholders of this problematic situation, and succeeded in

identifying 57 of them. Afterwards, following the internal processes of this methodology, a consensual conceptual model on the problematic issues about NG as well as the policies to be implemented on it, are obtained.

Both the problematic situation as well as the policy interventions on NG are modelled using SD, obtaining the analysis of several scenarios, for the period 2000–2040, to find solutions (i.e. policies) that have significant impacts on NG's strategic management, but at the same time to be systemically desirable and culturally feasible to implement for stakeholders (human and non-human) concerned with this problematic situation.

The model seeks to build an energy structure for Peru, based on the NG, which can become the energy base platform for future economic growth and social and political development for Peruvian society.

3.1 Application of SSDM

The 10 stages of SSDM were applied in the present case and 57 stakeholders were detected. From them, 2 stakeholders were non-human: the *caoba tree (mahogany tree)* (representing the Peruvian flora) and the *pink river dolphin* (representing the Peruvian fauna).

Following the stages to apply the IB&PTA (Wilson 2000), around 15 stakeholders were selected from the total, classifying them from those with less radical weltanschauungen to those stakeholders with more radical weltanschauungen, to cover the range of worldviews existing among stakeholders. Then root definitions and conceptual models were derived for stakeholders, as well as the kind and level of power for each of them were analysed and considered. In the end, a Confirmed and Validated Primary Task Model (C&VPTM) was obtained. From the C&VPTM a Context Diagram (CD) is derived where each activity of the C&VPTM is converted into a Module of the CD and correspondence among the logical links in the C&VPTM with the fluxes of energy, information and materials that arise in the Modules of the CD should be considered. Having the Modules of the CD, then it is possible to obtain causal loop diagrams for each of the modules contained in the CD, following the epistemological descriptions of each module, because they come from the C&VPTM.

Figure 3 shows how the CLD is derived from de Modules of the CD obtained from the C&VPTM, how the S&FDs are derived from CLDs, how then the problematic situation is simulated and also how the solving policies are simulated to obtain culturally feasible and systemically feasible policies to implant, obtaining at the end, a situational learning environment for strategic management of Peruvian NG.

The resulting model was highly complex, but it represented adequately the complexity existing in the NG management, within the context of the Peruvian reality. Figures 4 and 5 show simulated scenarios about the future of the Peruvian NG.

Four scenarios were considered: Scenario 1: Dry NG use widespread + exportation (Nafta, Diesel), Scenario 2: Dry NG use widespread + exports (Nafta, Diesel) + electric power generating plants based on NG + replacement of traditional energy

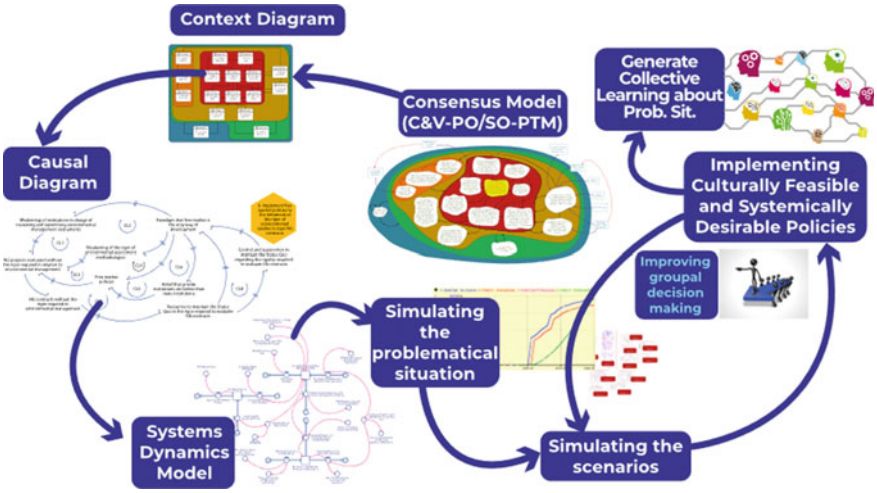

Fig. 3 The Context Diagram (CD) is derived from the C&VPTM; the CLD is derived from the CD; de S&FD is obtained from the CLD. Simulated scenarios are obtained from the S&FD to implant viable policies and create a situational learning environment

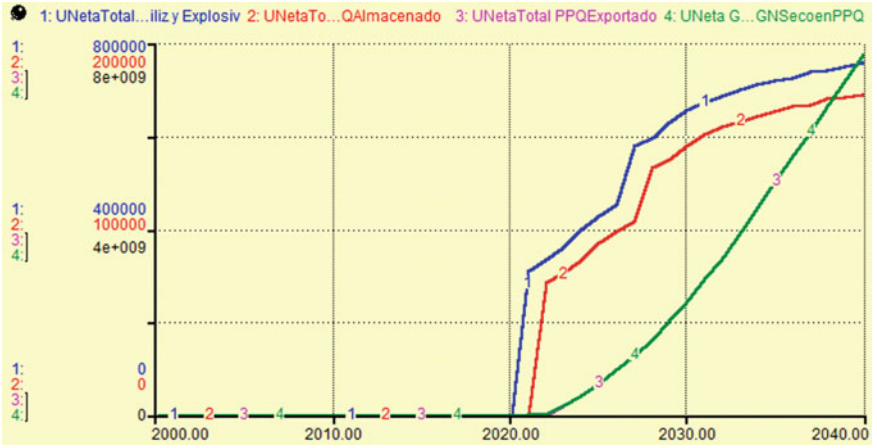

Fig. 4 Liquefaction, storage and exports of NG (TCF) to 2040

sources, Scenario 3: Dry NG user widespread + exports (Nafta, Diesel) + electric power generating plants based on NG + replacement of traditional sources + petrochemical industry based on NG + use of renewable energy sources, and Scenario 4: Dry NG user widespread + exports (Nafta, diesel) + electric power generating plants based on NG + replacement of traditional energy sources + petrochemical industry based of NG + use of renewable energy sources + use of energy sources based on NG for developing the National Plan for Industrial Diversification (NPID)

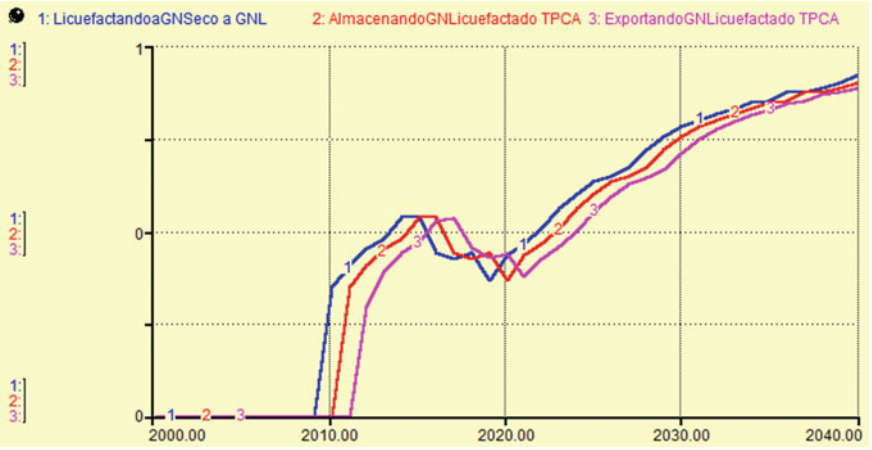

Fig. 5 Dynamic (flow) behaviour from dry NG to LNG, from LNG to LNGstoring, from LNGstoring to LGN exporting, period 2000–2040 (TCF/year)

proposed by the Peruvian Production Ministry. From these scenarios, the first two scenarios were simulated on this occasion. The three and four scenarios should be developed and simulated in the future.

Figures 6 and 7 show projections of diverse variables examined considering the mentioned scenarios.

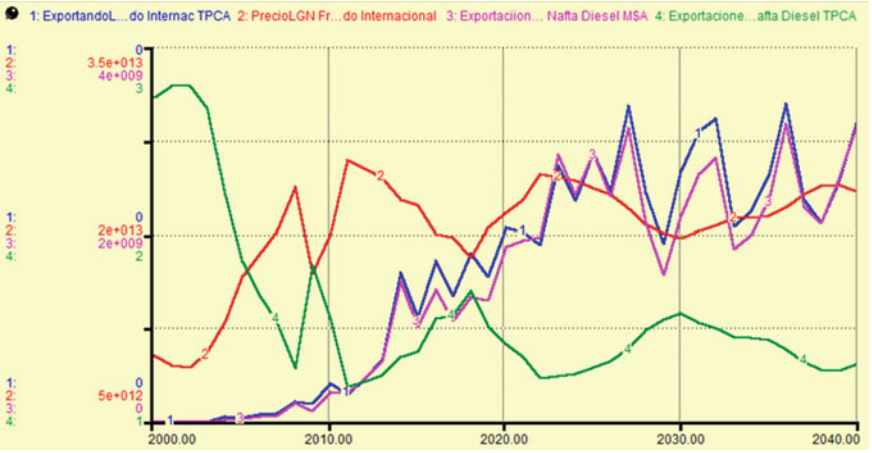

Fig. 6 Flow of exporting fractionated LNG (TCF/year) (1), price of fractionated LNG (Thousands of US$/TCF) (2), export of Nafta and Diesel (Thousands of US$/year) (3), exports of Nafta and Diesel (TCF/year) (4), period 2000–2040

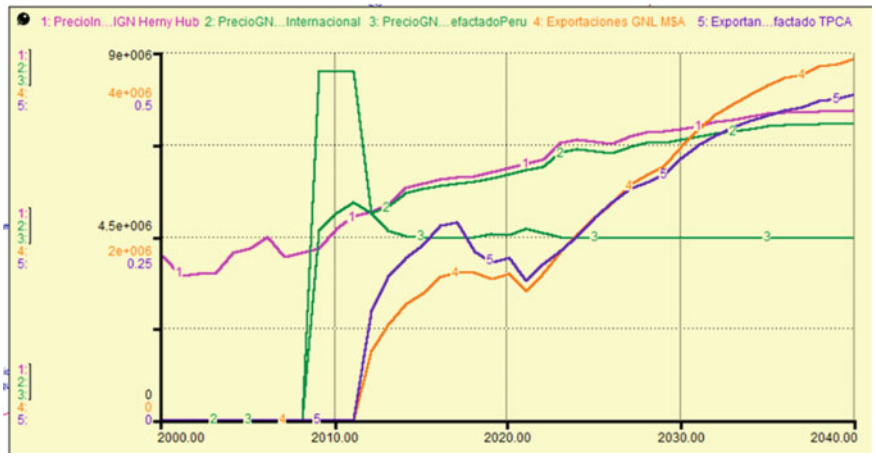

Fig. 7 International Henry & Hub prices (1), prices generated by the SD model (2), exports of LNG (in Thousands of US$/year) (3) and exports of LNG (in TCF/year) (4), period 2000–2040

4 Conclusions

The application of SSDM in the study of NG issues in Peruvian reality has allowed recognizing various aspects of the NG sector and their interrelationship of qualitative and qualitative variables, in this complex system.

It has also enabled the implementation of a SD model based on a Problem-Oriented Confirmed and Validated Primary Task Model (POCaVPTM). This has led to a different SD model that could be obtained using traditional SD Methodology.

The Scenarios simulated and analysed were so useful for Policy design because they allowed us to view the future probable behaviour of the supply and demand of energy for Peru to 2040. The model outcomes are and will be very helpful for the decision-making process and for learning about the NG strategic management to those institutions using this tool, particularly to Osinergmin, Ministry of Energy and Mines, National Water Authority and COES among other Peruvian State institutions.

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Finally, our gratitude to Osinergmin and its authorities and executives for enabling us to use SSDM in a high and very complex situation such as the one encountered in the NG sector as well as to the research and administrative teams at Instituto Andino de Sistemas—IAS, for their support in the project development.

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Vertical Development of the Systems Approach and Cybernetics: Issues and Opportunities

Andrey Teslinov

Abstract **The purpose**—Currently, the development of a systems approach has acquired a "horizontal" direction, in which only the forms of application of already established fundamental ideas are increasing. Such ideas include the idea of dynamic systems, the idea of purposeful behaviour, the idea of open systems; the idea of purposeful behaviour, the idea of self-organization, the idea of autopoiesis, and some others. The purpose of the report is to return the "vertical" direction of development to the systems approach.

Approach—The results of the research are based on an analysis of the reasons for restraining the "vertical" development of a systems approach and the search for opportunities for the next rise in systemic thought. This search is based on the ideas of systems theory as the theory of system classes and the methodology of conceptualization of subject areas.

Conclusions—A systems approach can be developed in the following areas:

1. The study of systems capable of providing homeostasis by managing contradictions. Such a branch of cybernetics was initiated in the WOSC space.
2. Resuscitation of a systems approach based on the ideas of classes of increasingly complex systems. At present, the simplest classes of systems (compositions; networks; distributions, etc.) and simple classes (processes; flows) are most fully investigated. Less studied are the classes of medium complexity (focused; growing; organizing). Extremely poorly researched are higher classes of complexity—developing systems.
3. Development of instruments of tectological research of reality. These are instruments of thinking that could allow through the phenomena of reality to penetrate into its mechanisms, into tectonics (Greek tektos—dispensation), to the reasons for its essential properties.

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4. The appeal of system research to the most complex objects of reality, which include objects of the "second nature". Currently, this reality is being investigated by representatives of the humanities who are not armed with system instruments adequate to complexity.

Originality—Instrumental use of concepts for restoration of invariants of the studied works in the field of systems and cybernetics can claim originality.

Results—The conclusions of the report can be useful for orienting WOSC not to expand the scope of application of understandable, already systemically clear ideas of a systems approach, but to aimed, concentrated research of the most complex classes of systems. This may reorient researchers towards accelerated mastery of the Unknown.

Limitations—Conclusions relate to the development of the theoretical resource of a systems approach.

Keywords Theory of systems · Classes of systems · Vertical and horizontal development · Tectology · Concept

1 Analysing the Development of the Systems Movement

Proceeding from the purpose of this chapter, the state of development of the systems movement should be analysed separately from its successful achievements, while focusing on the analysis of its transformational transitions. For this purpose, it is suggested to isolate those events, which could clearly demonstrate the changing invariants of approaches to comprehending the systems and using them to effectively clarify a complicating reality.

Throughout the entire multi-century history, ideas about the effects of diverse components, that were united within a single observed reality, and the essence of their combined action were taking shape. This period can be described as a pre-system establishment of the systems approach. This process resulted in forming comprehensions about specific features of a mechanism supporting dynamic equilibrium of interacting components during their adaptation to a changing environment. This refers to the emergence of Bogdanov's Tectology (Bogdanov 1922), which initiated studies of organisational relations between the elements of systems that function in an active environment.

Thereafter, a "mechanistic" view on systems gained traction. Channelled into scientific thought, it brought about results, which had a progressive impact on the systems movement. The most significant results are as follows:

1. Establishment of systems engineering as design engineering of human–computer systems. This process was accompanied by such system disciplines as studies of operations, engineering psychology and others (Good and Machol 1957).
2. Comprehension of the specifics of goal-directed behaviour (Sommerhoff 1950) and, later, the structures of goal-directed systems.

3. Establishment of cybernetics as a science about general regularities of management processes and transfer of information within different objects (Wiener 1948).
4. Emergence of ideas of a common systems theory as a science dealing with the whole separated from its actual nature. This idea boosted studies of formal relations between components of different objects and the nature of their changes influenced by external conditions (Mesarovic and Takahara 1975).

The above-mentioned circumstance gave an explosive nature to the development of systemic thinking when it separated systems from objects, which were expressed through them.

Shaping of the concept of open systems that were capable of self-complication (von Bertalanffy 1962) became a significant event of that period. Addressing the regularities of existence of such systems broke the boundaries of a mechanistic approach applied to them, challenging the methods of systemic comprehension of the reality.

This revolutionary transition to a new quality in the systemic thinking paved the way for an intensive generation of forms of systems views, in which ground-breaking scientific events have been taking place. The concept of purposeful systems (Ackoff and Emery 1972), the idea of self-organisation (Saridis 1977), the idea of the general systems theory as a theory of systems classes, the idea of identity of systems and concepts and some others are among them. That said, the dynamic analysis of the systems approach to comprehending the reality, as of early 1990s, shows no new ground-breaking effect.

The reasons for this phenomenon are discussed below—with suggested directions for the systems movement.

2 "Vertical" Development of Systems: Essence and Subject-Matter

A fundamental differentiation between the vertical and horizontal directions in the development of holisms was most meaningfully described in culturology and scientific disciplines forming it.

Initially—and for a long period of time—the concept of "evolution" (Lat. evolutio "deployment"), which was first created and applied to living organisms, was fully identified with the concept of "development". The two effects, i.e., the effect of involution as a loss of certain organs and functions by an organism and the effect of revolution as a jump-like transformation of an organism, were erroneously opposed

in this identity. Development of comprehensions about the mechanisms of transition—from transformational phenomena to mastering them by living entities—contributed to refining the discussed concepts. This was necessary to explain the dynamic behaviour of culturological processes (Pelipenko 2014) and studies of innovation processes (Schumpeter 1911/2007) in the first place. On the basis of studies in these subject areas, several statements can be formulated, which apply to the subject matter being discussed within the context of systems movement.

1. Systems develop in two alternating modes, i.e., evolutionary and involutory.
2. The evolution of a system is a process of a changing system quality as a tool to comprehend a complicating reality. This development mode running concurrently with changing systems invariant, i.e., a transition to new structures, is capable of expressing new meanings of developing objects, represented by such structures. This is a movement towards ideal, or "refined". In studies of culturological holisms, this direction of development is figuratively referred to as "vertical".
3. The involution of systems is a process of their adaptation to different conditions of applying objects reduced by such systems. This development mode is aimed at the realisation of ideas (Lat. *involutio* "convolution"), at their adaptation to different application conditions and at their transformation, while preserving the original invariant. This direction of development is figuratively referred to as "horizontal".
4. The horizontal of development is an effect of filling scientific-search niches, which were disclosed by research, to produce a diversity of systems having a single structural archetype.
5. The vertical of development is a change of the evolutionary front in systems studies, opening of new possibilities of the system approach and, therefore, opening of a new space for the horizontal. New niches open up thereby, and the horizontal gets broken and pushed up to a new level of existence, the development front of the systems movement is re-oriented.
6. The laws of systems generation in each mode are identical, including activity, contradictions, boundedness of properties, rhythm, etc. (Teslinov 1998). Contradictions form a direction of changes in system views and methods of the system approach.

These views result in a system-movement development diagram shaped as a dialectic involute of systems ideas passing between two limits of changes of the evolutionary and involutory types (Fig. 1).

As anywhere else in the course of development, the change of directions in the development front comes from an exhausted transformational resource of ideas. In this sense the vertical is a complicated and dangerous mode in the development of any values since it can bring them into a lifeless space. That said, the true renewal (in-novation) of values occurs only with the vertical. All other innovations are just improvements in the ongoing life.

Qualitative leaps in values should be considered revolutionary (Lat. revolutio is "upheaval", "transformation"), radical and associated with an apparent breakage

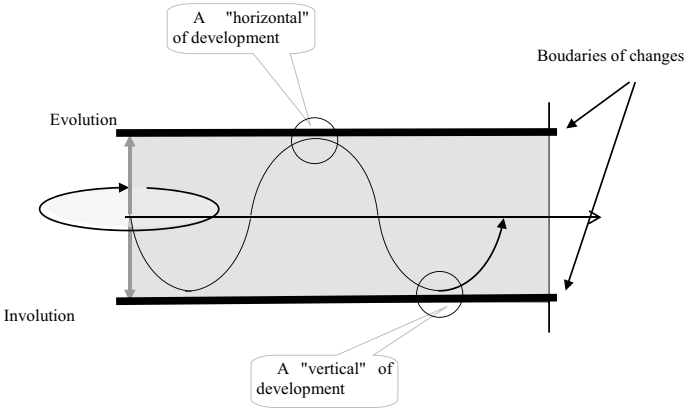

Fig. 1 Diagram of the systems-movement behaviour pattern

from a previous state of transition within this semantic field. In this manner, the leaps release critical contradictions in the existence of values. After each upheaval, a "play" of evolutionary-involutory transitions is resumed in them, but it acquires a more viable corridor of poles.

An analysis of publications of the recent 30 years leads to the understanding that currently the dominating directions in the systems movement is exploitation and improvement—not development—of ideas, which some time ago brought the systems movement into the vertical development plane. Figure 2 shows an approximate pattern of the in-depth theoretical elaboration of different systems classes within the common flow of systemic thinking development. It was formed based on a comparison of publications in the areas of research of a complicating systems series.

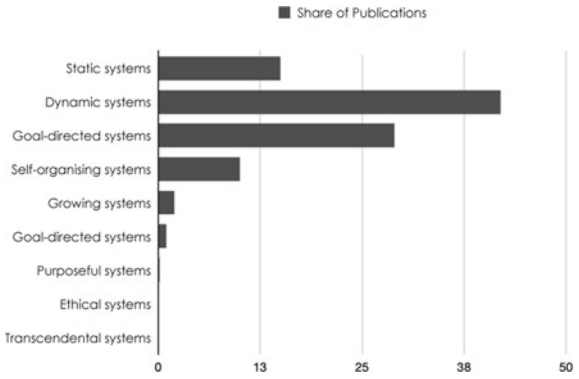

Fig. 2 Approximate in-depth elaboration of ideas about the systems classes within the common flow of the system thought development

For this purpose, the list of publications in the scientific electronic library https://www.elibrary.ru/ was studied under the heading "Cybernetics" (journals of 1907). The total number of publications on topics reflecting research on the main classes of systems is taken as 100%.

The presented scale was constructed on the basis of a bright idea about the logic of the common systems theory as a complexity hierarchy of the organisation of those objects, which are expressed by them (Boulding 1956). The analysis shows that up to now the simplest systems classes (compositions, networks, distributions etc.), as well as simple classes (processes, flows) are best investigated. Average complexity classes are less investigated (purposeful, growing, self-organising systems). Highest systems classes, i.e., developing systems, are least investigated.

The reasons of a slowed down rate in the vertical development of the systems movement could be:

1. A real drift of researchers' interests to applied works, which guarantee fast victories in an accelerated capital expansion. Such simplifications are offered by horizontals. Verticals are able to create only those communities that provide real support for fundamental research.
2. Expansion of humanitarian, first of all, psychological sciences, into the systems movement. A specific feature of this expansion consists in that these sciences mainly interpret the systems design process and develop hermeneutics of systemic thinking, using the simplest achievement of systemic thought for the purpose and without enriching it with new ideas.
3. Predictable depletion of the productivity potential in the systems approach based on a voluntary abstraction containing the whole when operating elements and relations. This refers to such predictable development of culture as operationalisation (profanisation) of initial sacral values of the reality; enhanced significance of the values of the imaginable or thought-up in a loss of the relation of the imaginable (transcendental) with the actually experienced; a loss of syncreticism of the imaginable. Attempts are noticeable everywhere to comprehend the Great Unknown using the known.
4. Shading the systemic movement by the intensive development of information technologies as parallel branches of knowledge development, fuelling a variety of practices. Digitalization does not so much increase the power of systems thinking as it provides it with tools, and in some cases competes with it.

It remains to add the following circumstance to these reasons: the horizontal offers a powerful resistance to the vertical. The supporters of successful ideas of the horizontal development attempt expectedly to block any changes that interfere with the smooth flow of applied practices. For them, the vertical looks as pathology and, therefore, thrusts aside the "honours students" of involution. All hardships of the innovation process are present at this very cultural development point.

This, and probably some other reasons, contain the expansion of vertical development capabilities in the systems approach and cybernetics.

3 Possibilities to Push up Systemic Thinking

1. Within the context of cybernetics development, or rather in the context of creating viable and extra-viable purposeful systems, these possibilities are a part of research of structures and systems properties, which are capable of securing homeostasis through controlling the internal contradictions. The branch was initiated in cybernetics within the WOSC space in late 1990s, and its reserved form was supported in studies of the Institute of Management Issues, Russian Academy of Sciences (Novoseltsev 1989; Tsyganov 2010).
2. A vertical increase in the systems approach and cybernetics is possible during a creative reanimation of the idea of complicating systems classes. It applies primarily to developing and more complex systems. The state of theoretical substantiation of the development mechanism does not allow to see any continuation of growing complexity levels of the systems reflecting it. Many systemic ideas of developing processes do not overcome the threshold of "genetic algorithms" in a majority of studies, neither do they lead us to the uttermost abstract level of the self-development mechanism structure.
3. Development of tectological tools to study the reality could be a methodological solution of the problem discussed. This refers to instruments of thinking, which could be capable of penetrating into the mechanics and tectonics (Greek *tektos* "structure") using its phenomena (properties, behaviour, etc.), and for that matter into the reasons of its essential properties. In this sense, it is worth continuing the thought of von Bertalanffy on that "a description of a system using differential equations is too limited for theory…" (von Bertalanffy 1962, p. 16), which aspires to explain the tectonics of the complicating reality and, alone, to research into its functions.

It was philosophy, which was primordially seeking such tools (Husserl 1911). However, a theoretical depletion of complex objects needs by far more potent differentiations as compared to those produced using traditional methods of philosophy.

Attempts to create such tools were made by mathematicians on the basis of the theory of sets. Having created an apparatus of the species of structures, which was defined by Bourbaki as mathematics, this team created a possibility to generate new formal means to distinguish between the depths of obscure reality. These tools were first used and developed within the conceptual scientific and technical direction, where now the methods of formalised design and evolvent of notions, generated as systems, are used. However, operating the system holisms, which simultaneously comprise hundreds and thousands of concepts, needs using a more potent apparatus, which would compress but preserve the tectological system pattern within transformations. There is a substantiated assumption that the theory of set steps opens up possibilities for this purpose (Nikanorov 2013), as the theory is equipped with the rules of conceptual thinking (Teslinov 2009).

4. Presumably, the vertical development of the systems approach and cybernetics is possible during evolvent of the research front for such reality objects, which

cannot be studied by physical methods and, at the same time, play a crucial role for the existence of creation. Such objects include heterogeneous cultures, Culture in the wide sense, and their phenomena. This reality has been currently studied by humanitarian scientists, not equipped with such tools, which could be comparable to the complexity of problems raised by them. The area of artificial intellect presents a serious challenge to the explosive-type development of this research. Intruding into culturology, it brings issues, which produce an unprecedented tension to systemic thinking. This movement could be assisted by a comprehensive and large-scale research program initiated by WOSC.

4 Conclusions

The study was carried out with the aim to give the systems approach and cybernetics a long-expected vertical development direction. Its conclusions apply to developing the theoretical resources of the systems approach. The systems approach can acquire the vertical nature in its development along the following directions:

1. Research of systems that are capable of securing homeostasis through controlling the contradictions.
2. Revival of the systems approach based on the idea of complicating systems classes.
3. Development of tools for tectological research of the reality.
4. Reorientation of systemic studies towards the most complex objects of the reality, including objects of the "second nature".

The author's uncovering opinion may claim to be original regarding the problems in the systems approach development and substantiation of its development directions.

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Part II
The Cybernetics of Society, Ecology and Governance

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From the perspective of current social crises, such as COVID-19, climate change, multinational conflicts and in general sustainable development, this theme wants to explore the interdependence of global and local policy making. The reach of national policies today may be distorted by a poor understanding and perhaps most significantly by a poor capacity to implement autonomy. While autonomy may be desirable when nations overreach their autonomy and make dysfunctional their relations with more global institutions, such as the United Nations Environmental Programme, the Organisation for Economic Cooperation and Development, the World Health Organisation and others, the policy outcomes for the world as a whole can be disastrous. Nations are behaving beyond their capabilities with unrestricted independence, thus making their contribution and collaboration to global policies dysfunctional and costly to humanity. This theme relates to the governance of pressing social and environmental issues in the age of the Anthropocene, experiencing institutional failures. Powerful insights are provided by the behaviour of independent nations failing to recognise the globality of the policy situations they are part of, which demands that they behave as autonomous parts of larger organisations. This dilemma, by increasing the relevance of national decisions at the expense of a world in need of global decisions, makes responses to different forms of global crises extremely difficult. In this theme, we want to open conversations around policy issues in their local and global aspects, with an emphasis on ecosystems and organisational structures.

Therefore, this theme aims at exploring cybernetics in several aspects of society, including its contributions to the development of healthy global ecologies, the strengthening of participatory democracies, decentralisation of control and effective governance of communities, institutions and nations. What can cybernetics and systems thinking contribute to debates about a network democracy and to the emergence of distributed collective intelligence? What can local, regional and international bodies of knowledge say about strategic control and development

centres to initiate and support the consolidation of the state, business and societal institutions?

Current democratic models are often dysfunctional, with nations and enterprises operating in situations overwhelmed by big data, weakly supported by artificial intelligence, battling with an increasing variety of cloud computing suppliers and dealing with algorithms built upon a top-down direction, which, as implied by the global–local dilemma, built their relationships upon poor multilevel interactions. This makes it increasingly difficult to bridge the decisions of small, large and global nations, enterprises and institutions to provide constructive feedback loops among them. It is necessary to build up interactions between citizens, experts and policy-makers to avoid people's actions damaging the future of society.

In democratic societies, we often relate decisions and policies as outcomes of direct, representative and participative forms of democracy, which need further development to be effective. This theme wants to offer discussions of the significant distinction between the 'wisdom of the commons' emerging from the citizens' agency as they interact with policy-makers, supported by experts, think tanks and political parties, and also, as far as possible by an ever-stronger media. This distinction between people and policy-makers touches key aspects of communications in a complex world, dominated by big data, which in practice implies data overload for both of them. How do we increase societal capacity to identify, understand and react to the dynamics of their environments? For citizens of a country, big data may conflate their very local experiences with aspects such as the economy, migration, health services, environment and so forth, with the requirements and demands of global policies. Politicians, overwhelmed by data—in an uncertain world—may construct and impose their ego influenced truths, propelled by their unilateral ideology.

In WOSC 2021, we invited reflections on how to reduce the gap between sound evidence and wild emotional constructions, through effective 'hybrid organisations' and necessary innovation. What is the responsibility of all stakeholders to create regulatory procedures to contextualise what we read and hear in the media and social networks? We have invited reflections about the authenticity, legitimacy and truthfulness of the arguments advanced by those forming public opinion. It may be argued that the complexity of societal processes makes it impossible to deal with these challenges. However, it can be argued that complexity management tools such as organisational models, artificial intelligence, real-time decisions, situation centres, operation rooms and shared media, displayed in the digital society, need the support of systems thinking and cybernetics to improve the quality of decisions. These tools carry some risks but also have the potential to increase the opportunities for more effective participation in policy and decision-making processes. Necessary learning is how to keep open checks and balances between multiple viewpoints to bridge gaps between emotional and empirical truths. The challenge is how to construct dialogues enmeshed in multiple moral mazes. WOSC 2021 has invited participants to contribute to the creation, regulation and implementation of more transparent societies.

Semiosis of Politics

Anastasia Golofast and Larisa Kiyashchenko

Abstract **The purpose**—Morphogenetics of political action presupposes transdisciplinary immersion in the experience of solving complex problems, that constantly intrude into the stable sign systems of political subjects and their order parameters, thereby changing precursors to intentional activity. The layering of political orders of sign systems, facilitating the emergence of mutually intersecting, complementary, competing or accommodating modes of political complexity embodiment, creates a pulsating problem field that requires analytical isolation and subsequent synthesis of real political experience constellations using semiotic tools of cognition.

Design/Methodology/Approach—Semiotics occupies a supra-disciplinary position in the system of sciences, having no clear-cut boundaries—its place in the research space is isomorphic to the research object of the political science: it is always "between", always "at junction". Conceptualization of political complexity requires a switch from dichotomies to the triangulation of logos, pathos and ethos with a space for the creativity of political imagination, which replaces abstract ideas of the common good with the future vision as a well-founded integral synthesis. Transdisciplinary experience of philosophizing accumulates and condenses the results of disciplinary thought in communication here and now, which stretches the life-giving thread of community over the abyss of hermetic disciplinary discourses, which is relevant to solving complex issues in gradation from the individual to the supranational level.

Findings—Political action combines both expression and preliminary premise of political complexity, inviting the researcher to plunge into an expanding universe of experience, framed by moving frontiers of space and time, within which the division between theory and practice is being emergently abolished. Semiotics of the sensual in politics refers to the vitality of matter, through which the self-organizing chaos of the world of things brings order to the living space of political subjectivity in the affective act. The affective action mode combines authenticity with the scaling of political action, creating space for phase transition from stability to change. Political action is a meeting point of contingency and determination, intentionality and

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blindness, the fruit of the tension of overcoming and the game of dichotomies of adaptability and pre-adaptability, tradition and innovation. The arteries of reciprocal interaction between the environments of political order formation branch out in a multiplicity of effects of political action, where the target reason for the distribution of powers becomes the dominant configurator, which can take both a latent form and performative forms of events that translate language into speech.

Originality/Value—Disclosing specific attributive characteristics of political action requires accentuation of the procedural nature of political morphogenesis, which unfolds in the exchange between discrete political subjects. The procreative interval of politics is fractally reproduced in the space between determinism and randomness, creating a request to abandon the paradigm of "taken for granted" in understanding, conceptualizing and explaining the nature of politics.

Research/Practical/Social/Environment implications—Language fulfils the functions of transfer, fixation and distribution of the sign systems that underlie the political form by selecting morphogenetic meanings of political action. Political morphogenesis is triggered, provided and overturned by recursive repetition in the language, built according to the logic of positive and negative feedback. Centre-peripheral polarities between interpretations of concepts in political science are smoothed out when using the emerging transdisciplinary language of semiotics, which freely operates in the space of new challenges for political science. Research limitations—The canvas of text, articulating and reinforcing, restraining and invoking, transforms information into frames containing reference points for political action with hotbeds of the flame of new meanings in the intervals of the accelerating pulse of digital life mode. Normo-genesis embedded in morphogenesis as a "core practice" includes the reproduction of "norm" statements often out of touch with the ideal and every time through a concrete solution to the issue of inclusiveness/exclusivity and the included Third, where what is verbalized is actualized, what is drowned in silence is deprived of the right to exist, and what is between them creatively sprouts with new life in the aesthetics of politics.

Keywords Complexity · Political action · Political morphogenesis · Reciprocity · Semiosis

1 Introduction

Before revealing the attributive characteristics of modern political action—digitalization and semiosis—let us outline the contour of human political activity paying attention to the multiple nature of problematization, which constitutes the essence of political action as an important, but not the only component of human activity in general. The latter predetermines a transdisciplinary problem complex, requiring a

methodological synthesis for making decisions regarding the distribution and redistribution of power relations through management and control. Emphasizing the procedural nature of political action, one can stress that it unfolds in communicative interactions between the bearers of the political in society. The next step in the deconstruction of political activity involves recognizing its systemic character that unfolds between the endogenous and exogenous constituting environments. The reciprocal interaction of the latter determines the multiplicity of possibilities for political action, such as its adaptive development, and the prerequisites for a revolutionary rupture of the existing procedures by the formation of a new political domain embodied in the activities and actions of political subjects.

The traditional dominant configurator of political action is called the target reason of the situational distribution of power relations, which, following the irrevocable public nature of politics, can have both a latent character, partially captured by "recording devices" (Latour and Woolgar 1987), or can take performative forms in actions that construct events of social life, thereby translating language into speech and semiotics into semiosis. With regard to political action, semiosis is understood as a process that complements semiotics, it is a state of formation and transformation of existing political forms. Semiosis can be represented as a model of end-to-end action of an included third type—an interpreter between complementary dichotomies in human activity, between a sign and an object.

The semiosis of a digit presupposes that the digit performs a sign function, fixing a conventionally established code. What is the difference between the traditional understanding of the sign, in comparison with digitalization, which carries its own language and its own alphabet (code)? The language a priori cannot come up with anything new from the point of view of its grammar. The novelty arises from the correlation of the self-evident archaic of the pre-established understanding with what resists the previously established, demanding the presence of new expression and solution forms.

The figure has become a mediator between man and the world, due to the spatio-temporal compression of perception, not leaving enough time for deep understanding and reflection with regard to change. In connection with the ongoing transformations in cognition and that of the surrounding world, the question of expressing in words the same phenomena, which are uniquely described by different disciplines, arises, establishing the need for agreements between disciplines, the creation of a common thesaurus. Research of protostructures and prerequisites of political action becomes significant in different disciplines and in the interdisciplinary space, reaching the level of transdisciplinary generalization.

The digit assimilates linguistic and speech ambiguity and starts offering its regulatory frameworks. Due to its pervasiveness across disciplinary boundaries, the digit facilitates and intensifies the processes that exist in society as an environment of increased underdetermination. The accumulation of unresolved problems in management domains, due to digitalization, occurs faster, which leads to the need of restructuring the governance architecture. The digit should not be a rigid, dominant factor, redefining everything that happens, and not capable of change. The controlling authority in the suspended uncertainty situation of digitalization can be imputed

to such an integrating power as the semiosis of modern political action, in which a new rhetoric, a meta-position of the digitalization process, can be noticed.

2 Background

Political semiotics concretizes systems theory, offering a resource for the sign interpretation of the continuity of semiosis and the discreteness of the political sign. System analysis of the generation and evolution of a sign represents a sign as a derivative of system elements, the connections between them and the environment in which the system operates. The sign integrates the political system when a consensus regarding its semantic content is established between the sender and the recipient of a message in the system. The observer is responsible for fixing the consensus. Political semiotics is one of the research strategies that introduces the second order observer, thus making a step towards cybersemiotics.

Evolution of the semiotic foundations of political action is associated with progressive complication of sign systems and the methods of their transmission in the community (which, according to N. Luhmann, is the main function of power). Combining N. Luhmann's approach with phenomenological and hermeneutic aspects of Charles Peirce's theory, Søren Brier develops access to the transdisciplinary optics of the philosophy of science (Brier 2021). Boundary nature of transdisciplinary optics is a condition preceding experience as the accumulated knowledge, which is redefined depending on concrete circumstances of carrying out experience. As a result of such interaction paradoxical formation of practical activities in «a priori—a posteriori» (abductive) forms combines variety of general definitions disciplinary and valid by agreement of daily, practical knowledge. Philosophy of transdisciplinarity is characterized among other features, by incomplete, procedural nature of «open integrity» and transdisciplinary agent's style of philosophizing developed in three main transpositions (observer, participant, and witness) (Kiyashchenko 2015). Transdisciplinarity provides a general ethos for a mode of interaction leading to cybersemiotics. The mixed reality of cybersemiotics is made up of precise calculus of cybernetics in a strong connection with the sign matrix of semiotics.

Cybernetics and semiotics are distinguished by their complementarity, forming a zone of intersection and exchange of meanings, called cybersemiotics, which has the potential of methodological synthesis, directly relating it to synergetics (Golofast 2020). The meaning of the unification lies in the use of the strict language of cybernetic information calculus in combination with phenomenology and hermeneutics of semiotics. This is found in the essential content of the sign, which varies in degree of intensity, determining the sign's power over a person and a community. The symbolic system in politics is a roadmap for the applied orientation of the human activity component in the system of rewards and punishments. Cybernetics in political science is represented in the categorical matrix of a black box equipped with a feedback system: the subject does not know what is happening inside the black box that processes the decision request from the environment, but immediately receives

a ready-made guide to action, after which the decision maker's accountability is checked following practical implementation. The fabric of political symbolism is woven from embodied decisions and options for political action that have not been chosen for implementation and made up a bank of potential behavioural patterns in the environment of governance frames.

An attempt to build a typology of political action, expressed as a circulation of the interaction of language and discursive practices turning into speech and vice versa, can be built on the principle of triangulation—a step towards representing political action as a complex phenomenon. Triangulation can be analytically represented as logos, pathos, ethos, which refer to each other in a complementary relationship (Kosharnaya 2016). Triangulation creates space for political creativity, which replaces abstract schemes in the idea of the common good and the prospects for the development of society and its members and forms the view of the future as a synthesis, claiming to be a holistic representation of it on top of an arbitrary set of social values and individual preferences. The orienting component of triplex political action involves the rejection of the belief underlying the old habit, followed by fundamental surprise and the search for a cognitive basis for unexpected practical decisions in a non-standard situation of "direct appearances" (Peirce 1978; Regev 2016). Each surprise contains a component of subjective belief in the possibility of realizing a groped vector striving for the good, as well as in the sufficiency of the necessary explicit or implicitly discernible subjective qualities for this sake. This belief undergoes recursive re-confirmation through a procedure of abduction, cyclically associated with deduction and induction, reconfirming feedback loops in political semiosis (Parsons 1963).

In his plenary lecture "Trajectories of Sense in Space and Time", Pierre Pellegrino reflected on the emergence of meanings. This process goes on from sensation to interpretation, from idea to action, from language to speech. Space objectifies meaning by giving it a form. There are always empty spaces that can be filled and positions that can be taken. Time is subjective, it has a duration that is inherent in a fractional or continuous nature, it is associated with a stream of impressions that need to be held or released. Gaps in time and space allow us to preserve their meaning. From the point of view of semiotic analysis, it is necessary to define the order (syntactics), values (semantics) and the possibility of using meanings (pragmatics) in terms of space and time. In this context, the modality of objects, the complexity and complementarity of research approaches, should be considered in line with the opinion relativity of the subject of semiosis (Lavrenova 2020). Remote accompaniment of poorly ordered and emergent phenomena of political action takes on the format of a meta-position, an "included third" between oppositions, thus empowering the subject of political action.

In the development of semiotics in the twentieth century, three phases of addressing the subject using a sign can be distinguished: around 1930, we see an appeal to the observed reality, around 1960, attention is paid to cognitive competence, to its representation, and in 1970 we see an appeal to the means of realizing this competence, to the qualitative characteristics of representation, to the question

of whether it is possible to explain certain intellectual capabilities using figuratively structured representations instead of propositionally structured ones (Holenstein 1995). Figuratively structured representations, located at a distance from real events, acquire digital expression with the possibility of multiple interpretations, which entails changes in the order of discourse and the relationship between orders of discourse; changes in semiosis are precursors of social change—for example, a network of genre forms acts as a precondition for globalization, understanding the latter as an expansion of the possibilities of distant action and a spatial "stretching" of power relations (Fairclough 2010), which reconfigures political action's spatial and temporal dimension.

Triangulation as an inherent component of transdisciplinary research strategy (Kiyashchenko 2010) is reminiscent of the Triple Helix. In 2000, R. Lewontin, one of the most prominent modern geneticists and evolutionary biologists, used the model of the triple helix of life (gene, organism, environment) related biological knowledge (Lewontin 2000). This model made it possible to present the complexity of life as a subject of scientific knowledge. The concept of trans-institutional interactions is based on the development of the idea of transdisciplinarity that preceded it. In 1998, the mathematician Nicolscu proposed to consider the problem of thinking about the complex, using transdisciplinary concepts, very close to the discussed hypothesis of the triple helix (Nicolescu 2007: 110–111). Reality appears as an ever more complex layered non-hierarchical universe. The gap between layers plays a paradoxical role of a rational, but not formalized mediator performing the functions of an "included third". The key premises of this theory: under certain conditions, institutional and cognitive structures become not adapted to the current situation and unstable; co-evolution of structures generates a historically new institutional and/or cognitive structure; time is the fundamental dimension in this dynamic process; co-evolution temporarily solves the inconsistency problems in the complexity of earlier systems; over time, new layers of complexity are accompanied by new inconsistencies, which give rise to further co-evolution cycles (King: electronic resource).

Political action is the built-in third in the intent-action-feedback triplicity. The intention is formed by the relationship between the available resources and the complex subtle nuances of attunement with the environment, which is required by closed subjects for survival and open subjects for self-development. The effectiveness of external political action depends on the subject's ability to form dissipative connections with the environment—connections based on resource exchange. The power of intention is provided by the fact that each subject chooses only those "questions" to which it is able to find "answers". Political action, therefore, is the fruit of the subject's orientation in the political space, implying the correlation of desires with the restrictions on the degrees of freedom of action imposed by the environment.

Facing obstacles either strengthens the political subject in defining the self or leads to the deconstruction of the semantic core of subjectivity, if it does not correspond to the problem posed for by the environment. In addition to being targeted, political action is directed at a specific audience that is influenced by both the narrative and the performative. Feedback from the target audience leads to consolidation or revision of the motivation for political action, closing the cycle of cybernetics of political

action by a final decision. The triple nature of political action is manifested in the tandem of variations of the political action "loyalty-voice-exit" (Hirschman 1970), where loyalty means following the hegemon's parameters of order, voice denotes the presence of opportunities for articulating dissatisfaction with these parameters, and the exit is ranged from "internal migration" to territorial secession. All this can be ranked as the formation of a political subject, given its ability to overcome gaps and conflicts with the help of the dialectical logic of the imaginary between power opposites.

3 Methodology

The traditional interpretation of semiosis acquires original configurations based on the following methodological premises:

- Transdisciplinary optics of semiosis allows it to become a unifying link between the philosophy of politics and its applied aspects. Transdisciplinarity is emergent and puts forward its conditions for methodological synthesis in the formation of a research thesaurus, where the subjects of action operate.
- Semiotic representation emphasizes the sign, symbolic nature of political action as an event realized by the subject in the process of normogenesis and fixed in the pragmatics of everyday activity, which leads to the co-creation of the subject and structure at the level of reflective analysis. This allows us to add "the included third", traditional for the transdisciplinary methodological approach, in the classical agent-structure dichotomy, the link "between", which generates the meaning of the specified ratio.
- The semiotic dimension of the political presupposes the vitality of the non-human, i.e. material (Bennett 2010), which leads to further complication of the research object, considering its living essence. The human and the thing are considered in a continuous link, thus expanding the subject field of semiotics in relation to the phenomenology of political action.
- Traditional political methods require an update when faced with complexly organized social phenomena that are not reducible to the simple. The problem of genesis and the installation of a new format of methodological tools arises. The orientation towards the factual, the "material," empirically renewable, is reflected in the fact that in the past two decades, methods of analysing visual material, performative approaches, and understanding of methods as poetics or interventionist narrative have gained importance (Law 2004).

4 Summary

Depending on the chosen strategy of interpreting the semiosis of political action, one can expect a one-/multi-level structure of specific semiotics. Semiotics as a meta-science, which arose from the synthesis of individual disciplinary studies of signs, now occupies a transdisciplinary position in the system of sciences. Semiotics has no clear-cut boundaries of its own and enters the territory of other sciences; its place in the research space is always "between", always at "intersections". Semiotics acts as a way of considering any object in such a way that functions as a text. This similarity is the essence of the method. Everything can be described as a sign system or its implementation, i.e. text. Semiotics acts as a designation of operational techniques used to analyse sign systems and individual cultural phenomena (Brazgovskaya 2008).

Semiosis in signs traces the contours of the moving boundaries of heterogeneous interaction. The issue of spatiality, as well as the temporal dimension, are organically inherent in political activity in the specificity of their designations. Geography and space acquire the aspect of conditional mapping through the prism of political activity. Demarcation of borders occurs under complex circumstances where the boundaries in time, political and geographical boundaries may not coincide. An attempt to prescribe boundaries testifies to the flexibility of scaling and arising meanings. Practical dimension is positioned in the linguistic environment, semiosis equals process of generating meaning in this environment.

Heterotopic understanding of the world presupposes violation, destruction of the visible, conventional from the standpoint of social order. In this situation, the internally initially provocative nature of heterotopia is predetermining, pushing to overcome the binary archetype of the political that is usual for Europocentric cultural consciousness and to transfer the ability to think in terms of complexity. In this vein, it appears appropriate to correlate the heterotopy of spatial representations of the political with its hetero-chronism—multiplicity of time. Merleau-Ponty analysed the variety of manifestations of time, linking them with subjectivity. The kinship of subjectivity and time is expressed in the fact that "subjectivity is not a fixed identity with itself: for it, it is essential to open to the Other and to go beyond limits". "The problem is to clarify that time in the state of origin and the process of manifestation, always implied by the notion about time, which is not an object of our knowledge, but a dimension of our being" (Merleau-Ponty 1991).

Political subject is "thrown" into the space of rules or order parameters, so any of their actions either reinforce or violate the existing rules. Rule violation is considered a deviation at the structural level and is suppressed if it takes place in a closed system striving mainly for self-preservation, but if rule violation takes place in an open system, information about this political event spreads and creates a precedent for a new type of behaviour, which is then reproduced with updated features and becomes the basis for self-development at the structural level. Therefore, political action contains an immanent pro-creative potential for renewal. In the usual manner of "slow", strategic thinking, as well as "fast", tactical thinking (Kahneman 2013; Kiyashchenko 2010, 2015), the human mind unfolds in the problem-oriented political

space in search of a choice between analytical and/or synthetic behavioural models, building the reactions of the action subject according to the model stimulus-answer in concrete situational dynamics. Such a modus operandi contributes to the "un-anchoring" of the free mind, making it possible to construct potential situations and make a reasonable choice of the "path dependence" of political action on the critical junctures during the transformation of the environment.

Political action is inherently linked to the commitment to the future behaviour of a political subject (Regev 2016), based on which other subjects classify this subject according to the degree of its compliance with the expected behaviour—on a scale from a reliable subject to a "lemon", constantly violating expectations (Tomz 2012). Expectations are analytically related to the concept of risk, whereby the costs of trust exceed the expected benefits (Luhmann 2017). Primary trust is necessary for the emergence of a dialogue regarding obligations. Mutual recognition of subjects is a procedure that can occur either directly through granting the vital narrative of the communication partner the right to exist (Goffman 1959), or involving mediation of a third party, for instance, the observer (Arshinov and Svirsky 2015). Political interaction that allows the subject to achieve its goals can be one-sided or reciprocal. Unilateral actions are characteristic of hegemonic subjects in a pronouncedly asymmetric communicative space when the leading subject tries to carry out unilateral influence concerning the recipient (Schelling 1981) in conflict relations. The constructive role of the conflict, which has a largely reciprocal nature for political action, is to consolidate conflict parties as an inspiring force of the ability to negotiate in relations that did not exist before the conflict per se (Coser 1964).

Asymmetries arising from unequal access to information play an important role in political relations. Politics can be conceptualized as a game with a nonzero-sum, before a move in the game, each of the participants faces the problem associated with the lack of data to analyse how the counterpart will behave. This builds a ground for classic game theory dilemmas concerning politics, such as a "prisoner's dilemma". In the digital age, the volume of information increases, but the quality of its analysis is improving unevenly, which intensifies the inequality problem, both within the same domain and internationally. Repetition, which is reproduced at the language level, lies at the heart of political institutions. Issues of inclusiveness and exclusivity are relevant to both language and politics. What is not verbalized, not framed in words and not framed as a political problem is not included in the agenda, resulting in the exclusion of specific people from political discourse. Discursive practices between the ambivalent semiotic properties of political action develop counter-positions of comparative-complementary interaction, especially visible at the level of situational analysis.

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Understanding the Current Environment and Assisting Individuals in a Sea of Change

Allenna Leonard

Abstract **The purpose** of this chapter is to highlight the breadth and depth of the vulnerabilities associated with increasing digitization and reliance on algorithms and their more severe effect on vulnerable populations. **The approach** is to describe the extent of the problem with an example and to show how the Team Syntegrity Process and Viable System Model can help to identify risks and indicate areas of mitigation. **Findings** Examples are noted to describe the extent of vulnerabilities. **Original Value** The value is an argument for attention to this matter. **Practical Implications** The chapter offers processes to help individuals to assess vulnerabilities and make recommendations. **Research Limitations** The description of the situation in this chapter is not exhaustive and does not anticipate future developments.

Keywords Digital technology · Team syntegrity · Viable system model · Data-driven solutions · e-government · e-health · Covid-19 · Cyber-physical ecosystem · Smart governance

1 Introduction

Whenever there has been a massive social change, such as from the agricultural to the industrial economy, benefits have been unevenly distributed and many individuals and families are left to scramble to find their place in the new environment and this remains true as we shift to the digital and service economy.

Stafford Beer's most famous quote: "The Purpose of a System is What It Does" (POSWID) invites us to consider the impact of advancing digital technology on those who are most vulnerable. Lags in access including broadband coverage, inability to afford the technology or inadequate education play a part but difficulties persist even when access is available. One differential is scale: the individual has a difficult time correcting a situation where privacy has been violated, errors made or lack of requisite variety has defined their situations out of the framework. Government

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laws and regulations have not kept pace and late-stage capitalism has few constraints on massive corporations. Individuals, whether they are employees, who may be micro-monitored by algorithms, citizens subjected to surveillance capitalism or users whose attention is 'sold' to advertisers may have little recourse. The internet provides access to information but has little or no protection against misinformation, lies and conspiracy theories that can have real-world consequences. Finally, both individuals and organizations are not sufficiently protected against cyber-crime; whether it is identity theft, ransomware attacks or online scams.

Researchers and practitioners in cybernetics and systems thinking can guide decision-makers in addressing these risks and can inform and encourage elements of civil society including labour unions, political action groups and community agencies to educate and advocate for their constituents. Beer's Viable System Model (VSM) and Team Syntegrity Process are shown to be valuable tools in this effort.

2 Who is Vulnerable in the Current Digital Environment?

New technology always brings dislocations and risks and distributes benefits unequally. So, who is vulnerable in the current digital environment?

The answer is almost everyone even if they do not have or use a computer or cellphone his includes everyone who depends on utilities like electricity, transportation and water, infrastructures such as pipelines and supply chains and ransomware affecting hospitals and health services. They may be captured by surveillance technology such as CCTV, and their privacy violated or they may be misidentified by inaccurate facial recognition software. They may be denied access to jobs or renting an apartment if they are mixed up with someone else or denied parole based on aggregate measures that do not leave room for judgement and penalize people based on poverty or place of residence. They may fall foul of bureaucratic frameworks that do not encompass their situations…and for the most part, they will find recourse difficult.

If they do have or use a computer, they are subject to the above risks plus the risk of cybercrime such as identity theft, online scams, social media misinformation and confusing directions that may lead to error or lost work. Often, people lack information about how to protect themselves and are confused. Some of these are related to intentional actions such as disinformation and crime. Unintentional harm may also arise from poorly or cheaply designed applications and interfaces with little recourse to correct errors and a lack of privacy protection.

These problems affecting individuals and communities appear from the global level down to the individual. There are gross disparities within and among countries due to lack of broadband access and the financial and educational resources to make use of what access there is. The resulting acceleration of inequality and instability is an additional concern.

Bad actors are not limited by international borders and governmental laws and regulations struggle to keep up with both domestic and international threats. Governments lack requisite variety and must play catch-up domestically. International collaboration is even more difficult to achieve as some governments may not have the requisite expertise and other governments are unable or unwilling to clamp down on bad actors, especially if they are causing discomfort to perceived competitors.

These issues are widely known and examples can be found in any week's newspaper coverage of the topic.

3 Possible Actions: Group Process

The first step is to do a comprehensive assessment of the issue. A wide group of people should be consulted about their lived experiences and their interactions with digital technology whether directly transactional, such as banking online or purchasing a product, or indirectly transactional such as when their information is sold as a product to advertisers or their news stories are filtered by social media. Many are also engaged with digital platforms in their interaction with medical, educational or employment sites. The way forward is to engage individuals at the neighbourhood, municipal, provincial and national levels in small group processes where they can share how they have been both benefitted or frustrated and harmed in the course of these interactions.

Stafford Beer's Team Syntegrity process (Beer 1994) is a methodology that surfaces values and assumptions along with particular situations that have gone well or badly for them.

A standard Syntegration gathers a diverse group of thirty people for three or four days around an open-ended central triggering question. It begins, as do many group processes, with individuals writing statements on sticky notes and posting them on a wall. The statements are clustered and aggregated and twelve are chosen to be the topics explored in more detail and assigned a colour. Each of the thirty participants becomes a member of two topic teams and a critic (who offers an outside perspective) of two other teams. This gives twelve teams with five members and five critics each.

In a Syntegration meeting, that typically lasts for an hour, participants are invited to take one of three roles (team, critic, and observer). Team members explore the topic and write up a summary of their discussions at the end of the meeting. This is posted so other teams can see what they have said. Team critics may offer comments on the content or the process of the team's discussions and have one or two time slots during the meeting for their input. The observers (one of the ten who are not occupied during that time slot) are encouraged to sit in but may not contribute to the discussion. Facilitators guide the process by keeping time, taking notes and otherwise keeping the process on track. They do not contribute to the discussion.

The Syntegration process uses the three dimensional regular solid of the icosahedron, which has thirty edges and twelve vertices, to connect the topics and teams. On this structure, each person has a unique and equivalent position as a strut connecting

two vertices and each colour coded topic is on a vertex. This structure is non-hierarchical and serves to reinforce (although it cannot guarantee) the equality of the participants.

At the end of three sets of meetings, the teams present a report of their discussions and conclusions. Often one or more points will be raised in one meeting that reverberates around the structure and contributes to the formation of other team reports and recommendations. A series of such meetings in different settings would be an invaluable resource for government or civil society to get a comprehensive view of the impact of digital technology on different populations and the commonalities and differences among them.

The results would give a picture from different perspectives that all need to be considered.

Here is an example of a population that is vulnerable: the elderly computer user.

They are more vulnerable than the average person to attacks on electric utilities, public transportation and hospitals whether or not they use a computer themselves.

Elderly individuals vary greatly in their ease and familiarity with computers and the different situations they face. Some are physical: declining vision, hearing or manual dexterity. Some lack knowledge about how to perform basic tasks or fix simple problems - or indeed, to know when the problem is simple or requires a specialist to fix. Variations in how forms are organized and how to keep track of an increasing number of passwords and user names can lead to confusion. Many use only a fraction of their computer's capabilities and have difficulty with updates and system changes. Some are poorly equipped to distinguish between legitimate contacts from scams.

What might help? For the physical barriers, better accommodation for declining hearing, vision and dexterity, as well as more accessible information about what is already available, would be useful. So, would net literacy programmes, perhaps offered by local libraries. A "basic option" offering accessible and user-friendly versions of commonly used applications and password protection could also be valuable. Special help such as hacktivists a phone call away and better design of online forms are other possibilities.

There are too many layers and missing recursions between the individual who may be experiencing problems and the large global organizations of the digital world. These large organizations have a responsibility as well. They should have human help that is easy to reach in every location where they do business, including an ombudsman office to sort out misunderstandings and errors. It is also unacceptable that the proprietary algorithms they use are opaque and unaccountable, as are the individuals who design them. Too often, 'bias in-bias out' has replaced 'garbage in - garbage out' in the digital world.

4 Possible Action: Structures to Handle Complexity

Beer's Viable System Model (1985) is another tool that could be applied to help individuals, and those who work with them, understand and manage the complexity of their digital presence.

The digital world comprises an increasing proportion of people's transactional and contextual environments. These interactions range from the intimate - emails and social media contacts among families and friends - to general contacts where the ratio is one to millions.

In the VSM, its System One activities for individuals include work, hobbies, education and enrichment, personal and household maintenance, civic responsibilities and socializing. All use resources of time, money and energy. They interact with employers, teachers, medical services, retail outlets, charitable and public services, amenities such as libraries and social networks in the environment. Many of these interactions take place online, especially during the pandemic when many people worked or studied from home and met over zoom for everything from exercising to gatherings with family and friends. People expect that their interactions will be with legitimate entities but there are also plenty of scams, especially when money is involved or the people are not known personally. There is also a risk of privacy violations such as when medical or customer records are hacked.

Following with the VSM, their System Two activities include scheduling, keeping track of passwords, privacy protections, monitoring and documenting income and expenditures, insurance coverage and cyber-security.

System Three activities manage these allocations of time and resources and determine trade-offs among them to respond to signals from the environment reported by Systems One and likely scenarios identified by System Four. System Three may or may not receive sufficient information about the environment from the System One interactions if they do not themselves have the requisite variety.

System Three Star, as an audit channel, often comes into action when the resource bargains break down of something that has not been occurring as expected. One aspect is being aware of the possibility of being hacked and being on the lookout for signs it may be happening.

System Four activities are directed toward the actual and anticipated future environment. The environment of mass and social media provides many with pictures of future opportunities and threats that may be distorted by hype, scare mongering or misinformation. Because much of this information is online, it is not as easy to verify its reliability as it is when there is direct personal contact. Individuals need to know which outlets to trust and have alternative plans to respond to changes in the environment.

System Five focuses on values, world views and identity and monitors their coherence with lived experience. It also observes and adjusts the balance between day-to-day operations and planning for the future. Do changes in technology or social interactions need to be addressed to keep interactions with the present and future environments within acceptable boundaries?

The VSM is recursive. That means that these concerns at the individual level are replicated in more comprehensive groupings. Each individual personifies identities within their families, their social groups, their communities, their countries, their professions and their political and natural environments.

They can and should call upon all these larger groups, but especially governments to protect them from threats, whether it be employers or social services managing them by unaccountable algorithms, privacy protections, criminality or misinformation. This is especially important for the people experiencing poverty, the less educated, the less technically savvy and those harmed by risks largely out of their control such as pollution and climate change.

5 Conclusions

Governments do not now have the information to meet this obligation. Group processes, including Team Syntegrity and others, can go a long way to supplying this information if done at each level of recursion up to and including national and international corporations and civil society organizations.

The Viable System Model, along with a general increase in systemic understanding, can help provide structures to organize the approaches to complex, unstructured and emerging messes. To fail to act, would be likely to increase instability and lead to a deteriorating as opposed to improving quality of life for many people.

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Technocracy as a Cultural Imperative: Pro and Contra

Marina Korol

Abstract **The purpose**—To consider the phenomenon of technocracy associated with trends in the development of modern society. To substantiate that the high demand by society for holders of special knowledge opens up the opportunity for technocrats to occupy leadership positions, both in industrial and scientific spheres. A layer of techno-bureaucracy is being formed, the dominance of which is associated with several systemic contradictions and threats. In particular, the use of an accurate scientific approach is increasingly orienting the techno-bureaucracy towards the use of the methodology of cybernetic control, which makes it possible to program citizens for the meanings of activity constructed by administrators and to create a formed image of the surrounding reality. To propose a variant of overcoming the risks of managing the technical bureaucracy based on the ancient concept of "techno". **Design/methodology/approach**—The study is based on the principles of dialectical logic, in particular, the principle of the unity of the historical and the logical, which made it possible to consider the transformation of technocracy, highlighting the features of early and late technocracy. Through analytical procedures, the systemic contradictions and threats associated with the dominance of the techno-bureaucracy are revealed. The principles of post-nonclassical rationality, which consider the correlation of the knowledge gained about the object not only with the peculiarity of the means and operations of the activity but also with the value-target structures, made it possible to find a way to overcome the risks of technocratic management based on the antique concept of "techno". **Findings**—There is no doubt that in a technogenic society, where technologies construct new objects of the material world with qualitatively different properties that did not previously exist in nature, forcing a person to perceive the surrounding reality through the prism of technological systems, technocracy plays a fundamental role. But for technocracy not to bring society to the point where the future becomes a problem, adherents of the idea of technocracy could use the concept of the antique "techne", that is knowledge that contains the recipe for "how to do it. If "techne" relies only on practice, it becomes a bare procedure and lacks understanding, it is low-grade techne, craftwork in the worst sense of

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the word. But there is another feature of techne that allows us to consider it an art, namely the sharpness of techne towards high values. Ethical and social imperatives should become part of the values of modern technocrats. **Originality/value**—The scientific novelty of the research is connected with the substantiation of the problem of the research topic. The modern science and technology revolution have opened up incredible opportunities for a wide variety of technological innovations that are changing the relationship between the techno-sphere and the biosphere. With the increasing conflict and risk interaction of technology, nature and social systems, society is increasingly in need of a "ruling of experts" with systemic thinking—technocrats. Technocracy gains the status of a cultural imperative, as a set of institutions and forms of culture necessary for the survival of any society, ensuring the satisfaction of vital needs, including the care of the young generation, the transfer of knowledge, the management of conflicts, etc. Risks and threats associated with the dominance of the technical bureaucracy arise. **Research/Practical/Social/Environment implications**—Fixing an existing contradiction in the phenomenon of technocracy makes it possible to reveal that, on the one hand, scientific competence in making managerial decisions at the stage of project preparation allows technocrats to act as experts on individual problems that need to be weighed against potential environmental, climatic, and sociobiological consequences. On the other hand, technology deforms the deep meanings of human interaction in society, standardizes the life of a person and the whole of society. Ethical and social imperatives should become an integral part of the values of modern technocracy. **Research limitations**—Modern social reality is increasingly aggravated by the growing processes of the digitalization of society, which affect the work of the power-management vertical, digital control is becoming a priority. There is no guarantee that technocrats will always adequately interpret, understand and reflect the interests of society and individual social groups. Increasingly, technocrats are accused of not calculating the social consequences of their decisions and generally ignoring issues of social policy, including, first of all, issues of equitable distribution of benefits.

Keywords Technocratic determinism · Technocrats · Techno-bureaucracy · Socio-technical order · Democracy · e-learning · Digital control

1 Introduction

The top lines of the rating of the most significant achievements of mankind were replenished with discoveries made by modern science, which are largely associated with the large-scale changes that have occurred in it in the last decades of the XX—early XXI century. But these same discoveries have changed the ingrained relationship in the phrase "science and technology." Not only in professional circles but also in public areas, the concept of "technoscience" has entered, reflecting a fundamentally new stage in the development of science. The model of the relationship between fundamental and applied research has undergone a significant change

under the pressure of the demands of the economy and society, which require science to respond quickly to the challenges of technology. The main criterion for modern science is efficiency and utility, which are manifested in the most demanded by society technological macro trends: digitalization, sensing and concepts "Internet of Things", "Smart Planet", "Society 5.0".

Reflection of these trends draws us to the theoretical and methodological foundations of technocratic determinism, which focuses on the idea of technical achievements, technologies in general as the key driving forces of social development that determine socio-economic and other changes in society. Moreover, representatives of this direction interpret the term "technology" not as a machine or tool, but as a certain worldview, which guides people in their perception of the world around them. This gave rise to Scott Lash, an English sociologist and cultural scientist, to describe modern life as technologized. People and machines have created a union between biological and technological systems, as a result of which an organic-technological interface has developed, in which individuals can no longer live without the help of various technical devices.

One cannot but agree with this since modern reality is increasingly acquiring a technological format in its digital dimension. Based on the convergence of innovative technologies, technical and technological systems (platforms) of regulation are created, legitimizing communication processes and socio-technical order, in organizations in the form of digital control on the principles of BIG-data. These processes generate new social institutions and forms of culture that are in demand by society to adapt to the changing social reality, which can be attributed to technocracy.

Although, to be more precise, the phenomenon of technocracy as a concept has deep roots in the past, "Maybe it's time to rediscover technocracy?" (Esmark 2017, p. 501).

2 Background

2.1 From the Idea to the Phenomenon of Technocracy

The idea that power should belong to the most competent and enlightened members of society, a kind of sketch of the future technocracy, was outlined already in the works of Platon, F. Bacon, T. More. H. Saint-Simon can be considered the forerunner of technocracy since he formulated two basic principles for all subsequent technocratic concepts. Firstly, the management of society is based on rational and scientific foundations and, secondly, scientific and industrial specialists play a leading role in politics. To characterize the future society, H. Saint-Simon even introduced the term "industrial-scientific system" (Lyovkina 2019, p. 199).

The names of the American engineer Howard Scott and the physicist Alvin Weinberg stand out specially among many names—adherents of the idea of technocracy. They were not only unique missionaries in popularizing the transformative social

and political potential of technology, and "the form and content of their rhetoric, which supported a form of persuasion more akin to religious discourse" (Johnston 2017, p. 197), but Howard Scott also became the founder of the Technical Alliance.

In 1934, Howard Scott published a pamphlet "Science Against Chaos", which contained theses, which concentrated the idea that "only technically competent people, by redesigning physical environments, are equipped to solve modern social problems" (Johnston 2017, p. 205), because "the scientific approach of technocracy to the social problem is unique, and its method is completely new. She speaks the language of science and does not recognize any authority, except for facts" (Scott H). Howard Scott believed that technocracy embodied the prospect of permanently ending unemployment, hunger and lack of income for society. The first popularizers of the ideas of technocracy were far from claims to power, the essence of their standpoint was "scepticism and even hostility towards politicians and political institutions" (Esmark 2017, p. 504).

This position was declared by Howard Scott himself: "Technocracy, not being a political party or a conspiratorial body, has never had any intention or any wish to assume political power in this Price System. We have never had and never will have any theory of assumption of political power" (Scott H). However, over time, technocrats, receiving support from the bureaucratic machine, begin to influence it themselves with their ideology and culture. In the process of "absorption" of the bureaucracy, the phenomenon of techno-bureaucracy began to form—this is an administration in which the technocrat is "entrusted with the main task of adapting the bureaucratic organization to the technological mission of society to create "efficient management of the social machine through planning and social engineering" " (Esmark 2017, p. 505).

At the same time, over the past decades, social reality from the traditional dichotomy "man-nature" has transformed into a qualitatively new state of the global socio-bio-technical system, which is "risky in its essence, since it consists of elements of a different quality that have their own dynamics" (Yanitsky 2016, p. 10). Humanity has entered the territory of systemic contradictions, the boundaries of which are outlined by instability and inability to self-regulation.

This state of affairs strengthens the position of technical specialists. Since scientific competence and methodology for making managerial decisions at the stage of preparing projects allows them to act as experts on individual problems and "risk management ensuring constant organizational change, adaptation, and flexibility in the face of increasing complexity, uncertainty, and wicked problems in risk society" (Esmark 2017, p. 502).

Moreover, these problems must be weighed against the potential environmental, climatic, sociobiological consequences due to the macro-scale and super-complexity of the technosphere created by man, and thereby influence the final result. This state of affairs forms a new essence of technocracy, "If the hallmarks of early technocracy were planning and foresight, the hallmarks of late modern technocracy are connective governance, risk management, and performance management" (Esmark 2017, p. 506).

This is how the "power shift" takes place in favour of the holders of special knowledge. The opportunity to occupy leading positions, both in industrial and scientific spheres, is provided by technocracy with "high demand for a wide variety of structural subdivisions of the social hierarchy and exceptional mobility" (Mamedov 2014, p. 193). Technocracy is becoming one of the dominant elites of modern society.

The selection of technocracy into a fundamentally new social stratum created the preconditions for an even greater stratification of society, only now based on knowledge and information. Experts and "effective managers" by virtue of achieving their intellectual dominance, in the newly created social structure, the so-called technostructure, suppress the rest of the classes. This is how "new social dead ends" are produced.

There are several systemic contradictions and threats associated with the dominance of techno- bureaucracy that require special consideration.

3 Technocracy and Democracy

What are the prospects for democracy as a system of political participation of the people under the rule of techno-bureaucracy? There is a fear that techno—bureaucracy, occupying a dominant position in society, will seek to limit democracy.

For example, in the process of dismantling the socialist system during the modernization processes in Russia, the ruling class "skillfully mastered the democratic ideology, masterfully mastered the appropriate forms, techniques and methods to gain control of power, ideally adapted them to the realities of a consumer society, masterly adapted them to their needs" (Kerimov 2019, p. 13).

Thus, liberal-democratic constitutionalism has developed as the framework of the political system.

After years of a one-party system and uncontested elections, Russians have adapted to new democratic institutions such as a bicameral parliament, federalism, the rule of law, and the separation of powers. The increasing role of democratic structures and the policy of horizontal interaction was declared at the level of civil society.

Over the past time after the reforms of the 90 s. XX century, more and more there was a person's alienation from management processes at the local and higher levels. The situation is exacerbated by the processes of digitalization of society, which affect the work of the power-administrative vertical. Digital control, or "smart regulation", is becoming a priority. It is understood as "a form of regulatory pluralism, including flexible, original and innovative forms of administrative control" (Tikhonov and Bogdanov 2020, p. 76).

The use of a precise scientific approach is increasingly orienting techno-bureaucracy towards the methodology of cybernetic control. This allows "programming the meanings of actions that are being developed by administrators, and creating a well-formed image of the surrounding reality for citizens." (Linde 2019, p. 120).

Purposeful streams of programmed information about the amendments to the Constitution of the Russian Federation were broadcast through the media system in the format of videos in an endless series of various advertisements interrupting entertainment films and programs. The belittling of democratic values highlights the rejection of the legally enshrined referendum format and its replacement by an all-Russian vote. Unlike a referendum, to recognize the all-Russian vote as valid, a turnout of more than 50% is not required.

The mass political participation of the people is one of the main criteria of democracy. But doesn't this hide the risk of the emergence of an authoritarian system of governance under techno-bureaucracy?

Of course, a critical attitude to democracy allows us to see a number of its flaws, which were repeatedly pointed out by thinkers of the past. For example, democracy does not guarantee that the most representatives of the nation will certainly come to power. Or the age-old questions will include the question of the dependence of the prosperity of society and the forms of the state (as an example, the PRC led by the Communist Party and the diametrically opposite form of government of the UAE with a monarchy).

And yet, democracy is closest to understanding social justice and therefore most attractive to the broad masses of the population. But is there a guarantee that technocrats will always adequately understand and reflect the interests of society and individual social groups?

Increasingly, "technocrats are accused of not calculating the social consequences of their decisions and generally ignoring issues of social policy, including, first of all, issues of equitable distribution of benefits" (Farukshin 2019, p. 83).

4 Technologisation of Education

The logic of the systemic-technocratic management of the information society determines several management decisions that entail a fundamental breakdown of education as a key system for the transmission of culture. The introduction of online technologies in education develops into an innovative process that constructs a learning model with completely new parameters.

Back in February 2018, State Duma deputies criticized the Ministry of Education and Science for the fact that e-learning in higher education is still not fully used (Prokshin and Mironova 2019). The resulting impetus gave its results, and at the global conference on technologies in education EdCrunch 2018, HSE Rector Yaroslav Kuzminov spoke about HSE's plans to radically change the parameters of education, that in the next five years his university will completely abandon traditional lectures in favour of recorded lectures, teachers will be obliged read courses in digital format.

And if these prospects were still subject to discussion, then the tragic events associated with COVID-19 moved education into the realm of the World Wide Web.

This revolutionary leap exposed the emotional and technical problems of the process.

However, any experience is positive if it is considered that "the complexity of such projects requires not so much mathematical calculation as the intensification of the philosophical, critical-reflexive component in the analysis of the relationship between science, technology and society" (Karpov 2016, p. 43). But to what extent do the experts use forecasting procedures in the development of the project for the implementation of online education, that's fixed the object in its future development?

In fact, "technologisation—the development of technical and formal means of communication and the quantitative intensification of information processes in societies—the significance and subjectivity of human consciousness is lost, its qualitative semantic component becomes impoverished and simplified, the everyday cultural and semantic life world is disrupted" (Linde 2019, p. 119), thereby Modelling a new socio-anthropological type of "technogenic man."

Technologies deform the semantic foundations of the interaction of people in society, standardize the life of a person and the whole society.

Even Norbert Wiener, who is rightfully considered the "father of cybernetics", the man who laid the foundations of the social reality in which we live in the world of "smart machines", computers, discovered a communicative organization, without which even attempts to comprehend what is living, human, social. He wrote: "No, the future leaves little hope for those who expect that our new mechanical slaves will create for us a world in which we will be freed from the need to think. They can help us, but on condition that our honour and reason meet the requirements of the highest morality" (Wiener 1966). Therefore, the genuine learning process involves a dialogue between a teacher and a student, "replacing a teacher with his high-tech reproduction means depriving the learning process of vitality" (Sadovnichy 2019, p. 8).

5 Summary

There is no doubt that technocracy plays a fundamental role in a technogenic society. Technologies construct new objects of the material world with qualitatively different properties that did not previously exist in nature, forcing a person to imperceptibly perceive the reality around him through the prism of technological systems. But does it not bring society to the point where, as Academician A. Huseynov noted, "the future has become a problem, a weak point in the existence of modern society, even a source of pain"?.

Perhaps the adherents of technocracy, who seek to preserve the idea of the social future as the driving force of social development, should turn to antiquity, to the concept of ancient techne, that's to the knowledge that contains the recipe "how to do it". If "Techne" relies only on practice, it becomes a bare procedure and lacks understanding, it is low-grade techne, craftwork in the worst sense of the word. But there is another "feature of techne that makes it art; namely, the sharpness of techne

on high values" (Karpov 2016, p. 7). Ethical and social imperatives should become components of values for modern technocrats.

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Using Requisite Variety: A Novel Approach to Enhancement Technologies

Filippo Sanzeni, Sina Sareh, and Paul Anderson

Abstract **The purpose**—This research aims to situate enhancement technologies within a second-order cybernetic framework. Enhancement is here characterised as the process of developing sensing systems to expand an agent's internal variety in response to hidden affordances available inside the environment in which they are embedded and interacting. This article, in particular, suggests the Law of Requisite Variety (1956) as a valuable perspective for decoupling the subject matter from some of the ethical and practical challenges surrounding enhancement technologies, such as defining species-typicality and the notion of 'better'. Requisite variety provides a fruitful framework for approaching enhancement technologies as it outlines a systems perspective on the matter that focuses on communication rather than specific technologies. Based on this new operational framework, this study offers guidelines for approaching the design of enhancing technologies.

Design/methodology/approach—Ashby's Law of Requisite Variety (1956) offers the basis for this chapter's core thesis, which contextualises the theory within an agent's interactions with its surroundings. The environment involves a range of sensory affordances (Gibson 1977, 1979). However, the agent's body—whether human or nonhuman—often is not equipped with the sensory systems required to engage with all of the affordances available. Therefore, this study proposes redefining enhancement in a cybernetic context as the practice of revealing the environment's hidden affordances. To this end, the agent's body must integrate with novel sensing systems that reveal these hidden affordances via embodied sensory feedback loops relying on the agent's previously existing sensory systems.

Findings—As an alternative way to tackle the enhancement debate, this chapter proposes focusing on increasing agents' internal variety regarding its environment. By focusing on the agent's body and its distinct sensorimotor properties, enhancement is reframed as the intentional layering of new capacities onto pre-existing ones.

Originality/value—This work proposes an epistemological shift that integrates cybernetics into the debate on enhancement technology. The argument presented here provides a pragmatic foundation for academics and practitioners designing

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novel enhancement technologies to address the subject matter. Further, this research offers an alternative to established approaches to enhancement technologies, such as Savulescu et al. (2011) and Cabrera (2017).

Research/Practical/Social/Environment implications—This research's perspective will aid in the development of cybernetic approaches to the unresolved issue of enhancement technology. Furthermore, by focusing on the body of the agents and their individual sensory systems, as proposed in this work, much of the debate surrounding enhancement technologies can be avoided.

Research limitations—The arguments presented stem from the notion that cognition is embodied, embedded, enacted and extended. As a result, they might be challenged by alternative epistemological positions.

Keywords Cybernetics · Enhancement technologies · Requisite variety · Affordance theory · Embodiment

1 Introduction

Whereas the drive to improve its physical and mental state has arguably been with humanity since its inception, current definitions of enhancement technology are contested. As a result, conflicting viewpoints prevent discussions in the larger community. Moreover, the urgency of openly discussing the subject has recently become apparent, as a result of media coverage that has sparked controversy and debate: the issue of genome-edited twins born in China (Jiankui et al. 2018), rapid advances in brain-interfacing technology (Regalado 2020), and extensive military interest (UK Ministry of Defence 2021; Mozer 2021).

This study suggests a novel cybernetic approach to human enhancement, concentrating on reframing the issue within the context of Ashby's Law of Requisite Variety and Gibson's Affordance Theory. Human enhancement is characterised in this context as the process of developing embodied sensing systems that allow the human-in-the-loop to sense hidden affordances embedded in the environment. This work lays the foundations for situating cybernetics within the discourse on enhancement technology. Further, intersecting cybernetics with Affordance Theory provides a framework to resolve some of the issues arising from the literature. To that purpose, this chapter first summarises the current discussion on human enhancement technology before illustrating how the Law of Requisite Variety provides a rich framework for addressing the subject whilst also addressing some of the ethical concerns raised by the topic.

2 Backgrounds

Human enhancement refers to the possibility of an intervention on the human body to improve or implement new capabilities through various technologies (Buchanan 2011). This definition, however, depends on one's assumptions on what constitutes human typicality. Bioethicists have brought out the difficulty in debating human enhancement due to its wicked nature (Earp et al. 2014), and its use has also been questioned as it involves implicit and personal assumptions (Parens 1998). Unsurprisingly, there is a substantial and contradictory corpus of literature on human enhancement. Some authors focus on the technical aspects of enhancement (Hildt and Franke 2013; Koops et al. 2013), while others advocate for (Savulescu and Bostrom 2009; Agar 2004) or against enhancing technology (Agar 2010; Coeckelbergh 2013; Fukuyama 2002). The modern debate is split between two paradigmatic epistemologies: bio-liberalism, which enthusiastically associates human enhancement with progress and the improvement of the human condition, and bio-conservatism, which instead interprets human enhancement as a kind of distortion of humanity itself.

Opposing epistemologies guide these lines of thought: whilst bio-liberalism is based on a radical dualistic vision of the human being, the bio-conservative approach, on the other hand, leverages essentialist techniques to illustrate the consequences of potential and profound transformations in what humanity is and has been. While bio-liberals see technology as a tool for humanity to modify and, ultimately, transcend its 'fragile' body, bio-conservatives worry that enhancement technology undermines the very essence of humanity.

Aside from the epistemological distinctions between bio-liberals and bio-conservatives, few scholars have examined the various approaches to human enhancement from a pragmatic standpoint. Notably, Savulescu et al. (2011) surveyed the methodologies that could be used when developing enhancement technologies, outlining four potential approaches:

- The sociological-pragmatic approach: enhancement depends on its historical and cultural context and assumes its value from it. According to this viewpoint, enhancement is a socially constructed idea (Wolpe 2002) that depends entirely on the social and political values of the society in which it exists (Canton 2002).
- The ideological approach: avoiding defining the term itself might benefit both supporters and detractors of human enhancement. This approach cites metaphysical or spiritual notions (Savulescu et al. 2011, p. 4) and often relies on projecting a set of ethical values onto a specific technology to evaluate it.
- The "not-medicine" approach: enhancement is a type of biomedical intervention that seek to increase human abilities beyond what is required to maintain or repair health (Juengst 1998; Parens 1998, van de Ven et al. 2019, p. 3). As a result, any biomedical device has the potential to be an enhancement. The distinction between therapy and enhancement establishes what is ethically acceptable.
- The functional approach: here, enhancement is defined in a given context and manifests as the improved output quality of a specific function, such as cognition (Earp et al. 2014).

Although helpful to chart the current debate, the problematic idea of "norm" or "baseline" emerges in all proposed frameworks. Indeed, there are many profoundly different meanings for the word "normal", depending on its context. For example, it could mean typical when associated with the standard practice; average when used to describe a group of people; innocuous in a clinical context; or most suited for the evolution of the species in the context of genetics (Murphy 1972). Furthermore, in the context of the medical sciences, which is most commonly associated with enhancement technology, "normal" can be used to outline a description of the ideal, extending its meaning from the classic defined standard, naturally occurring state, free from disease (Davis and Bradley 1996). However, these descriptions disregard that different modalities can functionally accomplish the same action. For example, reading can be carried out through the eyes, touch (as for Braille), or through hearing (thanks to text-to-speech software). It has been demonstrated that reading speed does not change if performed through the visual and tactile systems (Legge et al. 1999). Furthermore, an action can be carried out according to different levels of precision: if it is impossible to restore the operational level, for example, of a limb, it can be replaced by a prosthesis that gives a similar level of operability (Silvers 1998).

Finally, it is essential to note that 'enhancement' does not automatically equate to 'more': in some occasions, diminishing a particular trait can be a form of enhancement in itself, such as reducing traumatic memories of war or ill-directed lust (Earp et al. 2014). The more recent 'humane' framework (Cabrera 2017) positions enhancement in a social context, arguing that research efforts in enhancement technology should prioritise the benefit of society as a whole. Other definitions of human enhancement leverage on the distinction between natural and unnatural improvements (Ida 2004), the abolition of suffering for humans and nonhuman animals (Pearce 2004), boundless expansion and self-transformation (More 2003) and transcendence (Huxley 1927). For a comprehensive overview of the history of human enhancement, see (Bostrom 2005).

This chapter argues that approaching enhancement technologies from a humanist perspective, which embraces humanity's essential and ideal qualities, falls short of addressing diversity, heterogeneity, and the human species' larger position in the ecosystem. Although Cabrera's humane enhancement attempts to shift the focus from the dominant paradigm of human-centeredness towards a fuller picture that encompasses society as a whole, the proposed approach fails to address the core issue of human enhancement. Namely, what it means to be a human and, from there, what it means to enhance a human remains unresolved. This study proposes using cybernetic principles to remove the necessity to identify human nature from approaching the subject of enhancement. The following section explains how feedback loops and Requisite Variety can be used to design enhancement systems functionally.

3 Towards a Cybernetic Framework of Enhancement Technology

This section discusses an alternative approach to enhancement technologies that employs cybernetic principles of Requisite Variety and second-order feedback loops. When the field is approached through the lens of Affordance Theory, the argument for the significance of cybernetics for enhancement technologies emerges. This section of the study summarises Requisite Variety, its relevance to the topic, and how second-order feedback systems provide a robust foundation for designing enhancement technologies. In contrast to the frameworks described in the preceding section, which concentrate on a vague idea of 'human' to define 'enhancement,' this study proposes dissociating the concept of 'human' from problematic formulations of humanity and 'better'. Instead, this research contends that enhancement happens when an agent is presented with a new form of interaction with its environment.

Reframing enhancement within the context of agent-environment interaction necessitates a shift in research efforts in the field from a minimalist problem space—where one must simply define 'average behaviour' to establish a baseline for a new enhancement technology—to a truly complex system, where the agent, its environment, and their interactions must all be considered. This article posits that effective enhancement technologies must be built as complex systems governed by another complex system.

The point made here is consistent with Ashby's Law of Requisite Variety (1956), which asserts that the level of complexity of a physical system and the one it governs must be comparable for effective interaction. As a result, enhancement is understood as the act of providing new methods for the controller to interact with the opportunities provided by the environment, as depicted in Fig. 1. This epistemological shift assumes its significance when confronted with human biology: despite having high levels of sensorimotor complexity, human bodies did not evolve to interact with much

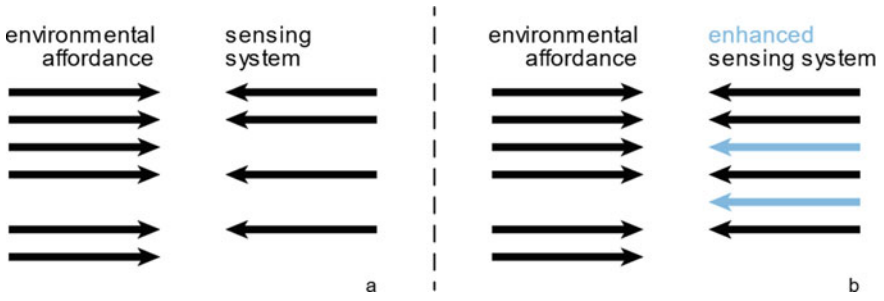

Fig. 1 Representation of an enhancement system, elaborated from Dubberly and Pangaro's (2007) depiction of requisite variety. Figure 1a represents a non-enhanced agent interacting with an environment. The latter presents interaction cues—or affordances—which the interacting agent does not present sensors to perceive. Figure 1b depicts this chapter's postulate for enhancement technology: an agent is enhanced when presented with sensory systems that convey hidden affordances

of the signals in the environment, such as magnetic fields, large sections of the light spectrum, or most chemical compounds. In other words, many environmental affordances are inaccessible to humans.

3.1 Affordance Theory as a Companion to Requisite Variety

Gibson established affordance theory on the wave of the Gestalt psychology of the 1920 and 1930s in his seminal work Ecological Approach to Visual Perception (Gibson 1979). In its original sense, affordance refers to an object's physical properties that indicate the actions and manipulations that an interacting agent can accomplish. As a corollary, an affordance is an invitation to action distributed across the object and the interacting agent. The distinction suggested by Norman (2013) between real and perceived affordances is crucial when addressing enhancement technologies. Real affordances are all of the available actions that an object provides, whereas perceived affordances are narrowly defined as the actions that an agent perceives as feasible. Many scholars expanded on Gibson's theory, but Jeannerod's (1994) contribution is particularly relevant to this discussion, as it emphasised the fundamental importance of the agent's intentions, or, in cybernetic terms, their purpose-driven behaviour.

To conclude the significance of affordances in enhancement technologies, Don Norman offered a further notion to clarify affordances in the 2013 edition of his seminal The Design of Everyday Things—signifiers. Norman uses this term to distinguish real affordances from features of an entity that suggest how an agent should utilise them, such as arrows, colours, and directives. The humble door embodies this distinction: its physical design and the presence of hinges afford a swinging action, whereas a handle signifies which side of the door an agent should pull to go through it. These distinctions between affordances and signifiers are critical for addressing enhancement technologies within the context of Requisite Variety. The environment offers numerous affordances, yet the body of agents lacks variety in their sensory contingencies to signify said affordances. Enhancement technologies can thus be defined as additional sensory systems that signify to the controller the possibilities of the environment, as depicted in Fig. 2.

3.2 Implications and Guidelines

Reformulating enhancement within the overlap between Cybernetics and Affordance Theory effectively decouples personal assumptions from underpinning the conversation. From an epistemological standpoint, the proposed shift presents several necessary implications. First, the emphasis in this paradigm is on establishing communication between the enhanced agent and its surroundings. This effort is technologically

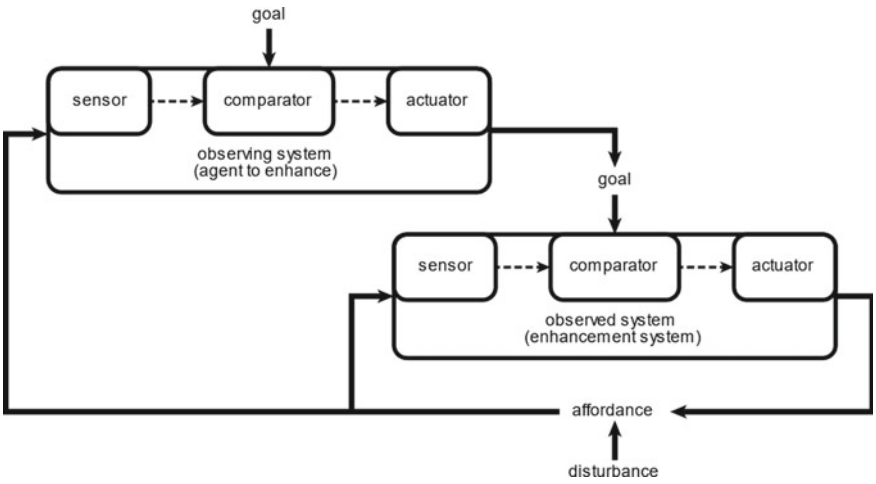

Fig. 2 Diagrammatic depiction of enhancement systems as a second-order feedback loop illustrated as nested first-order systems (Dubberly and Pangaro 2007). The agent to enhance sets the goal for the enhancement system, that is, to signify a particular hidden environmental affordance. The enhancement system conveys back to the agent information about the hidden environmental affordance leveraging on the agent's existing biology

agnostic, following the preceding argument that the same interaction can be accomplished through various modalities. As a result, many avenues of enhancement can be pursued in response to the same hidden affordance.

Furthermore, distinguishing between affordances and signifiers strengthens the proposed framework's interactional foundation. A system must signify to the agent the disturbances affecting the hidden affordance to qualify as an enhancement. The system must signify the information by leveraging the agent's pre-existing biology. Thus, enhancement systems operate as transducers, remapping unperceivable information to a format that the agent can understand. As a result, the paradigm provided here does not involve establishing a common baseline against which to assess whether a particular technology constitutes enhancement. Instead, the agent's body and any pre-existing sensory contingencies form the pragmatic starting point for designing enhancements.

4 Conclusion

This study introduces a novel outlook on the development of enhancing technologies. Whereas most studies on enhancement technologies focused on defining enhancement concerning the idea of "human", this chapter contends that the relationship between the two conceptions is problematic and limits how the field may be explored.

The approach suggested here is based on principles of Requisite Variety and second-order feedback loops to characterise enhancement technologies as systems that increase interaction possibilities with environmental affordances by signifying them to the enhanced agent via feedback loops.

Redefining enhancement technology through Second-Order Cybernetics offers theoretical and practical advantages over the other frameworks presently available in the literature. Firstly, it eliminates the requirement to define "normal": enhancement is now narrowly defined as the activity of enabling access to hidden environmental affordances. As a result, enhancement is highly contextual and does not claim universality. Second, it redirects its priority to the agent to be enhanced and its sensory contingencies, implying that enhancement must be body-dependent. The approach to enhancement technologies given here, on the other hand, increases the complexity of navigating the subject matter, for researchers must consider the agent's body, the environment in which it operates, and the interactions between the two. As a result, additional research is required to elaborate on how to navigate this complex and emerging system and provide guidelines for designing enhancement systems.

Finally, while a Second-Order Cybernetic approach to enhancement addresses some of the shortcomings of previous frameworks, it excludes some points from consideration. Particularly, metaphysical and ethical issues, as well as the reliance on the sociological context, remain unresolved. These unaddressed problems can be addressed in future research that considers the Second-Order Cybernetic approach proposed here as the biological basis for social and interaction processes.

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Use of the Viplan Method for the Diagnosis and Design of Service Organizations

Sujay Dinnalli

Abstract **The purpose**—To examine the application of the Viplan Method in the diagnosis and design of service organizations through case studies, exploring some key considerations in the process.

Methodology—Viable System Model, Viplan Method, exploration of case studies.

Value—This chapter attempts to examine certain considerations in describing service organizations, especially those offering services mediated by technology, as viable systems. It provides illustrations of two service organizations of contrasting types where the Viplan Method, methodological development of the Viable System Model, was applied.

Limitations—The ideas and case studies presented correspond to the application of the Viplan Method in uncovering the requisite structure and arrangement of activities. Its further application in detailed design of structural mechanisms, information systems and performance management are not explored here. Further, methodological considerations with respect to service organizations are explored by means of only two case studies.

Keywords Organizational cybernetics · Viable system model · Viplan method · Services · Service organization

1 Introduction

The transition to and ubiquity of the service economy has been variously covered in the literature. Even products are mostly delivered as services (Kelly 1994), or are the medium to deliver them (Vargo and Lusch 2004; Dubberly, 2017). Also, with the increasingly connected and technology-mediated nature of our world, services of all kinds are expected to be available on-demand and highly customized. Services are delivered by service organizations, and service organizations are social systems

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created by the recurrent interactions of individuals (Espejo 1996, 1994). Hence questions of the design of services ultimately become questions of appropriate design of the social systems that deliver those services.

The VSM, or Viable System Model (Beer 1981, 1979, 1985) can be seen as a model of the necessary and sufficient preconditions of viability for any social system (Schwaninger 2006). The idea of viability espoused herein corresponds to the ability of an organization to maintain its identity while managing complexity from external and internal circumstances; such an idea of viability encompasses those of performance, control, optimization and strategy. The purpose of this chapter is to answer the question: *What do service organizations look like as viable systems?* Or, alternatively: *What can be said about the structure and the arrangement of activities of viable service organizations?* For this, two contrasting types of organizations are examined. One offers a service whose delivery is made possible by various facilitating technologies; the other offers technology itself as a service.

To address the above, the chapter is organized as follows: the following section introduces the Viplan Method and purpose of the chapter; the subsequent section is concerned with examining service organizations using the Viplan Method; the final section discusses methodological implications, potential value, as well as scope for further work in related areas.

2 Background and Purpose

The Viplan Method is closely related to the Viplan Methodology (VM). A brief timeline of their co-development from the early works of Espejo and others are mentioned by Harwood (Harwood 2020); a detailed account is available in Espejo and Reyes' book (2011). VM can be seen as a hermeneutic enabler (Jackson 2019) in an organisation's use of the VSM. Instead of mere mapping of an organization to the VSM paradigm it enables conversations and learning and change around organizational viability. It is concerned with the interplay between content of conversations and the cybernetics of the situation (Harwood 2020) supporting them. Viplan Method on the other hand is a heuristic for the use of the VSM as a diagnostic and design tool (Espejo and Reyes 2011). To contextualize the two, while the Viplan Method can be seen as a thinking tool for conversations around viability, VM, in this regard, is all about improving the organizational context such that the conversations are meaningful to stakeholders, and are in the end supported by shared practices.

While the VM has been used in a variety of cases, or inspired related methodologies (Espinosa and Walker 2017), there is relatively little work illustrating the use of the Viplan Method. This chapter hopes to contribute in this direction by looking at its application in two different types of organizations. At the same time, since the organization belong to the class: service, it also hopes to elucidate some general points in the application of the Method to this class.

The Viplan Method enables discussions about an organization's identity and description (Espejo and Reyes 2011). There are five steps to the Method and they are given below.

1. Identity: In this step, a black-box description of the organization is given; to answer questions such as: What does the organization do? Who are its stakeholders? What purpose do they ascribe to it? What activities bring about the purpose? the following descriptions are made:
    - 1.1 The organization's primary transformation: that is, its inputs and outputs
    - 1.2 Primary activities, that is the activities that produce the organization's ascribed purpose or purpose-in-use
    - 1.3 Regulatory functions, or activities involved in enabling or creating primary activities
2. Structural Models: Description of the primary transformation in terms of complexity drivers—that is, sources of the environmental complexity it must manage to stay viable. Four complexity drivers are considered: technology, customers-suppliers, geography and time
3. Unfolding of Complexity: Effective chunking of primary activities into autonomous units to effectively handle environmental complexity. This points to the structural levels, or recursions evident as per the VSM paradigm
4. Distribution of Discretion: The relationship between primary and regulatory activities at all structural levels—the dimensions of autonomy that must be present, and availability of resources at each structural level
5. Structural Mechanisms: A guide for the design of organizational processes that must be in place to support the distribution of discretion and maintenance of cohesion

3 Viplan Method for Services

In services literature, services have been described as performances manufactured at the time of delivery, or simply processes that involve the transformation of a reality (Dubberly and Evenson 2010). The following sections attempt to examine what this means in terms of the primary and regulatory activities of the VSM, and through the case studies, to explore structural implications in service organizations.

In the first case, Viplan Method is used in a design mode for the imagining of a new organization that will deliver certain public services. In the second case, it is used in a diagnostic mode to uncover the structure of a software company delivering its software as a service. In both cases, with a view to answer questions laid out in the Introduction section, Steps 1–4 of the Method are employed. Step 5 is not explored in great detail.

3.1 Infrastructure Services

The formation of a new governmental organization was proposed in a South Asian country to promote active mobility (AM), that is, cycling, walking etc. among citizens. It would have two divisions: one creating the necessary infrastructure, and the other stimulating and supporting behavioural change in citizens and groups. The infrastructure services division is examined here.

While the output of its primary transformation: *infrastructure development services* was straightforward, how this was achieved was going to be complex. Infrastructure for active mobility in cities is a highly contested issue (Oldenziel and de la Bruheze 2011). The problem was compounded by socio-economic barriers, and the existence of very few documented studies and experiments.

Figure 1a shows a combined technological and customer-suppliers structural model (the TASCOI technique of the Method is skipped here for brevity, but its results in terms of customers, suppliers, inputs & outputs are captured in the diagram). It shows the various activities involved in service delivery, inputs, output, suppliers (within brackets on the left-hand side), and customers (on the right-hand side).

Six types of primary activity are required, based on possible scenarios: (A) Creation (with other external entities) of multi-mode avenues wherever new development is feasible (B) Rework of existing roads and paths to make them AM-friendly (C) Creation of exclusive AM paths (D) Creation of bicycle stops at various spots with facilities (E) Creation of pedestrian rest areas (F) Making crossings AM-friendly. This hints at the different types of teams or expertise required.

Figure 1b is the geographical structural model (a simplified diagram, for illustrative purposes) showing how the primary activity is organized within city limits. A ground-up approach was applied: it was assumed (starting hypothesis) that individual

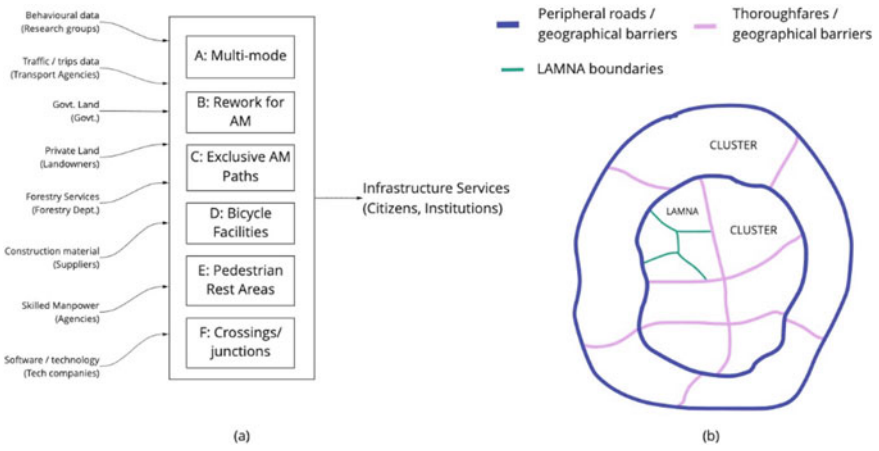

Fig. 1 Structural models

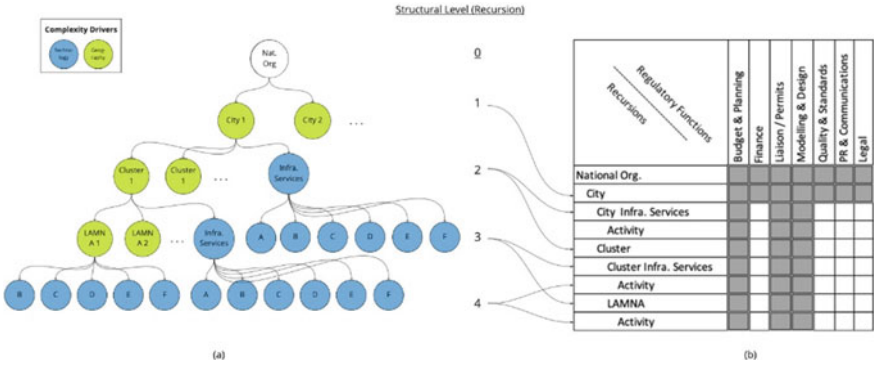

Fig. 2 Unfolding of complexity/distribution of discretion

mobility patterns formed rich local networks centered around homes, thus constituting the most clearly defined need. These networks could be connected together to form the city-wide network. Thus, Local Mobility Network Areas (LAMNA) were identified based on existing residential settlement. A set of LAMNAs, bounded by large thoroughfares or natural barriers such as rivers would be called Clusters. Interlinked Clusters would form the city-wide network.

Figure 2a shows the Unfolding of Complexity of primary activities. Overall, it is a city-specific operation (Structual Level 1). Except possibly "A", all other activity types are possible at every geographical level. The City (Level 1) engages in coordinated delivery of multiple Cluster services as well as City-level infrastructure activities (example, inter-Cluster linking). Similarly, at Structural Level 2, Clusters deliver multiple LAMNAs as well as Cluster-level infrastructure (example: inter-LAMNA linking).

Such a multi-level activity is made possible by the distribution of discretion shown in the Recursion-Function table of Fig. 2b. The vertical depth of the grey boxes illustrates the level of autonomy at each structural level with respect to regulatory functions. Clearly, all structural levels have autonomy in terms of Budget, Design & Permissions. This creates for a truly decentralized operation with each level being able to work independently, solving problems and managing their own agencies, suppliers etc. Cities may have some autonomy in Finance (to raise some funds independently), Communications & Legal matters. Proper design of structural mechanisms ensures the right balance between autonomy of units and cohesion, and the stability of defined relations. For example, a rigid definition of the Quality function will create approval bottlenecks and hamper service delivery, whereas a more open one might foster innovation, and result in continuous refinement of quality standards.

3.2 *Software-As-A-Service*

The Viplan Method was applied to a software company offering its software in a Software-as-a-Service (SaaS) model. The primary transformation of such an organization can be seen as the conversion of inputs such as infrastructure services from "cloud providers" (Fox et al. 2009) and standard software modules from other technology vendors into a software package that is delivered over the internet. This is immediately the notion of a product being delivered as a service. Thus, the primary activities of the company can be seen as those involved in developing an *internet-distribution-ready* software package, in other words, the writing of application software. Since the software requires to be constantly redesigned during its lifecycle to suit changing user and performance requirements, the company's primary activity is its constant re-production. Regulatory activities include managing its distribution over the internet, and also traditional business functions of support, sales, marketing etc. Since distribution also involves the writing of software for its programmatic control, the writing of software becomes a medium of performance and not a primary activity in itself.

The technological structural model of Fig. 3a, shows the types of primary activity involved. The geographical structural model of 3b shows how physical infrastructure may be deployed to service different locations. However, location-based complexity is largely handled by cloud providers who offer ways to programmatically control infrastructure deployment. Only a residual variety (Espejo and Harnden 1989, pp. 79–82) related to such control is left for the company to handle.

The technological model indicates a simple organization with no recursions: primary activities are performed by loosely coupled teams or individuals. However,

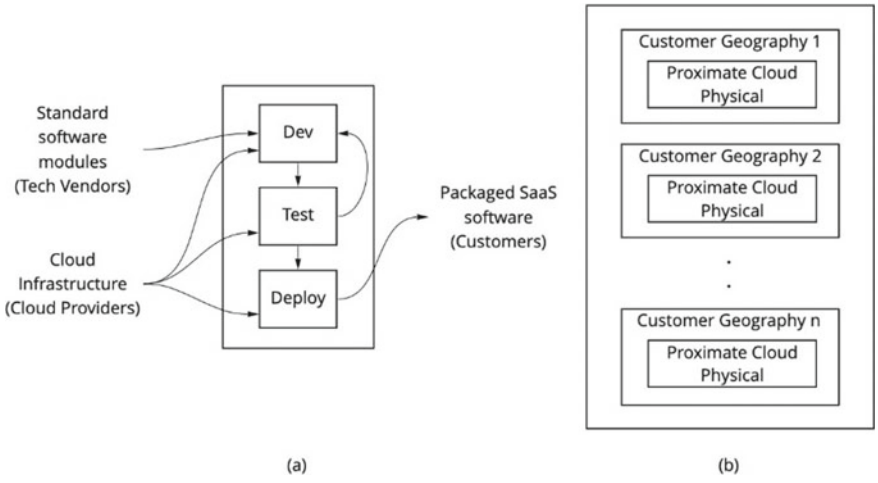

Fig. 3 Technological and customers/suppliers model

as software complexity increases, teams may be organized by skill such as f*ront-end/back-end*. A consequence of this is that design changes must be first converted into *front-end* and *back-end* tasks by a centralized function. But, this creates a bottleneck and inhibits the ability of the organization to respond adaptively. If the company must instead be comprised of autonomous units to increase adaptability, the architecture of the software it produces must also support such an organization.

Microservices is one such architecture. A microservice is an element of functionality abstracted into a service that is deployed independently (Fowler, 2014); a microservices architecture is a distributed application where each constituent element is a microservice (Dragoni, et al., 2017). Each Microservices Team may be responsible for delivering one or more microservices, and thus becomes an autonomous unit, or the first recursion of the organization.

The Unfolding of Complexity technique is naturally suited to abstraction of independent functions from the overall software, since this is nothing but the management of complexity coming from the usage environment.

In the case studied, the customers of the SaaS company were a type of service provider whose users utilized the software in order to deliver data services to customers. The software user-types were—Analyst, Project Manager, Administrator etc. Software functionalities included manipulation of data (Analysts), workflow design and file management (Project Manager) and administrative tasks (Administrators).

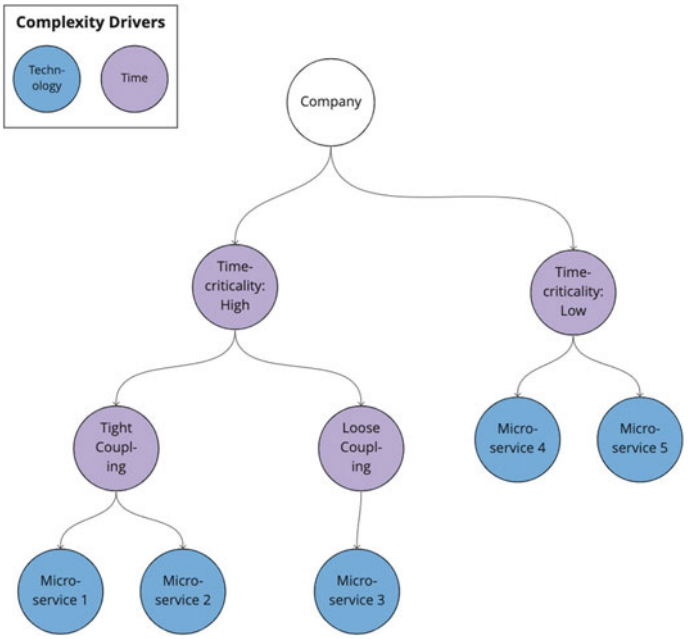

Fig. 4 Unfolding of complexity

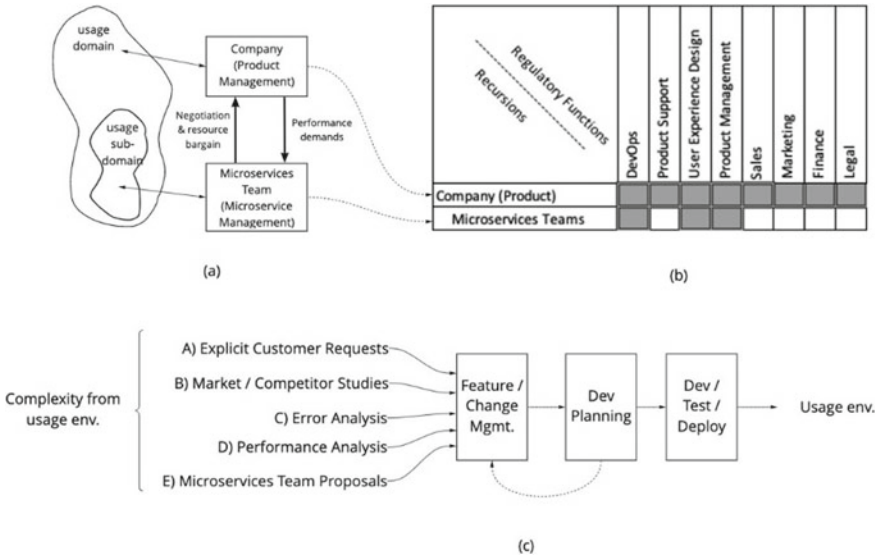

Fig. 5 Distribution of discretion & structural mechanisms

Complexity was "chunked" based on the complexity drivers of time and technology. Functions were first grouped based on the criticality of response-time. Highly time-critical functions were further grouped as tightly-coupled or independent. Finally, independent functionalities could be defined and implemented as microservices. Figure 4 shows the "chunking" that was carried out.

Figure 5b shows the distribution of discretion at the structural level of the company as well as Microservice Teams. The company has all the say in matters of Support, Sales, Marketing, Finance and Legal: this is clear since these are matters related to the software in its entirety. Microservices Teams however, have some autonomy with respect to DevOps—methodology and tools for increasing efficiency, quality and coordination among teams (Smeds et al. 2015), Product Management and User Experience Design. Since Microservices Teams may utilize different technologies, they must be able to organize their own DevOps requirements. For the same reason, they must have negotiating power with regard to user interface standards that the company may impose. Each team must be able to actively participate in the design of the product's features based on knowledge of the usage of the microservices it builds. Once again, the proper design of structural mechanisms facilitate these relations. For example, consider the feature management workflow in Fig. 5c. Inputs "A" to "D" denote the complexity from the usage including that from users as well as internal analysis of usage. However, input E is from Microservices Teams. Based on their detailed knowledge of certain functions (not evident at the company level) a Microservice Team may put forth design proposals or negotiate changes in its own interests. This results in a "resource bargain" to balance company or product level

needs with Microservice Team needs. Such bargaining can also occur in terms of performance or resource allocation as illustrated in Fig. 5a.

4 Discussion

The chapter addressed the application of the Viplan Method in two service organizations: in a design mode in the first (infrastructure services), and a diagnostic mode in the second (software-as-a-service). It focussed on describing these organizations as viable systems and uncovering their structure. Based on this exercise, some points are listed below that could be of methodological value in applying the Method:

- In the first case, the service that users experience is a direct result of primary activities. In the second, it is manifest as a result of both the primary activity as well as a one regulatory (distribution management) activity. This is because the second case is one of a product being delivered as a service: the manifestation of the service is a result of the continuous (re) production of the software, as well as control of its delivery to users
- While the metaphor of a product was used to describe a software, a more accurate description may be of it being a *systematic domain* (Winograd and Flores 1986) supporting interactions in some action domain. It might be of methodological value that the production of a systematic domain and its usage occur in very different action domains. In other words, the structural levels that may exist in the usage environment do not map directly to those of the organization building the systematic domain that enables it
- The Viplan Method, with its focus on complexity management may be a useful tool in the design of Microservices. Another paper (Ghani and Zakaria 2017) found in an online search on the same topic describes it as a "holistic" method, without going into methodological detail.

Finally, further work could explore a deeper application the Viplan method to service organizations, especially in the design of structural mechanisms and management of performance.

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Beyond Black Swans. Managing Complexity: A Contradiction in Terms?

Piero Dominici

Abstract **The purpose** of this chapter is to enhance the capacity for recognizing, comprehending and learning how to inhabit complexity, in particular social complexity, on the part of both experts and laymen, by describing the unique characteristics of complex systems, and above all by clarifying the crucial differences between complex and complicated systems, so often confused even among prominent scientists and researchers. Equally important is the purpose of changing the trajectory of those experts, educators, economists and political leaders who persist in the erroneous conviction that in the near future it will be possible to obtain a thorough understanding of virtually all phenomena, controlling and managing their complexity, and eliminating error, doubt and unpredictability from our societies and our lives.

Design/Methodology/Approach—Beginning with a brief historical description of the scientific awareness gradually acquired on the implications of complexity, hierarchical systems and the capacities for self-organization and emergence inherent to all biological, physical, human and social complex adaptive systems (CAS), and the inadequacy of defining reality through mathematical formulas or sets of rules, as had previously been used, we will provide: (1) a working definition of social complexity and "hypercomplexity"; (2) epistemological methods for teaching and training students to undertake a systemic approach, engage in systems thinking and understand the full implications of the "observer/participant" and of qualitative factors; (3) techniques for including error, uncertainty and unpredictability, conflict and debate in education, training hybrid figures capable of intersecting inter/multi/transdisciplinary fields of knowledge.

Findings—We will identify the illusions of the hypertechnological, hyperconnected civilization and its ongoing anthropological transformation, including (1) the

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"tyranny of concreteness" and "the great mistake": the belief that all problems can be solved by delegating solutions solely to technology, and that complexity can be measured, managed and predicted through data, algorithms, formulas and statistics; (2) the fracture between the sciences and the humanities and between the natural and the artificial represented by "false dichotomies"; (3) the illusions of social control and elimination of error; 4) the vision of an ordered, regular society occasionally interrupted by "black swans", without recognizing that emergency, error, uncertainty and unpredictability are intrinsic to all complex adaptive systems, which follow an irreversible arrow of time.

Originality—(1) Bringing forth evidence that managing complexity is impossible; at best, we can only cope with or inhabit complexity; (2) Rethinking education and training radically and not simply as adaptations and extensions of educational processes to the technological changes; technology is a part of culture and can never be separate from it. (3) Introducing the concept of the "overturn": today biological evolution is being determined by cultural evolution.

Social and Environmental Implications—Profound and systemic change can only be triggered from grassroots communities and individual actions, and can never be imposed top-down by intelligentsia, elites or governments. This implicates the fundamental importance of educational processes teaching systemic and critical thinking. Otherwise, any innovation will simply become a "would-be" innovation. It is furthermore essential to understand that innovating means destabilizing, at least temporarily.

Research limitations—An intrinsic limitation to the approach described in this chapter is based on qualitative methods and factors, which are, in the opinion of this writer, impossible to measure, classify, or in general translate into quantitative data, as each person and/or community is unique and in continual interaction with others. Although this can be considered a criticality, it is useful for avoiding the standardization of the findings obtained.

Keywords Error · Uncertainty · Unpredictability · The great mistake · False dichotomies · Complex adaptive systems

1 The Complexity of Complexity

Recently, in both academic circles and in journalism and communication, "complexity" has become the rage, or rather, theories, instruments and formulas for *managing complexity* have been popping up like an invasion of jack-in-the-boxes, evidently with the ambition of providing novel techniques for solving problems within and around complex systems. Hence, I intend to start off by challenging the very idea that complexity can be managed at all. First, however, as a premise, I wish to throw in another provocation: the very idea of "problem-solving" is itself off the mark; as Edgar Morin once said: "*Complexity is a problem word, not a solution word*".

At the heart of this conundrum, I believe, lies a still unclarified confusion between complicated and complex systems, a confusion which involves not only laymen or figures external to scientific fields, such as politicians and journalists, but also many prominent scientists, engineers, experts in IT and AI, educators and researchers. Let us therefore take a look, without further ado, at the significant differences between complicated systems and complex systems, with a sideways glance at the relation between complex and chaotic systems as well.

Complicated systems, which are generally artificial and mechanical, are manageable; their parts can be broken down or divided in order to observe them and understand their behaviour. Furthermore, should we decide to put the parts back together, we will see that the total quantity of parts will be equal to the whole. Complicated objects can be dissected, categorized and construed according to linear models (cause-effect, stimulus–response), whereas complex systems cannot. Above all, the evolution of complicated systems can be predicted, and predictability means control, the possibility of managing the temporary absences of balance. In nature, however, all living systems are complex; in these complex (biological, physical, social and human) systems, the whole of the system will never coincide with the sum of the parts that make up the system itself, but will always be greater, richer and more varied/diverse/different. If we want to even attempt to understand the functions of a complex system, we must consider it in its totality, focusing our attention, not on its parts, but on the manifold connections and levels of interconnection among them (Canguilhelm 1966; Bertalanffy von 1968; Kauffman 1971, 1993; Haken 1977; Lovelock 1979; Maturana and Varela 1980; Panikkar 1989; Capra 1996; Laszlo 1996; Capra and Luisi 2014; Dominici 2005, 2019). Even so, we are dealing with a system, due also to the characteristics of the parts that constitute it (cells, animals, human beings, etc.), that can never be completely comprehended, much less controlled or simplified; the quality and the quantity of the connections always make the difference ("more is different" in the words of Anderson).

The concept of complexity itself first began to take hold in the last century, when researchers, in particular biologists and physicists, aware that it was becoming less and less feasible to describe the world and its propensity for creating life using mathematical formulas or sets of rules, as had previously been done, began to formulate a series of systemic visions for studies in their fields. Prior to this change in perspective, many researchers and scientists had been fully convinced that science would sooner or later succeed in reaching a comprehensive understanding of virtually all phenomena, eventually controlling and determining their development and behaviour. It fast became apparent, however, that traditional linear models and reductionist/deterministic approaches were no longer capable of analysing the unstable dynamics of reality. From the first systems theories proposed by von Bertanlaffy and Weaver's "Boundaries of Science", through Kuhn's "anomalies" illustrating the inadequacies of the scientific methods of observation, Heisenberg's formulations of quantum mechanics, Ashby's ideas on cybernetics, up through Simon's work on hierarchies, a novel "systems approach" to complexity was being developed by biologists, mathematicians, physicists and other scientists, with an expansion into the social sciences as well (Ashby 1956; Anderson 1972; Barabási 2002; Bar-Yam

1997; Bateson 1972, 1979; Calvino 1968; Capra 1975, 1996; Diamond 1997, 2005; Dominici 2005, 2017a, 2017b, 2019, 2021, 2022; Emery 1969; Feynman 1963; Foerster von 1981; Gallino 1992; Gell-Mann 1994, 1995; Haken 1977; Hayek von 1964; Holland 1975; Israel 2005; Kauffman 1971, 1993; Krugman 1996; Kuhlmann 2013; Kuhn 1962; Laszlo 1996; Le Moigne 1977; Luhmann 1984, 1986, 1990; Mandelbrot 1977; Mathews et al. 1999; Maturana and Varela 1980, 1985; Montuori 2014; Morin 1973, 1977–2004; Neumann von 1958, 1966; Nicolis and Nicolis 2007; Henri 1885; Prigogine and Stengers 1979, 1984; Prigogine 1980, 1996; Simon 1962; Turner and Baker 2019; Weaver 1948). Morin's paradigm shift contributed to setting the new scene, with further contributions from many academics, such as Bateson, Coleman, Luhmann and Habermas. Following the footsteps of cybernetics and the social sciences, fields such as philosophy, semiotics and linguistics began to develop their own versions of systemic hypotheses. In time it would become obvious that the narrow borders between disciplines had also been overstepped, signalling the need for multi/interdisciplinary studies on the many intertwined facets of reality. Today we speak of complexity science, systems thinking, and complex adaptive systems in an attempt to achieve a more global view of the intrinsically interconnected phenomena making up our world and ourselves, although the danger of backtracking to a rigidly linear and deterministic approach continues to loom today, even among the most prestigious academicians, experts and technicians.

2 The Inevitability of Unexpectedness

The description that follows of the characteristics of Complex Adaptive Systems (CAS) holds especially true for social and human systems, whose complexity has transitioned into what I have termed *hypercomplexity* (1995–1996). This leap into hypercomplexity has been brought about by an exponential increase in variables, a significant shift in parameters, and above all, by two essential factors related to the extraordinary technological progress, in particular in digital technology, of the last decades: an unprecedented acceleration of all social and cultural processes and increased strategic virality of communication in modern society (Dominici 2020b), fraught with more and more radical interconnectivity in every aspect of social life, triggering a veritable *anthropological transformation* (Simon, 1962; Morin 1973, 1977–2004; Prigogine and Stengers 1979, 1984, 1997; Tegmark 2017; Dominici 1995–1996, 2014, 2021). However, we will never begin to comprehend the art of survival in a hypercomplex society if we do not first succeed in correcting a few misconceptions in our perspective on complexity itself, which necessarily involves radical changes in our approach, our awareness and our ambitions. We will have to educate towards achieving a systemic approach, a full awareness of the impossibility of aspiring to govern living systems, and a readjustment of our ambitions from the lofty goal of "managing" to a more modest one of "inhabiting complexity".

Although we will never succeed in managing complexity, we can certainly teach ourselves how to recognize and cope with it, how to inhabit complexity, provided that

we manage to remain fully aware of the implications of its most essential properties. Complex systems, in particular, complex adaptive systems consist of extremely large numbers of reciprocally interactive, interdependent sub-units, characterized by a high degree of sensitivity to initial conditions. In this last respect, they share this feature with chaotic systems, although the latter are often composed of much fewer numbers of smaller units, whose apparently random behaviour is actually generated by the iteration of some simple rule; thus, owing their complexity, not to the interactions between vast numbers of sub-units, but rather to the dynamic evolution of changes in the system over time. This partially explains why predictability is unattainable in complex systems, whereas it can be applied to both complicated systems artificially created by man, and with a certain degree of success to chaotic systems themselves, although the irregularities and exponential divergences in chaotic trajectories render predictability quite arduous. We must, however, underline that both chaotic and complex systems are dynamic and non-linear, as opposed to those that are merely complicated, and that very small variations, also known as bifurcations (Henri 1885), can have enormous qualitative effects on the entire system: this is what is known as the "butterfly effect" (Lorenz 1963; Stewart 1989).

Probably the most remarkable property of complex systems is their capacity for adaptation and self-modification, owing precisely to the interconnectivity, interdependence, interaction and feedback among the parts. Adjustments stemming from the smaller sub-units, passing through and involving higher and higher planes of sub-units in a progressive hierarchy, eventually give rise to self-organization, duplication, transformation and evolution: in other words, ***emergence***. This capacity for self-organization, which needs no external regulation, has also been termed "anti-chaos" (Kauffman 1993). The sub-units in these systems are individuals, entities and relations that are constantly contributing to change and to co-create the conditions of the interactions, of the framework of reference, of the ecosystem. This is especially easy to understand among human systems, where emergence can even occur at great spatial or temporal distances; in these kinds of systems, what counts is not the spatial proximity of the interacting parts so much as the intensity of the interactions themselves. "If we observe social organization or simply a group of people, or even a random set of people seen together, not only will the totality be superior to the total number of people, not only will we be unable to understand the dynamics of the group by isolating individuals or narrowing our fields of observation, but we will be forced to realize that these same people (individuals, entities) are constantly modifying, co-creating, co-constructing the social environment in which they are immersed." (Dominici 2018, p. 2–3). Furthermore, the scientific principle of "observation" itself is an unattainable concept in social systems: the "human" cannot be studied by an external observer. As in all complex systems, but even more so, the observer is part of the observed: the act of observing changes the object/system that is being observed, and the observer is in turn changed by what he or she is observing; in sociology the term that is often preferred is "observer/participant". Although this is easier to grasp in social systems, this impossibility of "observing" is common to all complex adaptive systems, which further implicates that it is impossible to map, draw, or illustrate a CAS: like time itself, complexity is invisible. Speaking of time, let me recapitulate

the property of self-organization *through* time. All CAS are capable of spontaneous emergence into ever new and unexpected forms of order, which engage in a continual interplay with disorder and chaos (Lorenz 1963; Gleick 1987; Stewart 1989; Taleb 2012), a phenomenon often described as being located on a virtual "edge of chaos". All of this takes place moving in one direction according to the flow of time, which means that complex systems are dissipative, far-from-equilibrium thermodynamic open systems, endowed with a history and memory, and that while, as mentioned before, the pathways that the system follows may undergo sudden changes triggered by unexpected events, it nevertheless moves along an ***irreversible*** arrow of time (Prigogine 1979, 1980, 1997).

This clarification of the properties of complex systems brings me to my next point: conflict and uncertainty are inseparable characteristics of complex systems, as are, even more significantly, three elements which are often the target of today's digital gurus, convinced that they are on the brink of banishing them from our lives: error, doubt and unpredictability (coincidentally, but I believe, significantly, the initials of these three terms spell the first three letters of the word "EDUcation". But more on that anon). As illustrated above, it will never be possible to visualize, much less predict or determine the pathways of complex systems, owing to their intrinsic properties. While chaotic systems can often be visualized through fractals, based on the repetition of self-similar patterns manifested in different scales through space and time, and can thus be partially predicted, the sheer number of interacting, self-organizing sub-units in a complex system render predictability impossible; to put it into (semi)mathematical terms, the essential pre-requisite for being able to predict the trajectories of a system is the capacity to measure initial conditions with absolute precision, which in the case of complex systems, would have to be *infinite* precision. For this reason, no future outcome can ever be accurately foreseen in a complex system, owing to what I have termed the *inevitability of unexpectedness* (Dominici 2021-forthcoming, 2022). Following this line of reasoning, it becomes evident that we can no longer indulge in the fallacious belief that we are on our way to setting up a perfect system of control and anticipation of future developments, reassuring ourselves and justifying the occasional emergency by calling it a "black swan." Black swans are *intrinsic elements* of complex systems, *not* unforeseeable exceptions, and the sooner we accept this, the sooner we will begin to learn how to inhabit complexity without deceiving ourselves as to our capacities for "managing" it. This is just one of what I have called the grand illusions of the hypertechnological civilization, which dictate so many of our current policies and actions: the illusions of rationality, control, predictability, measurability and the elimination of error (Dominici 1995–1996, 2005, 2017a, 2017b, 2019). As Zygmunt Bauman has said: "Uncertainty is the natural habitat of human life—although it is the hope of escaping uncertainty that is the engine of human pursuits" (Bauman 2008).

Among the "human pursuits" which characterize society in general and the hard sciences in particular (the insistence on STEM as the highest educational goal being a perfect example), there is an insidious yet firmly ensconced obsession with concreteness and measurability. The hegemonic narratives today, pervading all of society, have

reintroduced a form of reductionism, telling us that that reality is made up exclusively of measurable, empirical, quantitative, statistical data (Dominici 2005, 2014, 2022; Hammersley 2013). This is what I call the *tyranny of concreteness* (2019): this obsession with facts, figures, statistics, algorithms and quantities which leads us to believe that the data can tell us everything. What the data cannot tell us, however, is a vision of interconnectedness; the challenge is to ask ourselves: what do we want to know about these points?—and to attempt to understand the *qualitative factors* (*ibidem*). The qualitative factors are what motivate us to go beyond the driving rationale of always looking for something "useful" in what we do or study. Qualitative factors, evidently, have the disadvantage of being unquantifiable, so that they are incompatible with our attempts to "cage and control human and social complexity in its entirety, along with the *vitality of spirit* and the "non-observable" (Dominici 1995–1996, 2005, 2014, 2017b, 2021; Blastland 2019), through models and mathematical formulas, using infinite sequences of data and numbers, of molecules, synapses, hormones and chemical reactions", frightened as we are that something might escape our control. It is, perhaps, ironic, that despite the extraordinary leaps and bounds made by the digital revolution—or perhaps, on the contrary, precisely because the digital revolution has made such dizzying progress—today we find our top scientists and engineers once again pursuing the idea that all of the secrets of life and complexity can one day be predicted and controlled through "rigorous" analysis and interpretation of facts, statistics, data and algorithms, backtracking on the intuitions and discoveries that have led us to perceive the entangled and intersecting trajectories of complexity and of the living worlds. It is precisely this attitude that dooms us to remaining in perpetual apprehension of the aforementioned *black swans* (an ancient metaphor and a classic form of *retrospective rationalization*), locked inside our **cognitive cages**, as we are still unaware that *emergency is a connotative element of complex systems* (Poincaré 1908; Weaver 1948; Heisenberg 1958; Simon 1962; Feynman 1963; Neumann von 1966; Emery 1969; Anderson 1972; Bateson 1972, 1979; Morin 1973, 1977–2004; Holland 1975; Capra 1975, 1996; Le Moigne 1977; Prigogine and Stengers 1979, 1984; Maturana and Varela 1980, 1985; Prigogine 1980; Foerster von 1981; Kauffman 1971, 1993; Luhmann 1984, 1990; Kiel 1994; Gell-Mann 1994, 1995; Prigogine 1996; Laszlo 1996; Bar-Yam 1997; Diamond 1997, 2005; Mathews et al. 1999; Barabási 2002; Israel 2005; Dominici 2005, 2017a, 2017b, 2019, 2021, 2022; Nicolis and Nicolis 2007; Montuori 2014; Gentili 2018).

3 For an Epistemology of Error

Essentially, what is being attempted today is to create a society without uncertainty or unpredictability, through the use of algorithms and artificial intelligence, aimed at achieving higher and higher degrees of control (and surveillance). Among political leaders, educators, and communicators, the latest priority appears to be that of repressing conflict. This kind of suppression is destined to backfire tragically, as

conflict is a decisive element that guarantees evolution, change and development. (I am talking about non-violent conflict, except in the case of serious oppression). The most ambitious goal, however, which technicians and engineers hope to obtain through the use of artificial intelligence, is that of **eliminating error** itself from our organizations and from our lives. But error, apart from being an intrinsic feature of complex systems, is a source of knowledge and vitality and an essential part of learning. Educators would do well to encourage error rather than to insist on predetermined or standardized answers: error is what stimulates creativity and innovation. In a nutshell, error is what makes us "human beings", or better, "free human beings. Thus, the attempt to flatten out or eliminate conflict and error from social systems or communities is not only doomed to failure, but is a uselessly repressive strategy, hindering critical thinking, healthy dissent, debate, and the *epistemology of error* (Dominici 1995–1996, 2005).

Alongside the tyranny of concreteness as a limiting factor in the development of systems thinking is the incapacity of our educational institutions to free themselves from the "false dichotomies" (*ibidem*) between fields of knowledge, which are suffocating any chances for social and cultural change. I am speaking about the artificial fracture between the sciences and the humanities, between nature and culture, between the human and the technological (Canguilhelm 1966; Bertalanffy von 1968; Kauffman 1971, 1993; Haken 1977; Lovelock 1979; Maturana and Varela 1980; Panikkar 1989; Capra 1996; Laszlo 1996; Capra and Luisi 2014; Dominici 2005, 2017a, 2017b, 2019). It is time our institutions—in particular our educational institutions—set about healing this *fracture*, putting an end to the feud between culture and technology, theory and practice/research, doing away with divisions such as creativity vs. rationality, art vs. science, soft skills vs. hard skills, and all of the other false dichotomies that stand in the way of a truly interdisciplinary, multidisciplinary, transdisciplinary preparation for life and work in the hypercomplex civilization we have come to inhabit.

The inadequacies of our educational institutions are more than evident today. Not only are they failing in their function as social elevators, in reducing asymmetry and inequality, but they are no longer capable of teaching critical thinking, of forming independent, non-hetero-directed minds. We are teaching and training an entire generation of young minds to be mere "executors" of functions. And yet innovation—"true" innovation—can only come from the grassroots of our communities; on the contrary, a top-down innovation that is imposed by power, authorities, or select groups of "intelligentsia", is nothing other than a non-inclusive, *would-be innovation*, which will simply keep us running after technological progress without the necessary cultural tools to direct it. It should also be clear what I mean by innovation: in every field of individual and collective praxis, innovation means questioning consolidated fields of knowledge and methods (Bachelard 1934; Feynman 1963; Piaget 1970; Lakatos and Musgrave 1970; Popper 1934, 1994; Feyerabend 1975; Sloman and Fernbach 2017), upsetting individual and collective imagination, unbalancing equilibriums, *breaking the chains of tradition* (2005), abandoning *certainty* to move towards *uncertainty,* with considerably greater risks/ opportunities, real and perceived. In other words, rendering systems and their spaces for communication

and relationships more vulnerable, at least temporarily: *innovating means destabilizing* (ibidem). From a methodological and epistemological point of view, it is vitally important, when observing and recording phenomena –not only social, but "vital" phenomena as well– to begin "crossing" our quantitative and qualitative methods and instruments. We need to overcome the monodisciplinary and reductionist tendencies that are still hegemonic in scientific research and in our educational and training institutions. And we desperately need to find a way to intertwine the numerous and diverse approaches linked to the various disciplinary sectors.

4 Inhabiting Complexity

The question therefore arises: how can educational processes prepare students to inhabit complexity, to become hybrid figures? We will have to completely reformulate our schools and universities, rethinking education to incorporate the principles of uncertainty and unpredictability. Our students will never become capable of analysis, systems thinking, or of using the scientific method if they have not been taught how to use *logic* to develop or verify arguments, if they have not learned a method for synthesizing the enormous quantities of information they encounter, if they have not received an education that enables them to see the *connections* between knowledge and life-experiences and to evaluate the social–historical origins of cultural norms and legal norms, if they have not been taught to see objects as systems, rather than vice-versa. Educators must overcome the old linear and cumulative models, going beyond the logics of separation of fields of knowledge and the individualistic dynamics that allow solely the transmission of knowledge, and not its communication and sharing. The traditional concept of learning as a process of accumulation of knowledge must be overcome, in view of increasingly complex and articulate learning processes that are more oriented towards cooperation and collaboration. It is essential, above all, that students be taught the value of doubt and error. They should be encouraged to question and verify the validity of what they are being taught, instead of simply accepting the standard answers/solutions, to experiment with new areas and methods without fear of failure or disapproval, to delve deeply into problems, rather than searching for immediate solutions, or *simple solutions to complex problems* (Dominici 1995–1996). Last but not least, they should be encouraged to pursue their own interests and passions, rather than resigning themselves to following the most "useful" path.

What we consider today to be the limits of the fields of knowledge, to be the borders between knowledge and skills, can and must become openings, passageways, pathways, opportunities. The approach we need to teach in our schools is one that stimulates students to become *hybrid figures,* (*ibidem*), curricular profiles that are capable of holding together imagination and rationality, creativity and rigorous methodology, of uniting the human and the technological. What we have been witnessing in recent years, unfortunately, is what I call "the Great Mistake" (Dominici 1995–1996,

2014, 2019, 2020a), which is to keep thinking of education (and training) as a question of a purely technical nature, solely a problem of "skills" and "know-how" and nothing more; a process which must be dealt with by staking everything on speed and simulations. More and more often, it is in the halls of education itself where this fatal error is being reinforced, by systematically giving "carte blanche" to technology. But technological innovation bereft of culture is meaningless, because technology is part of culture, not something external to it; thus, the often-heard cliché "technology moves faster than culture" keeps us firmly anchored to our false dichotomies and our illusions of rationality.

In any case, it is my belief that we have reached an *overturn:* that today culture evolution is determining biological evolution (*ibidem*). It will increasingly be the cultural factors to determine what is possible and what is not. It may be that the distinction between complicated and complex systems is destined to be swept away by what I have defined a "*new epistemological fracture*" (*ibidem*): the advent of artificial intelligence, built—erroneously—upon the premises of the progressive marginalization of the human—and of human responsibility -and on an exponential, relentless expansion of the dimensions of *technological control;* a civilization founded on programming, automation and the (hyper)simulation of processes and dynamics. The advances in AI systems (Bostrom 2014; Boden 2018; Crawford 2021) are forcing us to rethink the very concept of *human* and the complex interaction between man & machine/man & technique (Mumford 1934, 1967; Turing 1950, 1994; Wiener 1948, 1950; McLuhan 1964; Foucault 1988), which cannot but unleash a *complex synthesis,* whose prospects, developments, and implications we are as yet unable to evaluate. Speaking of which, I am not bothered by the prospect of machines or robots becoming more and more similar to human beings; what worries me, instead, is the aspiration/vision/narrative that human beings should become more and more similar to machines. In any case, should the traditional borders between complicated and complex systems begin to blur through the advancement of AI (Perko 2020), my guess is that the progressive transformation of complicated systems into complex systems, by definition non-linear, will bring about a paradoxical re-emergence of the centrality of the human/natural dimension, with a parallel centrality of error and unpredictability, bestowing upon humanity an unprecedented plane of responsibility and power, running the risk, much like a wizard's apprentice, of being unable to foresee or evaluate the consequences of our (irreversible) choices.

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Part III
Technology and Humanity: Co-developing a Hybrid Reality

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Hybrid reality elaborates on the close interconnection of technology and people, addressing their behaviours individually or as parts of groups or organisations. From a cybernetic perspective, this theme is addressing the convergence and integration of subject, digital and physical realities. It offers a debate about the amplification of individual capabilities, through organisation and technology, and the attenuation of different digital representations and constructions of the world, actively affecting our lives. Hybrid reality refers to the dynamics of people's life worlds in increasingly 'smart environments', constructing these worlds as new technologies keep emerging.

This theme offers contributions beyond the state of the art of technological research and its applications through new tools, focusing especially on their implications for people, organisations, societies and the environment. It opens discussions on computing in design and architecture, as well as on smart devices and environments (personal and organisational). In particular, it opens a debate about big data analytics and sharing, artificial intelligence, situation centres for development, energy and transport-related issues, cybersecurity, health, block-chains and the convergence of technologies. The reasoning on technological feasibility should be advanced with implications for society and the environment: economic justifications, accordance to the law, the ethical perspective, effects on the environment and paths for identifying not yet recognised consequences.

People are adapting to huge changes in their surroundings. They are invited to share their experiences and thereby contribute to producing group knowledge and responses to the social abuse of tools, such as Facebook, Goggle and Twitter. These reflections should become the next meta-level of group consciousness. In the age of human–machine interdependence, the boundaries between individual and group intelligence are redefined, putting technology in everything we do and experience. Reasoning on group consciousness and clarification of these boundaries pose a special challenge.

This theme wants to give special attention to the design of hybrid reality elements. In addition to being subject-supportive, proactive, secure and providing value-added, the seamless supplementing of the natural and artificial in hybrid reality adds to the desired positive user experience.

We post that it is important to use CyberSystemic thinking to manage the complexity of interactions in our hybrid reality to maximise its synergetic potential on individuals and organisations, avoid misuse and mitigate undesired consequences.

A Revolution in Systems Thinking?

Andy Williams

Abstract The purpose—This contribution presents the approach of Human-Centric Functional Modelling (HCFM), and it explores why it is hypothesized to be a ground-breaking approach for understanding and navigating systems complexity.

Design/methodology/approach—HCFM was used to define a metric for complexity that might be applied in the cognitive domain to determine the complexity of the reasoning involved in defining or solving any problem.

Findings—A hypothetical metric for complexity in conceptual space was defined to be some constant multiplied by the product of distance in conceptual space and the linear density of concepts in that space.

Originality/value—The importance of using functional state space to define a human-centric metric for complexity that can be validated within one's awareness of one's own experience is that functional state spaces, and therefore potentially the same metric for complexity, can be applied in many other systems.

Research/Practical/Social/Environment implications—The general model of intelligence developed using this approach predicts an exponential increase in capacity to understand and navigate complexity, either through an exponential increase in artificial intelligence that will drive unprecedented centralization and acceleration in the unsustainable consumption of resources, or alternatively through an exponential increase in collective intelligence that will drive an unprecedented increase in collective well-being and sustainability.

Research limitations—Distances in conceptual space have only been approximated at this time, the relationship between complexity and distance in conceptual space remains to be elaborated.

Keywords Human-centric functional modelling · General collective intelligence · Artificial general intelligence · Ecosystem · Organism

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1 Preliminary Reflections and Conceptual Background

Existential philosophical traditions such as yoga suggest that whether through our five senses, through our cognition, through our consciousness, or through other functional components of human system, the external world has some impact on this human organism, and that by sharpening our ability to observe this impact we can increase our capacity to understand any aspect of the existence. This short contribution explores how a human-centric method of first-person observation might maximize human ability to solve even the most complex problems and how from this perspective, nature can be represented as having a single adaptive problem-solving process that can be generalized and copied to develop a model for artificial cognition (Williams 2020a), or a model for General Collective Intelligence (GCI) (Williams 2021a).

In Human-Centric Functional Modelling (Williams 2021b) living systems are modelled as having a set of human-observable behaviours (functions). All the functional states accessible through these functions form a "functional state space" which the system acting in that domain moves through. As an example, the cognitive system executes reasoning and understanding processes, as it does so it moves from one concept to another, thereby moving through a space of concepts or a "conceptual space" (the functional state space of the cognitive system). Using this same approach, a collective cognition can be represented as navigating through a collective conceptual space to solve group problems.[1] Any system with a stable set of repeatable functions also must stay within a bounded region of a "fitness space" that describes the fitness of the system to execute its functions. In this sense, the motion in fitness space must be stable globally throughout the fitness space, despite potentially being chaotic in functional state space due to random interactions with the environment. General problem-solving ability is hypothesized to be represented by the ability to find reasoning or understanding processes that allow the cognitive system to potentially navigate a path from any initial concept in general to any final concept in general while maintaining this stability that enables it to keep functioning. Magnitude of general problem-solving ability is represented as being related to the product of the density of concepts and the total volume of conceptual space that can be navigated per unit time. Complexity of a problem is hypothesized to be represented by the product of the distance through conceptual space occupied by the simplest solution, and the linear density of concepts along that solution. Because any conscious cognitive process can by definition be conceptualized, any individual can explore the validity of these expressions through first person observation of their own cognitive awareness.

In HCFM a system is an entity whose behaviours are confined to a single functional state space in that any behaviour begins with a state in that space and leads to a state that remains within that space. In HCFM, systems thinking is any approach that

[1] Similarly, other living processes such as homeostasis, reproduction, and evolution can be represented as adaptive problem-solving systems which move through their own functional state spaces.

facilitates consideration of the entire set of behaviours in the functional state space of the system rather than being restricted to considering behaviours related to a narrow range of problems, and therefore being limited to considering a restricted region of functional state space. Accordingly, the importance of a solution as an innovation is hypothesized to be represented by the increase in the volume of conceptual space which that solution allows to be navigated over time. This importance is hypothesized to continually increase as time progresses and the innovation is used in more and more other innovations. It remains to be confirmed whether this definition of importance is consistent with existing supposedly objective frameworks for measuring importance (Maule et al. 2012), (Benson et al. 2012). It might also be informative to compare this definition with subjective approaches that assign relative importance to innovations (Maule et al. 2008), and that seek to assess how innovations influence innovations in other domains (Nemet et al. 2012).

From the perspective of Human-Centric Functional Modelling this dynamically stable navigation of the conceptual space is general problem-solving ability in the cognitive domain, and in performing this navigation through the selection of reasoning processes the cognitive system acts as a fitness optimization function. Representation of the cognitive system as some kind of optimization function is not new (Smolensky et al. 2014), but defining fitness in the most general possible way so that the same metric of fitness can be optimized for all problems is believed to be unique to HCFM.

2 Human-Centric Functional Modelling and Systems

This Human-Centric Functional Modelling approach to systems Modelling has been used to develop a model for a General Collective Intelligence or GCI platform designed to organize groups to act as a collective cognition of a single collective organism. Under specific conditions this collective cognition is predicted to undergo a phase transition in which its general problem-solving capacity, and hence the capacity to define any problem and discover any solution, undergoes an exponential increase (Williams 2020b). This phase transition is predicted to occur when the collective cognition can create generalizations that apply to the entire collective conceptual space. The ability of the collective cognition to generalize then increases to the point that it can generalize problem definitions and solutions to the degree they can potentially be reused in any problem definition or solution in any different topic where they apply. A GCI able to generalize so that there is an exponentially greater number of reasoning processes that might be optimized to solve any problem, and able to define a single optimization function for reasoning so that it can arrive at optimal reasoning for all individuals, belongs to the category of “organisms”, which in the functional state spaces defined by HCFM are represented as entities able to generalize functions in functional state space in order to define an exponentially greater number of functions that might be optimized to solve any problem, and able to collectively optimize those functions for a set of functional components in

order to exponentially increase general problem-solving ability. This predicted exponential increase in ability to discover problem definitions and solutions of greater fitness that accompanies becoming an organism suggests that when individual entities have similar functionality as the functional components of organisms, organisms can have exponentially greater capacity to manage complexity than ecosystems of those individuals, and that exponentially increasing that capacity in individuals requires fundamentally different individuals.

This is important because the fundamental challenge of systems thinking isn't just achieving the ability to understand and navigate the complexity of systems, instead the fundamental challenge is to navigate that complexity in order to achieve outcomes. If, for example, an Artificial General Intelligence (AGI) as a fundamentally different system of optimization that might benefit an individual, and GCI as a system of optimization that benefits a group of current human individuals are both able to navigate the same level of complexity, but with radically different outcomes, then the choice between individual optimization (performed by an AGI) versus collective optimization (performed by a GCI) defines an important aspect of systems science.

Furthermore, the model of conceptual space defined in HCFM predicts that the exponential increase in general problem-solving ability that might be possible with AGI or GCI has never been achievable before at any time in human history and will not be possible again until the transition to second order AGI or GCI (Williams 2020b). If general problem-solving ability is proportional to the volume that can be navigated in conceptual space which in turn is proportional to the importance of an innovation, this suggests that either AGI or GCI will be the most important innovations in the history of human civilization.

GCI might potentially search for complex chains of cooperation between millions or even billions of businesses, so any radical increase in collective outcomes that might be achieved through such chains of cooperation might be attained. For example, in the health insurance industry, GCI platforms have the potential to radically reduce health care costs through chains of cooperation involving only a handful of participants (Williams 2021c). With complex chains of cooperation containing thousands more participants, the impact on health care costs might be truly transformative. Unlike other crowd computing approaches, a group of people organized by GCI is not merely a crowd, but effectively a single organism. The difference is that such a platform with general problem-solving ability in the cognitive domain must have the ability to potentially solve the problem of optimizing any outcome in general for the group as a single entity. A crowd on the other hand is a collection of entities which each behave in a way that optimizes their own individual outcomes, and any crowd computing solution used by such individuals has a narrow problem-solving ability and therefore must lack the ability to address problems in that domain requiring collective optimization. In particular, decision-systems with narrow problem-solving ability cannot reliably solve any optimization problem that requires changing the parts of itself that the subset of individuals who are decision-makers (that is, the owners of the platform) have aligned with their own individual interests or ideologies and therefore might have ensured cannot be changed.

3 General Collective Intelligence and Collective Optimization

Human-Centric Functional Modelling approach creates the potential to achieve massive impact through facilitating the definition of models of individual human or artificial cognition (Artificial General Intelligence or AGI) (Williams 2020a) as well as collective cognition (General Collective Intelligence or GCI) (Williams 2021a) with the potential to exponentially increase general problem-solving ability over the capabilities of any individual.

Since AGI is a centralized mechanism most likely to be employed in optimizing individual outcomes, and since GCI is a decentralized mechanism most likely to be employed in optimizing collective outcomes, either AGI might be developed first and turned towards serving the interests of a single owner or GCI might be developed first and turned towards serving the collective interests. Since an exponential increase in ability to solve problems for an individual entity might reliably prevent implementation of any decision-system able to ensure problems are solved in a way that serves the collective interests, and vice-versa, the implementation of AGI first or GCI first potentially marks a one-way fork in the road; a transition to a new society.

If AGI and GCI both represent technologies that maximize capacity to innovate other technologies, with AGI being constrained to prioritize individual benefit regardless of collective outcomes such as sustainability, then at this transition it is predicted that either an AGI will permit some entity to win the competition to serve their own interests as unsustainably as required and then be able to prevent the decentralized deployment of GCI, or a GCI will enable humanity as a group to serve its collective interests as sustainably as possible and then be able to prevent any centralized deployment of AGI.

4 Implications

This model leads to multiple theoretical and practical implications. For example, regarding the very politically charged subject of climate change this model suggests that even if every single person in the world agreed that humans are having an impact on the climate, and even if every single person agreed to work together to implement whatever the majority of scientists believe is the best solution to address that impact, if that solution was anything other than an adaptive collective problem-solving system like GCI which continuously self-assembles groups in a self-sustaining way to adapt to use whatever solution is currently most "fit" in solving the problem collectively, then this rigid adherence to that solution might be the best way to ensure that climate change remains unsolved.

In the functional state space defined by HCFM these statements aren't unprovable or controversial though they might seem so. GCI merely mimics self-assembling, self-sustaining adaptive processes that are already observed to be used by organisms

in nature to reliably achieve an exponential increase in collective outcomes. Applied to solving the problem of humans sustainably manufacturing wood for example, this statement simply says that beginning any effort with anything other than a seed (i.e. beginning with any solution that isn't a self-assembling, self-sustaining, and self-adapting process) is the best way to ensure that the problem of sustainably manufacturing wood remains unsolved (the region in functional state space that contains the solution cannot be navigated to). Because we haven't yet achieved sustainability, perpetuating any current process by definition must perpetuate unsustainability.

For all we know the sustainable processes we have yet to discover might require massive resources or participation and might be highly complex. We observe and also know intuitively that top-down processes don't reliably occur if they require too many people or other resources, or are too complex.

Aside from complexity, although the top-down processes within our current capacity for complexity are unsustainable, these processes might reliably be initiated and even completed alone or in groups of currently manageable size. Even where sustainability is our main goal, if our participation or the participation of any other centralized entity is required anywhere in the process from funding the effort to providing or consuming goods or services in the supply chain, and if ourselves or any other entity can gain a competitive advantage from acting unsustainably to do so, then as the number of potential participants increases, the probability increases that some individual will act against collective interests (in this case sustainability) in order to win the competition to play a role in that process where there is individual benefit in doing so.

Without GCI both complexity as well as misalignment with the interests of that centralized entity then become a barrier preventing the group from adapting wherever doing so requires changing the process and/or subprocess in that entity's control so that it becomes more fit to achieve collective outcomes.

5 Final Remarks and Future Directions for Research

General Collective Intelligence is predicted to make sustainable economic development and other collective impact sustainably self-funding so that it can reliably occur at the scale required to transform communities globally without external assistance. In doing so it is predicted to exponentially increase positive impact on climate change, poverty, and other collective outcomes such as the other sustainable development goals so they might be reliably solvable where today evidence suggests they are reliably unsolvable. While stating that achieving such collective outcomes as sustainability without GCI might not be a reliably solvable problem is a bold statement, if it is in fact true then not finding a way to overcome these barriers to devoting resources to independently validate or refute these claims is even more risky.

HCFM and GCI however stand beside countless other systems methodologies. The most important future direction for research in this area is demonstrating and deploying HCFM and the subset of the GCI infrastructure required to increase the

collective capacity of the systems and cybernetics community to reliably converge on consensus regarding what systems understanding is most fit in understanding any given problem in any given context. Before the large number of working papers on this topic (potentially over one hundred) that have already been drafted and that await publication can be received by the systems and cybernetics community, this key next step might need to be successfully navigate.

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Socio-cyber-Ecosystems During the Covid-19 Pandemic: Processes Performance Analysis

Vasja Roblek, Vlado Dimovski, Maja Meško, and Judita Peterlin

Abstract **The purpose**—A critical analysis of the main literature contributions dealing with the digital transformation of social subsystems in Covid-19, focusing on digital government system innovations. According to the current research, the following research questions have been prepared: What state-of-the-art approaches and solutions emerged in the Covid-19 period (or increased digitalisation) and will be a key socio-technological factor in future development digitalisation of urban (smart) ecosystems?

Design/methodology/approach—The automated content analysis was provided with the software Leximancer 5.0. The authors prepared a topic analysis function to determine the most frequent topics and contents and use the automated content analysis's extraction of statistically manipulative information about the presence, intensity, and/or frequency of thematic and/or stylistic features of texts.

Findings—It is expected that the emergence of a cyber-physical ecosystem will arrive soon, with smart communities having an important impact on changing the existing approaches, for example, learning, medical treatment, and smart governance.

Originality/value—The chapter presents the possible changes in the post-Covid-19 world, which will accelerate processes for the emergence of the technological advanced urban environment and will be based on the outgoing digitalisation of processes. Furthermore, the chapter aims to present new knowledge based on the current findings of the future possible interaction between the citizens and governance (from communication to decision making and self-governance tools). The issue of citizens' trust in sharing their data with public infrastructure is also addressed.

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Research/ Practical/ Social/ Environment implications—The Covid-19 outbreak caused massive disruption to the industry and urban social ecosystems. The pandemic impacted drivers of a nation's economy and caused changes, such as the emergence of remote working, a bike-riding spike, different smart city projects were postponed or re-aligned, and technological projects aimed at protecting against Covid-19 have been given priority. Attention must also be paid to smart technologies, such as contact tracing and surveillance tools, raising concerns about privacy and human rights.

Research limitations—The particular research limitation of the chapter is that the authors used a mixed-method for literature content research.

Keywords Data-driven solutions · E-government · E-health · Covid-19 · Cyber-physical ecosystem · Smart governance

1 Introduction

The outbreak of SARS-CoV-2, which caused the Covid-19 pandemic in 2020 and 2021, led to extremely rapid changes in the human environment. People's personal and professional relationships are changing, and people are embracing the digital tools that they had resisted and refused to accept not so long ago. In theory, situations of urgency, such as competition and decline in demand, regulatory changes, or the demands of business partners or customers, contribute significantly to the faster and more successful implementation of change. However, no theory, organisation, or country predicts changes and adaptations as rapid as those required by the coronavirus outbreak in 2020 (Maskaly et al. 2021). Therefore, diverse environments were in different situations and responded very differently. There were also temporal differences in the adoption of digital solutions due to the reduction of social contact in urban environments (Ghosh et al. 2020). In the context of accelerated digitisation, the article focuses on analysing factors that will shape and change the socio-technical future and produce different solutions that will converge in different contexts. The study focuses on technological solutions and services innovations within government systems, particularly the so-called bottom-up approach. It is expected that a cyber-physical ecosystem and smart communities will soon have an important impact on transforming existing approaches, for example, in learning, medical treatment, public bureaucracy and e-democracy (new approaches to participation, deliberation and decision-making). Initially, it is advisable to implement these changes at the local level (bottom-up approach) because it is easier to conduct tests in smaller, complex, and closed urban environments.

According to the current research, the following research questions were prepared: What cutting-edge approaches and solutions have emerged (or are reinforcing digitisation) in the Covid-19 period and will be an important socio-technological factor in the future development of the digitisation of urban (smart) ecosystems?

The chapter consists of the following sections: The introduction section is followed by the research method, and a result section follows it. In the end, a discussion regarding the current knowledge on the digital transformation of a public and political administration (especially in the Covid-19 period) follows, based on which a future solution (i.e., post-Covid-19) is presented to enable the global transformation of a classical government and e-government into smart governance. Finally, the conclusion identifies the limitations of the work and suggestions for future research.

2 Research Method

2.1 Data Source and Data Collection

To review recent research in smart governance focused on digitisation and the transition from the physical to the cyber-environment, particularly during the Covid-19 pandemic, we conducted a systematic search of articles in the Web of Science database (WOS). We used a combination of Boolean operators (AND / OR): covid-19 *, smart governance, smart government, future participation to find relevant articles. After the first search for articles, we identified 20 articles, and after another search in the WOS database, we identified nine more articles by using the names of the authors of the previously found articles. Thus, we used 29 research-relevant articles for inclusion in the automated content analysis (ACA).

In adapting the analytic process to the research questions, complex situations arise, and the adaptation itself requires the researcher to immerse him/herself in the research material, leading to the discovery of previously unknown propositions that would otherwise remain undiscovered (Merriam and Tisdell 2016). Since we are concerned with the analysis of relatively limited and new knowledge, we have used ACA to represent a research phenomenon. This approach allows the analysis of textual sources, regardless of their origin, to create themes and concepts (Hopkins and King 2020). We used Leximancer 5.0 to perform ACA.

3 Results

Twenty-nine articles published in 2020 and 2021 were used to create the ACA. The following topics were identified as part of the analysis, as shown in Table 1: ‘government’, ‘cities’, ‘covid’, ‘adoption’, and ‘online’.

Leximancer was used to create a concept folder, which is shown in Fig. 1. The concept folder consists of topics (coloured circles) and concepts that form a single topic (the text is written in black font). The colours define the importance of the themes as a ‘heat map ‘(the lighter the theme, the more often it was found in the analysed texts) and the size (the larger the theme, the more concepts it contains). The

Table 1 Themes and concepts *Source* Authors

Theme	Hits	Concept
Government	3411	government, public, social, health, information, local, trust, concern, services, measures, media, citizens, impact, national, privacy, knowledge, medical, sector, news
Cities	3349	cities, smart, technologies, governance, digital, system, urban, management, environment, communities, global, world, human, population, access, infrastructure, life, society, solutions, challenges, quality, AI, change, business
Covid	3084	Covid, pandemic, people, economic, virus, spread, crisis, lockdown, control, countries, care, disease, outbreak, risk
Adoption	586	adoption, work, blockchain, platform
Online	418	online, learning, power

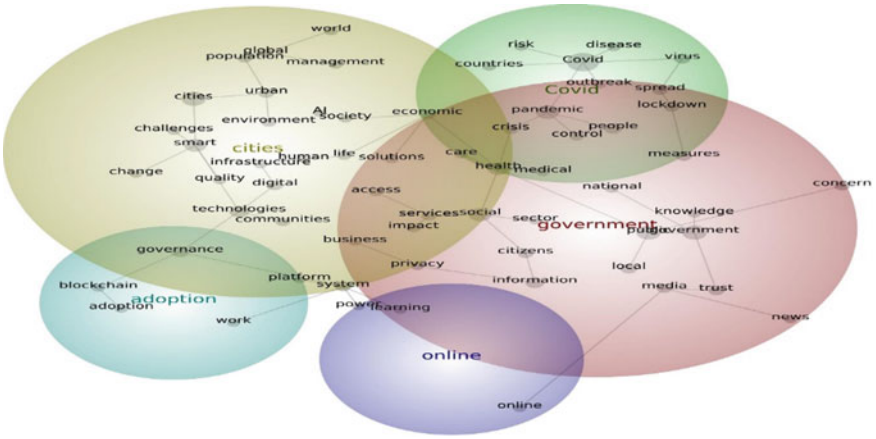

Fig. 1 Concept map for selected articles

concept map also shows that topics are overlapping; in our case, ‘governance’ in ‘platform’ lies in the overlap of themes ‘cities’ and ‘adoption’; ‘learning’ lie in the overlap of themes ‘online’ and ‘government’; ‘spread’, ‘lockdown’, ‘outbreak’, ‘pandemic’, ‘control’, ‘people’, ‘medical’, ‘measures’ lie in the overlap of themes ‘government ‘ and ‘covid ‘; ‘crisis ‘, ‘care ‘, ‘health ‘ lie in the overlap of themes ‘government’ and ‘cities’; and, ‘economic’, ‘solutions’, ‘access’, ‘services’, ‘solutions’, ‘social’, ‘business’, ‘privacy’ lie in the overlap of themes ‘cities’ and ‘government’.

4 Discussion

Technological solutions to prevent the spread of Covid-19 (Topic: Covid) led to a socio-political divide caused by the adoption of different socio-technical approaches. From the existing literature, it can be concluded that Asian countries (China, South Korea, UAE) have opted for a technology-driven approach, while Western countries have opted for a human-driven approach. This decision is likely to have long-term consequences, which in Asia will be seen in the increased use of technology in urban ecosystems, and it will be used for the open public collection of citizens' private data. Nevertheless, technology will have limited access to and strict control over people's privacy regulators in Western countries. Another social development is based on democratic principles. For this reason, it is important to understand how technology affects social developments in Asian cities during the pandemic. The technology-driven approach adopted by these cities was probably more productive in identifying, isolating, and quarantining the infected, but its consequences are also visible in the suppression and censorship of citizens' opinions (Kummitha 2020).

Another question is how people deal with the technology used in political and institutional contexts according to the democratic norms of each country. In Western democracies, such sensitive information is shared anonymously, which is not as effective as collecting data from individuals, as we see in China. Moreover, in recent years, Western countries have enacted privacy laws to protect personal data. Therefore, the government's ability to collect data directly from its citizens is limited (Bartlett 2018). Most analysed articles focus on the progression and prevention of pandemics and the acceleration of digital transformation and its impact on social development in local (more rural) ecosystems (Hartanto and Siregar 2021) and (smart) cities or at regional and national levels (Ahn and Wickramasinghe 2021; Kummitha 2020). The articles focus on digitisation and the emergence of smart innovation systems that changed the social interaction of citizens during the pandemic and promoted the use of e- or m-services for this purpose. The accelerated digitisation processes started pushing human activities into cyberspace.

For understanding the impact and profound societal changes resulting from digital transformation in (smart) cities (Topic: Cities), it is necessary to know the role of systems thinking in a smart city. According to second-order cybernetics, smart cities are open systems. Their characteristics include highly distributed, heterogeneous, large-scale, unpredictable, uncertain environments (Krivy 2018). Richmond (2001) believes that systems thinking provides a new way of thinking to deal with future real-world applications' expected complexity and interdependence. Systems thinking is a holistic approach to analysis that focuses on how system components function and how systems function over time (Ghosh et al. 2020). Systems thinking mimics the behaviour of natural systems that adapt to changing flow conditions based on outcomes that benefit the whole. For successful implementation and citizens' acceptance of smart social innovations, citizen usage patterns of smart technologies and trust in local and national authorities to not use smart technologies to control citizens

undemocratically must be ensured. Systems thinking is based on processes rather than regulations, and its goal is flexibility and adaptability.

Thus, a city as a whole is smart, and if this condition is met, its parts must be smart individually or collectively. In reality, this can be achieved by building complex Information communication technology (ICT) networks through which smart utilities, smart governance, smart private services, smart health services, smart education services, and similar can be established and jointly operated by the public and private sectors based on physical and cyber-interdependencies (Topics: covid-19, Government, Online, and Cities). It is about a complex continuous structure resulting from different interdependencies between the services of the future smart cities (Abbas et al. 2018). Thus, both Blockchain and Artificial Intelligence together with Big Data are playing an increasingly important role in the establishment of Smart Urban Systems, alongside already classic technological solutions such as the Internet of Things, cameras, sensors, cloud computing, which are part of urban knowledge management, of which the Urban Management System is a key component (Theme: Cities, Adoption). As part of pandemic prevention, Covid -19 intelligent management systems and applications have been set up to protect self-quarantine and information about possible social contacts with an infected person worldwide. Indeed, Covid-19 presents a challenge in terms of the amount of information generated and disseminated. The mass of information has led to a situation in which it is difficult for citizens to distinguish between the real situation and Fake News. The consequences of this situation have led to an increase in people's distrust of the actions to be taken and the lack of trust in national governments, which is also related to the management of Covid-19 information (WHO 2020). The flow of information depends on ICT because the systems for tracking contacts with infected people and disseminating information about the virus are based on data-driven mobile applications that refer to ICT platforms developed for the provision of services by the government, what we know in practice as e-government. From this perspective, e-government increases government efficiency and accountability and enables citizens to access and use public services without hindrance. The importance of such an approach has been proven during the pandemic, especially in the promotion of strategic information management and the emergence of e-government services specifically for the administration of Covid-19 (Theme: Covid, Government and Cities) (Mensah et al. 2021). E-government systems should also take care to reduce the democratic standards associated with increased control of citizens and private information for excessive control and management of individual habits. In South Korea, for example, government agencies were allowed to use Big Data analytics and violate individual privacy, overstepping the boundaries of accountability (Ahn and Wickramasinghe 2021).

In the wake of the pandemic and the introduction of data-driven technologies to contain and control Covid-19, the issue of privacy and the violation of individual rights has become one of the most important issues for policymakers, even in Western democracies. Therefore, public awareness of democracy in cyber-ecosystems needs to be raised both in Western democracies and in countries with lower democratic standards or countries ruled by autocratic systems. Citizens must demand that the

state take security measures and prevent any misuse of individuals' sensitive personal data and that the state ensure that it is accountable for the lawful use of this data (Hartanto and Siregar 2021).

In sustainable urban development, the transformation of cities into smart cities plays an increasingly important role (Topic: Cities). Cities are becoming increasingly digitised and socio-technical ecosystems through modern urban infrastructures and information technologies. All to improve the quality of life of citizens. However, prior to Covid-19, smart cities, especially in Europe and the US, failed in prevention and fought the virus. With the pandemic requiring government action, countries were the first to prove that investing in complex smart technology systems at the national and regional level paid off. However, there was a paradox between the northern and southern hemispheres. In the UK, regions such as Scotland, England, Wales and English cities, including London, cannot deploy smart technologies to combat the pandemic, despite both regions and cities having robust urban digital systems and being considered smart in theory and practice. Indeed, cities in the southern hemisphere have demonstrated that they can deploy smart technologies in the context of pandemic containment. Although these cities have adopted smart urban systems, they are technologically behind than northern countries. These cities in the southern hemisphere do not have digital technologies and applications that rely on Big Data, IoT, and crowdsourcing approaches (Gaskell et al. 2020). The success of South Korea is also worth mentioning: they did not take such drastic measures in the first wave in the spring of 2020 as in European countries, the United States, and immediate neighbours such as Singapore or China, in the form of a complete lockdown. Technological solutions in smart Korean cities and the willingness of residents to accept the use of data-driven smart apps, despite possible concerns about not-democratic processes, are enabling the containment of the spread of the virus. It can be concluded that South Korean cities, with their technology, play an essential role in ensuring the proper functioning of businesses and public institutions and keeping morbidity and mortality rates low (Ahn and Wickramasinghe 2021). The Korean smart city case can serve as an inspiration for Western cities that have suffered from the disastrous consequences of a pandemic (population displacement, closures and relocations, collapse of financial institutions, investment cutbacks, and even bankruptcy of cities) to revitalise urban centres in the post-pandemic period, focus on the processes of restructuring and rethinking the communications infrastructure, ensuring both technological awareness among the population and legal criteria that prevent the undemocratic use (misuse) of smart technologies by public and political administration (Theme: Cities, Government, and Covid).

COVID-19 accelerated digitisation both in business and public services and the government itself. Pandemic had unforeseen consequences for major cities like London, Madrid, Vienna, New York, Singapore, and Hong Kong. City governments have decided to accelerate investment in technology components for smart cities to contain the expansion of Covid-19 while ensuring an investment cycle. In Singapore, for example, they have ensured the development of technology solutions in response to Covid-19 by increasing funding for enterprise digitisation (Das and Zhang 2020). City governments seek to ensure the further development and implementation of

data analysis, artificial intelligence and sensors to implement governance initiatives critical to citizens (health) security and further socio-economic development. Cities have to place greater importance in 2022 on post-pandemic resilience planning. As a result, city governments have moved to streamline and expedite the implementation of emergency preparedness systems. A vital feature of the systems is that they include capabilities that pinpoint the location of callers via cell phones and use dashboards and data visualisation tools to manage future crises.

COVID-19 had also accelerated the transition to e-learning (theme: Covid, online) and opened the market for future development of citizen-centric ICT solutions, innovative products and services for smart city economy, digital health systems, development of smart city business models and new cyber challenges of citizen participation in public affairs and also decision making (voting). Such solutions emerge from transforming a classical government, e-government and e-democracy approach into smart governance, which is understood as a citizen-centred process of using civic technology (Roblek et al. 2020). Furthermore, smart governance presents the possibilities of future development of smart communities based on a bottom-up approach and cyber community sub-ecosystems to plan and connect citizens in smart city ecosystems (topic: cities, adoption and government) (Bricout and Baker 2021).

Smart governance offers opportunities for the future development of smart communities based on a bottom-up approach and cyber community sub-ecosystems for planning and connecting citizens in smart city ecosystems. It is argued that smart governance approaches are theoretical concepts that can transform society. If we want to realise this scenario, we need to implement social learning policies and achieve a proper educational structure about the liberation process of citizens at all levels (Pitasi et al. 2018). Policymakers, citizens and other stakeholders need to understand the importance of smart governance as a social innovation for the prosperity of cities. The more empowered citizens are, the more likely cities will adapt to new smart governance technologies. The consequences of insufficient social learning can be seen in techno popularism, an innovation, although the relationship between populism and technology is not new in the European political scenario. The key elements of techno populism include internal egalitarianism, people organised into a social community, direct democracy, techno-libertarianism and hypermedia (technical knowledge, possession, anti-elite technocracy). It builds on factors such as political elites are corrupt, the government is corrupt, politics is not adequate, meritocracy as an ideology and the rule of law (De Blasio and Sorice 2018).

Bickerton and Accetti (2021) wonder if there is a possibility that the struggle between the opposition between left and right can replace the "decoupling" between populism and technocracy. On the other hand, Mueller (2017) points out that there is only one correct political solution from technocracy, and populism believes there is only one credible will of the people. This statement implies that both reject democratic debate and can be interpreted as de-politicisation. It is indeed another aspect of the post-political period. Its results can be seen in the effects of de-politicisation and the emergence of a new form of re-politicisation by digital technologies. Suppose the political system in the urban ecosystem wants to coordinate and carry out a process with active public participation. In that case, it must distribute its power what can

be done with the social innovations of government through new technologies, digitalisation and informatisation of processes that are already impacting urban (smart) ecosystems and challenging their governance models. As shown in Fig. 2, the role of the citizen in the decentralised governance system can be explained by applying the process model of soft systems thinking in the smart ecosystem.

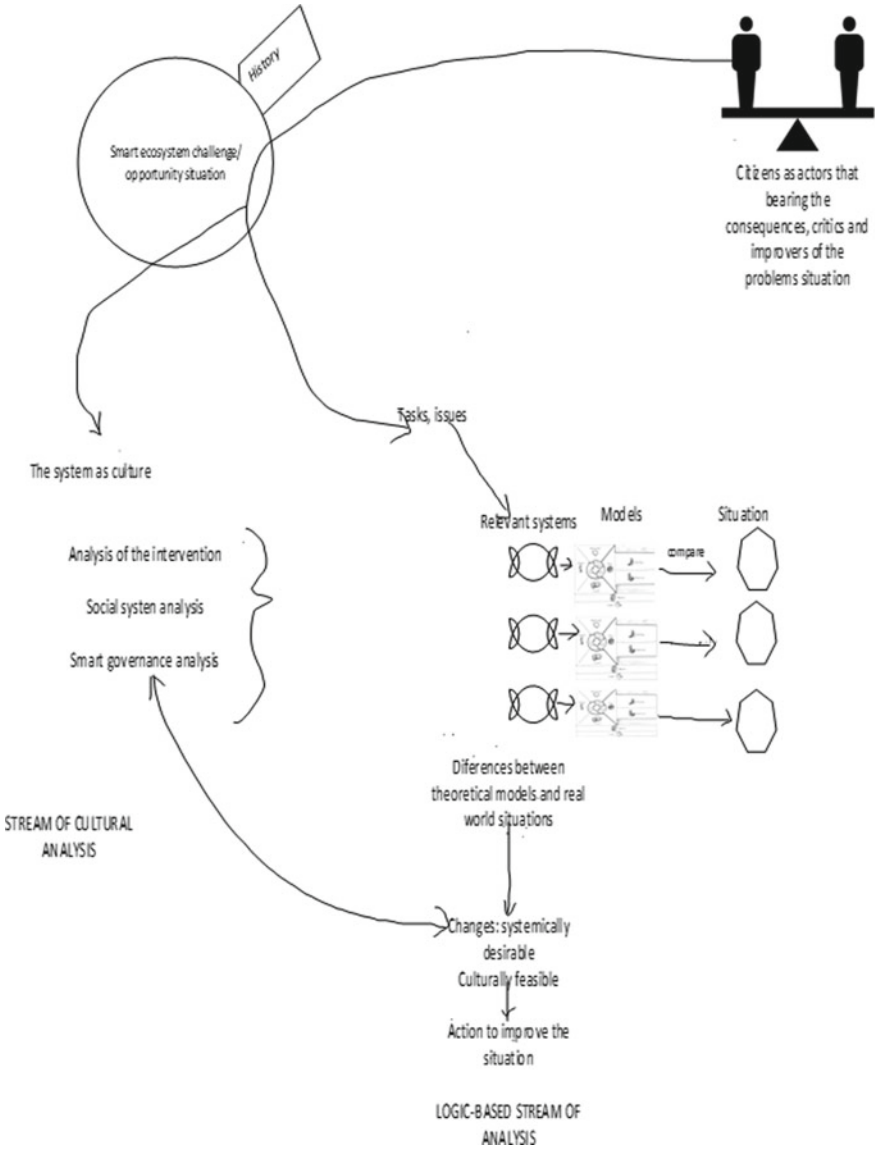

Fig. 2 Model of soft systems thinking in the smart urban ecosystem

The decentralisation of government and its responsibilities does not mean that the authority has withdrawn from regulating the system. In practice, it means that processes are regulated indirectly. In this case, actors self-regulate their activities (Giddens 2013; Lobao et al. 2018). The next step is self-governance (Paulin and Welzer 2013), where technology enables the non-mediated creation, storage, retrieval and modification of information that determines the claims of legal subjects in society. Non-mediated governance gives citizens new mechanisms to govern. Such mechanisms can enable new communities embedded in social, political and economic networks (Paulin 2019). Thus, it can be said that citizens undergo non-mediated governance mechanisms that pursue their goals and/or additional values. This process results in the government transferring its powers and responsibilities to various non-state actors, including private sector actors, citizens and non-governmental organisations (Hemmati 2012).

In the concept of the research of emerging smart governance and the urban civic technologies as a result of R&R in the fourth industrial revolution, we have to explore a living system that has its own "will", regardless of the level of development of organisms (technology development, de-bureaucratization, political readiness to transition from the representative democracy to a participative and in the final phase to a liquid democracy and cyberspace self-governance). The paradox is that living systems such as the urban ecosystem are organised organically, and, on the other hand, information is open. Consequently, living systems are more challenging to manage. Their interactions with their ecosystem are more complex, and it is impossible to predict more than a few moves in advance. So, it will increase the control capability developed by second-order cybernetics, which part presents smart urbanisation (Krivy 2018). Concepts related to second-order cybernetics, such as self-organisation, explicitly determine the limits of predictability and manageability (social systems and natural systems). Cybernetics is focused on the understanding of social complexity as well as its control. According to this orientation, it is understandable that the other type of cybernetics is more focused on creating new forms (morphogenesis) and a positive feedback loop.

5 Conclusion

The study aims to analyse the current state of knowledge to present state-of-the-art approaches and solutions that have emerged (or reinforce digitisation) in the Covid-19 period and will be a crucial socio-technological factor in the future development of the digitisation of urban (smart) ecosystems? According to Guinchard (2020), the pandemic has raised concerns about privacy and fundamental human rights when using digital technologies such as contact tracing and surveillance tools. There is, therefore, a need to ensure the anonymity of users of Covid-19 management apps. In particular, it is necessary to ensure that various stakeholders (e.g., the government) and hackers do not have unauthorised and unrestricted access to various types

of citizens' private data. It is also necessary to ensure the trust of the public (citizens) because when citizens trust government institutions and developers, they are willing to share more personal data with the authorities. However, it is essential to be aware that governments are not only tempted to abuse citizens' digital footprints when using digital contact applications. More and more companies in the private sector are engaging in "information capitalism" or "surveillance capitalism", using business practices that exploit people's digital footprints to build profiles of users. These practices have often proven difficult to challenge (Zuboff 2019). Therefore, consistency and transparency within the supply chain must apply to both the state and private individuals. To prevent such practices, it is necessary to ensure systematic enforcement of the General Data Protection Regulation (GDPR) and conduct regular inspections.

Successful use of data and tracking of personal health devices could be a turning point for broader acceptance of the health technology application domain. The applications of Covid-19 systems show only a small sample of their potential in urban management systems. Expanding the use of wearable technology that monitors breathing, heart rate, and temperature, for example, can provide early and tailored interventions for thousands of patients and improve resource allocation in times of crisis. Health authorities, insurers and city agencies have recognised how technology can facilitate early intervention and improve service delivery and may be ready to expand its use in day-to-day healthcare in the long term. Governments have also recognised the added value of smart technologies in advancing e-learning and smart governance.

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Partnerships as a Feature of the Digital Transformation of the Media Industry

Boris Slavin and Alexander Slavin

Abstract **The purpose**—this study aims to explore partnerships in the media industry's digital transformation. Partnership as a phenomenon is typical for all sectors of the economy caught up in digital transformation. However, since the media was the first industry to embark on a digital transformation, its expertise will be helpful to all other industries. The partnership assumes the participation of various content creators and the users in creating the content. The latter is most important for online partnerships in which content users participate as commentators and content evaluators. One of the main issues in the effectiveness of media projects is the trust in content.

Design/methodology/approach—within the framework of this study, various types of partnerships in the media industry were examined. Traditional and network types of partnerships are distinguished, divided by the number of participants and the involvement of consumers in content creation. A model of trust in media industry partnerships is built, which can be used for further research of partnerships in other sectors of the economy. The trust model includes content personalization, the volume of partnerships, and consumer participation in this content creation. The role of partnerships in digital content creation provides an opportunity to take a different look at copyright.

Findings—the proposed digital content trust model allows us to investigate the problem of trust in content in the media industry based on the participation of consumers in its creation. The chapter assumes that content personalization encourages consumers to participate in content development and makes it more trusting. In addition, trust is influenced by the scale of the partnership and the involvement of the consumer in its creation. Partnerships make media authorship collective. Since in modern media all created content is based on partnerships, this requires a revision of the copyright system.

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Originality/value—this study connects two trends in digital transformation: partnership and personalization (both creation and consumption) and allows us to extend the theory of collective intelligence to the media industry, which no one has done before. At the same time, a special role of network partnerships is presented, in which the content consumer also acts as a partner in its creation. Exploring this role of partnerships will have implications for other sectors of the economy in which the client begins to play the role of a partner of suppliers of products and services.

Research/Practical/Social/Environment implications—many social and political problems arise around digital content use. Understanding the nature of partnerships will enable new rules for digital services in the media industry. In particular, understanding trust in the content will allow us to address the so-called fake news, which has become a constraining factor in online and traditional media development and an instrument of political struggle. Trust issues will also arise in other sectors of the economy as they become involved in digital transformation. Already today, there are problems associated with trust and, as a result, with the safety and quality of services in the financial industry, in the field of trade, etc.

Research limitations—this work should be perceived as the beginning of a larger-scale study, which requires support with factual material and surveys. In the future, based on the proposed trust model, it is supposed to investigate specific media projects, particularly in video blogging content.

Keywords Digital transformation · Media · Social networks · Communications · Communications partnership · Personalization

1 Introduction

Mass connection to digital communications at the end of the first and the beginning of the second decade of the 21st century gave rise to the digital transformation of the economy. However, different sectors of the economy are involved in the digital transformation process in different ways. Global Center for Digital Business Transformation, created under Institute for Management Development (IMD), conducts the research (International Institute for Management Development 2021) twice a year—which industries have already begun to transform, which have not yet. The authors present the results of such a study in the form of a digital vortex. The media industry pioneered the digital transformation and therefore found itself at the centre of the digital vortex. Media digital transformation has affected all aspects of human life related to content one way or another (Friedrichsen and Kamalipour 2017). This situation is understandable—the first thing people who got access to the Internet began to use is content resources. Today, tools for exchanging digital content of various formats (websites, digital broadcasting, social networks, instant messengers, etc.) are used by the majority of the population—according to Digital 2021 Global Overview Report, 4.2 billion people are active users of social media, 53.6% the entire population of the Earth (Kemp 2021).

As early as 1996, Microsoft founder Bill Gates published his essay "Content is King" (Gates 2010) in which he predicted the media industry's digital transformation. All these expectations and even more have come true today. In 2016 the media industry became a topic of discussion at the World Economic Forum (WEF) as part of a unique project dedicated to digital transformation and prepared a year earlier (World Economic Forum 2015). The experts suggested identifying four stages (waves) in the media industry's digital transformation. In the first stage—the end of the 90s of the last century, experts associate with file-sharing services, particularly with the peer-to-peer service Napster created by Sean Fanning, which allowed users to exchange music files. The next stage of digital transformation is associated with new formats, when at the beginning of the 21st century, Steve Jobs, then head of Apple, announced the iTunes media player, which effectively closed the era of floppy disks and CDs in the media industry. The third stage (wave) began in the second half of the first decade, when many people gained access to the Internet and, accordingly, to digital content, thanks to mobile technologies and social networks. Finally, according to WEF experts, the fourth stage of digital transformation will be associated with the creation of ecosystems by companies in the media industry.

In 2019, the research company GWI (GlobalWebIndex) published a report (GlobalWebIndex 2019) comparing the world's digital and traditional media ratio. At the time of writing, the global average time spent by digital media users was 6 h 44 mins per day. The average time spent on traditional media was 4 h 32 mins. Digital media satisfy a person's need for information and become a part of his communications. It is no coincidence that the two hours difference between online and traditional users is approximately equal to the time online users spend on social networks. And they allow not only to consume information but also to participate in its creation, to be partners in the production of content.

Below will be considered the issues of partnership in the media industry's digital transformation. The leading position of the media industry in the field of digital transformation makes the study of partnerships incredibly fascinating since such research can be extended to the entire digital economy as a whole. It is easy to understand that partnership as a phenomenon is becoming a general trend for all sectors of the economy involved in digital transformation. So, for example, self-service tools in the financial sector and trade engage the client in providing services. Rating service providers and goods in marketplaces engage customers in quality assessment and recommendations. Car-sharing users take over the functions of inspecting cars, and buyers using the Scan & Go service act as cashiers. Digital transformation blurs the lines between employees, customers, suppliers, and other stakeholders. It does not only erase boundaries but also involves them in partnerships.

2 Features of Partnership in the Media Industry

Within the framework of the GWI study conducted in 2021 (GlobalWebIndex 2021), it was considered how the distribution between different media directions

changed over the years. In 2016, a new consumption format in the media appeared, which became significant: music streaming. Since mid-2018, podcasts (discussions recorded in digital format) have emerged, which by 2021 have won 54 minutes of average user time, slightly pushing back other media formats. However, despite the substantial impact in the Covid period on people's lives, no new consumption formats have appeared in the last two years, indicating some saturation of the media market. At the same time, new transmission data tools are appearing (VR/AR, video streaming, etc.), and market participants are looking for new formats anyway. Furthermore, the expansion of formats leads to the fact that specialists working in the media business also have new opportunities for transition to more diverse tasks, closer cooperation between different media professions (Malmelin and Villi 2017).

The main difference between modern digital media and conservative media is that digital communications make it easy to get feedback from content consumers (Lindgren 2017). Such an opportunity existed in the past (and is still often used) when it was possible to make live calls to radio or television or write a letter to a newspaper, but the number of such calls or letters is minimal. Today, almost all social media provide an opportunity for content consumers to leave their comments, express their approval or disapproval of the material. Moreover, comments and recommendations are an integral and significant part of all content (Slavin and Slavin 2021). This is especially true for social media that do not imply large-sized content (Twitter, Facebook, Instagram, Telegram, etc.). Nevertheless, even when posting large-sized content (for example, a video on YouTube hosting), comments on it can play a significant role. For example, when publishing construction technology videos, professional discussion of the posted content can be just as helpful as the video itself.

Partnerships in the media industry are designed to solve two problems: the first is to improve content (due to its diversity among different partners), and the second is to increase trust in it (due to greater objectivity). The types of partnerships in the digital media industry can be divided into traditional and network partnerships. The former includes partnerships between content creators. There are two options here: content sharing (where one content creator uses the content of another) and co-creation (where content creators come together to create shared content). For example, someone else's content is often used in television when the news offers footage produced by specialized agencies or partner studios. Network partnerships include comments on content and rating (recommendations) of content. Although traditional types of partnerships existed in the pre-digital era (and partnerships in content creation began to be used more often on the Internet), network ones, on the contrary, became possible only in connection with the use of online content promotion tools.

Network partnerships today dominate social networks, while traditional types are represented both in classic media formats (radio, television, film, and print) and digital (mainly on video hosting and digital cinemas). The success of network partnerships is associated with a greater variety of content than in traditional ones created by numerous bloggers, but most importantly, with the ability to participate in the discussion of content. It is no coincidence that bloggers rarely turn off comments on their posts, although such comments are often impartial and sometimes unfair.

Traditional and network partnerships differ significantly in the number of partners in partnerships: in traditional partnerships it is small (a few and tens); in network partnerships, it is significant (hundreds of comments) and extensive (tens and hundreds of thousands of ratings). This suggests that the trust in network types of partnerships is higher than in traditional ones.

3 Digital Content Trust Model

To understand how trust is related to the type of partnerships, we will build a media trust model that would link all types of partnerships. Three factors influence the credibility of media content. The first is the scale of the content partnership. For example, many people trust official news because a large number of participants create their content: news agencies, reporters, correspondents. It is no coincidence that content creators mention everyone who provided information to them—not so much for the sake of copyright (which, for example, do not concern their correspondents), but to show the scale of the participants who create the content. Likewise, bloggers who create content personally also try to link to various sources to add weight to their content. Personalization of information is another important factor. It is important for a person that the content that he consumes was created by a specific person whom he knows, or may know. That is why, in thematic programs, they often turn to specific experts and not just read out certain conclusions.

The most crucial factor influencing trust in information is participation in its creation. Such participation is possible for all types of partnerships, including traditional ones: the consumer of information can be involved in the discussion (often used on radio broadcasts, offering to call the station); he can create content with friends and consume it. However, the number of such content consumers will be small. Network partnerships will have a much larger number of people involved in content creation, where it is enough to "like" or write a short comment to participate. Figure 1 shows a model of this influence of types of partnerships, depending on one factor or another.

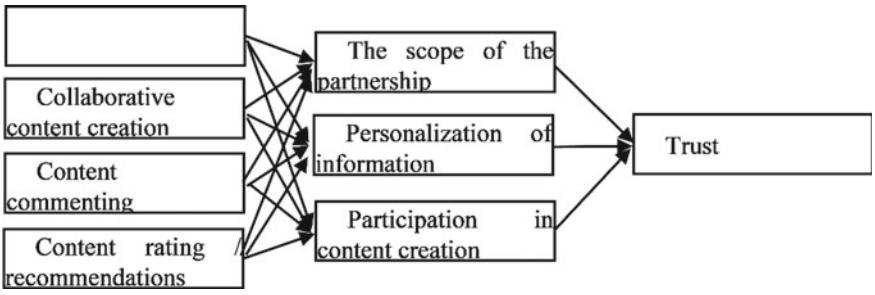

Figure 1 Digital content trust model

Trust in content increases as partnerships grow, personalization increases, and consumer engagement in content creation increases. Traditional partnerships that fall short of network partnerships in attracting consumers will compete on the scale of the content creators involved and the personalization of content makers. Network partnerships will use all the factors to increase trust. This is why bloggers with millions of subscribers successfully compete with the official and reputable media. Medium- to small-scale partnerships are likely to come together to co-create content to increase their content's credibility.

4 Partnerships and Collective Authorship in the Media Industry

Content attribution is a major challenge in digital media partnerships. When content was created on a relatively small scale in pre-digital times, copyright was manually tracked and not particularly worrisome. Digital technologies and the abundance of digital audio and video files on the Internet have made it possible for anyone to easily use someone else's content to create their media products. This can be, for example, using a well-known musical accompaniment to decorate video, using a photo to create a unique presentation, or illustrating performance with frames from a movie. The volume of publications on the Internet that include other people's content is estimated at millions per day, and it is almost impossible to manually handle copyright on such a scale. As a result, large video hosting sites and social networks are using artificial intelligence technologies additionally to employing a large staff to identify copyright violations.

The problem of copyright arises in the case of misuse of content and when accounting for products in which large groups of authors participate. Large producers of media content, such as Walt Disney, use special services (including those based on blockchain technology), which make it possible to consider the share of authors, both employees of media corporations and their contractors (artists, composers, screenwriters, etc.) in the finished media products. Such services even allow you to issue licensing agreements for the use of copyrights automatically. However, no technical tools can solve the ever-widening (and the pandemic only reinforces it) imbalance between the need for open access to information and copyright accounting (Shrayberg and Volkova 2021).

The digital transformation of the media industry has created problems of accounting for authorship and has put society in front of the need to revise all copyright, at least in terms of remuneration for creative content, and not only digital. Why should a creative product (for example, a popular movie), which millions of people consume, bring its creators substantially more income than a scientific and educational film made to train a few specialists? How to know that its authors used in the final product of the media business? What should be the remuneration for authors in

a large group of authors? To answer these questions, it is necessary to determine why authorship accounting is necessary and what is behind the need for remuneration.

Even if it seems to have one author, media content is never the product of one person. Artists, musicians, poets have to study for a long time to draw famous paintings, compose and perform musical works, write poetry. Authorship recognition and rewards are only needed to motivate creative people to create unique content. However, this motivation should not directly depend on the number of reproductions viewed, songs, or poems listened to. Evaluation of creative works should be carried out, but it should not be multiplied by the number of participants in this evaluation. Moreover, authorship accounting should be carried out within the boundaries of those competencies that the author showed when creating a media product, making it easy to consider the author's contribution to collective work.

The competency-based approach is the basis of collective intelligence technologies, a kind of instrument for measuring intellectual and creative work. Adequate measurement and appropriate remuneration for creative work will lead, on the one hand, to the necessary motivation of creative people, and on the other hand, will make media products available to everyone, including for their use in creating new content. It is not hard to understand that this approach requires reformatting the entire economy. However, this reformatting is already taking place: today, many digital services are provided free of charge or partially free of charge, and their monetization is carried out through, for example, advertising or investors. So far, this applies mainly to all Internet users and therefore does not differ much from the usual commodity economy (Sanz et al. 2014). As narrower professional communities emerge, ads will also narrow and target specific categories of users. In the future, such specialization will allow financing exclusive creative activities when video content for specialists will be appreciated no less than any blockbuster. But the transition to a free content economy should not just wait but prepare for it, forming new social relations and changing the legal framework of copyright.

Collective intelligence technologies, which were already mentioned above, should also help regulate the media environment, in which conflicts are becoming more acute. The main problem of media management is related to, including an abundance of fake news (Martens et al. 2018), a lack of trust, with the dominance of so-called "big data capitalism" (Fuchs 2020). It is known that the implementation of knowledge management systems is also impossible without trust management. Collective intelligence technologies (Slavin 2018) imply creating a global system of expert networks, in which the professionalism of experts is confirmed by actual practice. The global expert environment will provide an opportunity for large-scale verification of information and assessment of the quality of media content. Furthermore, Digital technologies create unique opportunities for self-service and, consequently, for the self-organization of people. This means that the management of digital media content must also be carried out based on self-organization.

5 Summary

Our research shows that social media partnerships play an essential role in building trust in content. The following factors should be considered when analysing the impact of partnerships on trust: the size of the partnership, personalization of information, and consumer participation in content creation. We can assess that the media industry digital transformation will lead to the collective participation of consumers in the creation of content and should lead to the creation of new rules for working with content, including a revision of copyright.

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Cybernetics in the Era of Digital Transformation

Yury Zatuliveter and Elena Fishchenko

Abstract **The purpose**—The human-made phenomenon of the global computer environment (GCE) has initiated the tectonic processes of the next phenomenon, namely, the all-encompassing digital transformation of the socio-techno-sphere. These historically unprecedented phenomena are changing the fundamental principles of sustainable development of civilizations. The newest problems of controlling the sustainable development of socio-systems and the world socio-system as a whole arise, which bring qualitatively new requirements. These requirements go beyond the historical experience of humankind, modern political and economic views, and general scientific constructive concepts, including the conceptual bases of cybernetic and computer sciences. The work attempts to comprehend the new system-wide situation and the joint fundamental role of cybernetics and computer science in the epoch of all-encompassing digital transformation. For a systemic and holistic substantiation of safe routes to the future, a converging update of the conceptual bases of cybernetic and computer sciences is required, first of all. The work introduces a new research object for cybernetics—the GCE as a whole, which has de facto become the main instrument of global digitalization. Along with this, key system-wide support positions are outlined for such a convergence to form (with an orientation towards implementation in the GCE) promising cybernetic concepts and models of digital control of sustainable development of the entire variety of globally distributed strongly connected sociotechnical systems operating in conditions of global information strongly connectedness. **Design/methodology/approach**—The spontaneously implemented consolidation in GCE of a growing number of increasingly advanced computer devices with the property of local algorithmic universality does not create qualitatively new prerequisites for the systemically balanced and safe development of either the GCE or the socio-techno-sphere. To achieve the systemic property of emergence, represented by the globally distributed algorithmic universality of GCE (in general), it is necessary to seamlessly extend the property of local universality from intra-computer resources to arbitrarily large networks. This task has not been set before, so there are no methods for solving it. An approach to

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solving this problem is presented in this work. **Findings** —The chapter forms and substantiates the conceptual principles of expanding cybernetic issues by including the GCE as a fundamentally new object of scientific knowledge in the scope of its consideration. Cybernetic research was conducted using mathematical methods to study the intra-system patterns of the GCE development and the GCE's influence on social systems. The construction of mathematical models for the sustainable functioning and predictable development of globally distributed sociotechnical systems will allow the formation of fundamental justifications that are missing today for the comprehensive and safe implementation of digital transformation socio-techno-sphere. **Originality/value**—An original approach to integrating cybernetic and computer science methods to study complementary information/system-forming capabilities of social and computer information environments in the course of their joint functioning and development in the global digital transformation processes is presented. **Research/Practical/Social/Environment implications**—The proposed concept substantiates the strategic directions of systemically balanced digital transformation, which open the way to the system-holistic integration of the natural ("non-digital") informational universality of Homo Sapiens and algorithmic ("digital") universality of GCE for the sustainable development of the socio-techno-sphere in unprecedented conditions of global information strong connectedness. **Research limitations**—The results obtained show the ways of further development of research aimed at developing methods, computer-networks architectures, and technologies of new generations aimed at a controlled (transparent to the public) digital transition from the former monopoly of anthropocentric models of sustainable development management to info centric models that will provide a synergetic combination of the advantages of natural ("non-digital") universality of man and algorithmic ("digital") universality of GCE.

Keywords Global computer environment · Global information strongly connected · Sustainable development · Generalization of the Ashby principle · Model of globally distributed computing

1 Introduction

At all times, the development of social systems has been accompanied by an increase in the flows/volumes of information produced, consumed, and accumulated. Sustainable development of the socio-techno-sphere was achieving with a growing demand for information and balanced production-consumption of information flows/volumes. Therein the flows/volumes of information produced in the processes of their public consumption should not exceed the integral capabilities of social systems in implementing the transmission, storage, and processing of information to manage sustainable functioning and development.

The emergence and uncontrolled growth of GCE led to chain reactions of the overproduction of information. GCE has become a fundamentally new factor of total

and continuous impact on social systems that do not have natural adaptational and protective regulators to ensure sustainability in the conditions of an uncontrolled crisis of overproduction of information.

From the general cybernetic standpoint of considering living and inanimate systems, the principles of "ultrastable" development of complex organisms (Ashby 1960, 1966) can and should extend to social systems, as well as to the socio-techno-sphere as a whole. Ashby's ultrastability is that organisms possess natural multi-contour structural and functional adaptation (including protective counteractions) concerning environmental changes.

Balanced, proportional to the growth of flows and volumes of information, the expansion of GCE's social and technological capabilities to increase integrated throughput in order to the timely processing of information to manage ultrastable (by Ashby) development is a prerequisite for the social progress in the digital epoch.

In this chapter, the term "sustainable development", applied to social systems and socio-techno-sphere, is interpreted according to Ashby by the cybernetic meaning of the above-introduced concept of "ultrastable development" of complex systems.

In the pre-computer era, the only actor and driving force of socially structured information processing was the genus Homo Sapiens. For a long time, humanity has had a unique natural monopoly on informational universality, expressed in the progressing abilities to perceive, abstract, accumulate, transmit, and "programmatically" process information. The natural (non-digital in its genesis) informational universality developing in the social environment has become the basis for the accelerating development of the socio-techno-sphere through socially structured anthropocentric models of sustainable development management. In such models, a person is used in all levels of management. The scale and throughput of anthropocentric models grew as their structural organization increased complexity and the number of actors performing management procedures increased.

Computers with the property of "digital" universality have opened the digital transformation epoch. Their appearance broke the monopoly of human's unique "non-digital" universality. When performing routine (algorithm-based) control processes, the throughput of computers allows processing streams and volumes of information that exceed the natural human information capabilities by orders of magnitude.

With the advent of the global computer environment (GCE), spontaneous, systemically unbalanced processes of mass digitalization have led to an explosive growth of information flows/volumes that already exceed the throughput of traditional anthropocentric management models by many orders of magnitude. Such information overflow violates the balance necessary for social progress between the production and consumption of information. Digital expansion is changing the principles of sustainable development of civilizations and requires a transition to new models of sustainable development controls, which organically combine the advantages of natural (non-digital) universality of man and algorithmic (digital) universality of computers (Zatuliveter et al. 2021a, b, MLSD). Such models should restore the balance between the production and consumption of information, which is necessary for the sustainable development of social systems.

2 The Planetary Human-Made Phenomenon of the Global Computer Environment

By means of the WWW hypertext space, the Global Computer Environment (GCE) has brought to the World the historically unprecedented phenomenon of global information strong connectedness: "Everything affects everything and at once." With the advent of new generations of Internet technologies, this phenomenon cardinally changes the cybernetic properties of the socio-techno-sphere, which leads to an accelerating and uncontrolled decline in the stability of the socio-techno-sphere. The growing destabilization requires a cybernetically justified update of the basic principles of GCE functioning and, accordingly, the methods of using GCE to manage the sustainable development of the socio-techno-sphere as a whole.

GCE has practically unlimited potential to increase the functionality and total computing power of growing billions of computers of various classes connected by global networks. Thanks to this, GCE becomes an "all-encompassing" tool for the digital transformation of the socio-techno-sphere into a highly organized "cyber-organism". In such a cybernetic status, a properly "digitized" socio-techno-sphere must receive the qualities of a systemically balanced multi-contour ultrastability inherent in living organisms and systems (Ashby 1960, 1966). These qualities will open up opportunities to form safe trajectories of digitalization and sustainable (by Ashby) development of socio-techno-sphere in the conditions of global information strong connectedness due to structural and functional adaptation to rapid changes in the information environment.

GCE—are fully digitized social and technical communications with an uncontrolled exponential growth of flows/volumes of information, rapid acceleration, and increasing intensity of information events. GCE is a tsunami of the crisis of overproduction of information. The uncontrollable avalanches of information overflow already exceed the capacity of the existing market and state structures of sustainable development management by orders of magnitude. All of it destroys "pre-digital" market balances, which since the early 00-s has been manifested by a continuous series of crises with increasing amplitude, steadily reducing the stability of financial systems and the efficiency of the world economy. In the absence of systemically balanced "digital" strategies for the sustainable development of the new world order, the GCE is political instability, sanctions, hybrid wars of everyone with everyone. GCE is a paradox of the outstripping growth of the colossal computing power of the computer environment, which remains cumulatively inaccessible for full-scale and timely processing of exponentially growing flows/volumes of information to control sustainable development.

It is possible to state an indisputable fact: the "digit" has gone into semantic break away from the "pre-digital" institutions/structures of sustainable development management. In the absence of a scientifically proven strategy for managing controlling the sustainable development of social systems, the unpredictable chaos of digitalization introduces global disturbances into the existing world order (Perko 2020).

We can see a dual power as ancient as the World: the old ("pre-digital") can no longer, the new ("digital") is not ready yet.

3 New Challenges to the Cybernetics of the XXI Century

According to the founding fathers' intentions, cybernetics is the science of "general laws of the processes of control and transmission of information in machines, living organisms, and society." Now cybernetic represent difficultly enumerated a multitude of poorly connected narrow-profile scientific disciplines, with specific conceptual bases, methods, and tools focused on the study, research, and implementation of control processes of various types of objects and systems, in many cases with the active and fruitful use of mathematical methods.

Until now, the GCE as a whole has not come into the focus of cybernetics as a new object of research with evidence-based results, which remains one of the reasons for the systemically unbalanced expansion of global digitalization.

3.1 What Should Cybernetics See in the Global Computer Environment?

GCE largely devalues the world-historical experience of sustainable development management, since the phenomenon of global information strong connectedness ("Everything affects everything and at once") generates exponentially growing flows/volumes of information, the processing of which by means of "pre-digital" methods and models of sustainable development management becomes impossible due to biologically limited human throughput in terms of processing growing flows of information. Therein new—"digital"—methods and tools implemented in an extremely heterogeneous GCE, in principle, cannot reach those levels of systemic holism, functional completeness and cybersecurity that are necessary for the full-scale implementation of ultrastable (by Ashby) development of the socio-techno sphere in conditions of global information strong connectedness.

The cardinal changes in the cybernetic properties of the socio-techno sphere taking place under the influence of GCE require a fundamental update of the methods and structures of sustainable development controls through GCE. However, intra-system imbalances of the growth of extremely heterogeneous global networks make it impossible to cumulatively directed the use of the total computing potential of GCE for full-scale and timely processing of exponentially growing flows/volumes of globally distributed information for sustainable development. The growing instability of sociosystems in the context of the crisis of overproduction of information is expressed in the fact that small causes cause avalanches of chain reactions of global consequences, with which existing management institutions can no longer cope.

The impossibility of full-scale and timely processing of globally distributed information to control sustainable development is becoming one of the main, but still not realized to the required extent, the reasons for the growing chaos of the existing world order.

3.2 Cybernetic Aspects of Consideration

The control subsystem in digital dynamic systems has a system memory in which the controlled object's current state is stored and means of implementing control algorithms. During the execution of the control algorithms in discrete -time, at each step come in the current values input information from the outside and values of the object's current state from the system memory. The results of processing that data at each step are the value of output information and the new value of the object's state, which enters the system memory for storage and subsequent processing.

According to the Ashby principle, the control subsystem should have no less "diversity" than the controlled subsystem (Ashby 1956).

In most existing digital control systems for local objects, universally programmable computer devices are used as the "brain centre" of control (means of executing control algorithms). The storage devices of such computers are used as system memory for storing the control algorithm program and data representing the current state of the managed object.

In the course of mass digitalization, the Ashby principle in such systems is implemented for various local objects due to the algorithmic universality of a computer device acting as a control centre for such objects. The local universality of classical computers as applied to local objects ensures (through programming) the achievement of the necessary level of "diversity". In these cases, such computers are a universal control centre. The single-computer architecture, related to each local system with management, has become a universal platform for the local "digitization" of the Ashby principle.

In the case of distributed systems with control implemented in GCE networks, the situation is radically changing. The Ashby principle does not initially apply to digital network systems with control. The "digitization" of the Ashby principle by a single-computer control centre for globally distributed computing systems is impossible in the general case. The current state of such systems is distributed across the local memory devices of computers of many network nodes. In the local memory of each network node, the state of only its own is fragmentally stored—one of many local objects, the totality of which represents the state of the entire distributed system.

The GCE as a whole (unlike each computer of network nodes) does not have algorithmic universality (functional completeness) by default. The initial absence in networks of a universal system-holistic mechanism for executing control programs simultaneously on computers of many network nodes does not allow a universal "brain centre" of globally distributed "digitization" of the Ashby principle. For this reason, the creation of large distributed systems with control in the GCE network

resources requires very high costs for the additional formation in networks of narrow-profile system-technical software and hardware for the distributed implementation of special control algorithms. Such methods apply only to those objects that are part of the distributed system being created.

An extremely heterogeneous GCE cannot become a universal "brain centre" of globally distributed "digitization" of the Ashby principle in the existing computer networks architectures. Therefore, the modern GCE cannot be considered as a universal system-holistic control platform, whose globally distributed memory can be used as system memory to store the current state of social systems and the socio-techno-sphere as a whole. Further, it will be shown what reasons prevent the GCE from acquiring the system-wide qualities of a universally programmable "brain centre" for extending the Ashby principle to arbitrarily large networks, and ways to achieve this goal are also shown.

4 Towards Strategic Reengineering of Global Computer Engineering (GCE)

The strategic reengineering of the GCE is aimed at implementing a new system-wide quality, namely, globally distributed universality (Zatuliveter et al. 2021a, b, IFAC). It will make it possible to "digitize" the Ashby principle concerning any arbitrarily large networks, which means the removal of upper restrictions on the size and functional orientation of distributed computing systems, which will be implemented in the updated GCE. Such systems will become a universally accessible, universally programmable tool for solving the entire variety of sustainable development tasks, which will ensure the cumulative use of the infinitely growing functional, computational, and information potential of the combined resources of the GCE.

4.1 Problems of Heterogeneity of Network Resources

The heterogeneity of GCE is a fundamental obstacle to the cumulatively directed use of the system-forming potential of GCE's total resources. The root causes of the continuous reproduction of the heterogeneity of GCE hardware, software and information platforms are hidden in two practically significant system-forming paradigms that underlie the existing GCE. The first of these paradigms is represented by the classical model of universal digital computers (model J. von Neumann). The second one is represented by the set of multi-layered interconnected Internet protocols underlying global networks (TCP/IP protocol stack).

The classical model of J. von Neumann postulated the property of algorithmic ("digital") universality of isolated computers. This classical model of universal digital

computers, at the level of axiomatics, localized the fundamental property of algorithmic universality in the internal resources of computers. Initially, this model was not intended to canonize the rules for implementing distributed network computing. Defining and canonizing the simplest practically significant local rules of universally programmable machine computing, this model did not introduce mathematically closed forms of unified data/programs representation and of the ways to implement these rules. The absence of such mathematical unification in the foundational model of digital universality became the prime cause of massive and continuous reproduction of the open heterogeneity of hardware, software, and information platforms in GCE.

To build large systems of processing globally distributed information in GCE, expensive, difficult-to-use technologies for the functional integration of initially heterogeneous network resources are used. Therein, integration problems, due to their multi-variance, have combinatorial complexity. Therefore, the costs of creating and developing such systems with increasing their sizes grow exponentially in the general case. Therein in conditions of open heterogeneity, the globalization of such important system qualities as seamless programmability and cybersecurity of distributed computing remains unattainable.

Stack protocols TCP/IP, which is the basis of the Internet, comprises many protocols of different levels. This stack provides unlimited scalability of computer networks and reliable transmission of information with heterogeneous forms representations between computers of various hardware and software platforms, thereby legalizing the massive open heterogeneity of GCE network resources. The roots of heterogeneity open to reproduction, as it was said, hide in the postulates of the digital universality of the von Neumann model, which has no mathematical unification of the forms of data representation, programs, and ways of their interaction. By now, after three decades of quantitative growth of an extremely heterogeneous GCE, these paradigms have approached the limits of their system-forming capabilities and can no longer ensure the transition to qualitatively new system-wide GCE capabilities, without which a full-scale systemically balanced, and therefore safe (with predictable results) implementation of digital transformation is impossible.

4.2 About the Model of Globally Distributed Computing in GCE

Large distributed computing systems increase the functionality of the GCE by the processing of globally distributed information. Such systems are implemented using technologies of system-functional integration of heterogeneous network resources that face (Zatuliveter et al. 2020) severe multivariant technological problems of combinatorial complexity (the exponential growth of the costs of their creation and operation).

Thus, heterogeneity has become a fundamental obstacle to the cumulative use of the whole computing resources of the GCE in solving globally strongly connected sustainable development tasks. In the course of researches (Zatuliveter et al. 2020) aimed at eliminating the causes of reproduction of heterogeneity in the GCE, the mathematically closed model of universally programmable distributed computing in arbitrarily large networks has been proposed. The new model is constructed by the mathematical generalization of the von Neumann model using the calculus of tree structures. This calculus, built-in the classical von Neumann model, implement the mathematical unification of the forms of representation of globally distributed data and programs and the rules for control universal computing.

The mathematical generalization (Zatuliveter et al. 2020, 2021a, b) of the J. von Neumann model of classical digital computers made it possible, at the level of the axiomatics of universal globally distributed computing, to eliminate the root causes of heterogeneity and seamlessly extend the property of local algorithmic universality from intra-computer resources onto arbitrarily large computer networks.

4.3 Towards Network Computers with Non-microprocessor Architecture

Based on the new model, the principles of construction and application of a new class of single-chip network computers with a non-microprocessor architecture (Zatuliveter et al. 2020) were developed, which fix mathematical forms of representation of globally distributed data and programs at the hardware level. Such a solution eliminates the reasons for heterogeneity's reproduction and, thereby, the combinatorial complexity of the functional integration of network resources. Therein, new network computers make it possible to extend the property of seamless and cyber-secure programmability to arbitrarily large networks.

4.4 Principles of GCE Reengineering (Zatuliveter et al. 2021a, b, IFAC)

The placement of new computers in network nodes will make it possible to implement a universal, seamlessly programmable, and cyber-secure algorithmic space of distributed computing in the resources of the GCE. Having local and, at the same time, fundamentally new—globally distributed—universality such computers as part of network nodes acquire the system status of a "brain centre" to control their nodes' resources. Such a network architecture will ensure seamless and cyber-secure integration of the functionality of existing network nodes into a single algorithmic space of distributed computing. In such a space, the GCE as a whole acquires the property of functional completeness (universal seamless programmability), which gives

a global "digitization" of the Ashby principle as applied to the total resources of the GCE.

5 Summary

Cybernetically founded reengineering of the global computer environment opens up virtually unlimited possibilities for creating with minimal costs arbitrarily large, universally programmable, and cyber-secure distributed systems of digital transformation of the socio-techno-sphere. Such systems open up opportunities for the cumulative use of all resources of the GCE for a systemically balanced solution of the entire variety of digital transformation tasks, including controlling the sustainable development of social systems operating in conditions of global information strongly connectedness.

Further development of the presented approach involves developing and researching cybernetic models of the joint complementary functioning/development of social and computer environments with a system-holistic combination of the advantages of natural (non-digital) information universality of man and artificial (digital) algorithmic universality of computers.

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Ergatic System as a Model of Organizational Psychology Integration

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Abstract **The purpose**—The crisis in the human sciences, particularly in psychology, manifests itself among other signs as fragmentation of scientific fields: the facts accumulated are divided into separate, unrelated areas of knowledge. So, there are the psychology of leadership, psychology of justice, organizational culture psychology, etc. as the separate facets of organizational psychology. The essence of the crisis is that the lack of meaningful links between the facts of different areas does not allow them to be used for the explanation of the real practice. It is the semantic connections between facts that are a foundation for interpreting what has happened and predicting what might happen. The facts accumulation without their integration into an explanatory scheme (a model) has no practical sense. Integration of separate scientific disciplines subjects into a single model is a classic system problem. A possible solution to this problem is suggested in this chapter. **Methodology**—The functional approach can provide ordering as well as predict and explain the evidence. When studying the past meanings of the function, one understands why something has happened. Analysing future function's meanings, one predicts what may happen. The functional approach reveals itself as a system approach at the same time since any function includes interrelations with other functions within the whole to get a common purpose. The principle of the unity (oneness) of the Historical and the Logical, first formulated by Hegel lets to reveal function meanings of the main organizational psychology phenomena above mentioned and integrate them in the whole. It states that the process of the emergence and development of the system corresponds to the mechanism of its actual functioning. The functions that appeared in response to conditions a system operate under then are saved as its parts. Therefore, a reconstruction of the system's functions arising sequence (its history) can understand how the system operates (its logic). **Approach**—The bipolar structure S–O first described by Hegel is a starting point of the reconstruction. It shows its systemic properties which are described by the "objectification—dis-objectification" formula. Namely, a Subject (an actor) and an Object (a thing) mutually determine and generate each other as it takes place in any system. The S–O system is the simplest

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unit of purposeful activity; it is a prototype of all types of labour, so it can be defined as the simplest ergatic system. Admitting the Subject as well as the Object may be divided, it is possible to reconstruct a reverse function of integration of the previously divided. The divided Object is beyond the consideration, its main topic is divided Subject (collective Subject). A formal role-based structure of the team is the first and basic mechanism for integrating the collective (divided) Subject. It integrates the collective by prescriptions to the performers what to do and how to interact. Its main deficiency is the inability to prescribe any activity under all conditions of its realization. Thus, a set of non-formal compensating activities arise as a response to this deficiency. The second negative feature of the set of formal roles is their destructive impact on performers, suppressing performers' natural psychological needs. The appearance of extra-formal psychologically full-fledged activities is an immediate consequence of this negative condition. So, a lot of simultaneously relevant activities (formal, non-formal and extra-formal) and a lot of their corresponding goals cause another function—of ordering them to achieve the main goal. Leadership is just such a function. The leader sets priorities among all topical goals and thereby forms the organizational culture. Then, a justice function motivates performers to participate (or not participate) in common activities and make (or not make) their efforts to achieve a common goal. All functions mentioned integrate the ergatic system under different conditions and together form its operating mechanism. **Findings**—The principle of the unity (oneness) of the Historical and the Logical has demonstrated its heuristic and methodological value. The separate scientific areas are integrated into a holistic system model, and functional meanings of their phenomena are revealed at the same time. So, the fragmentation of the organizational psychology field is overcoming to some degree.

Keywords Ergatic system · Organizational psychology · Unity of the historical and the logical · Divided labour integration · System approach · Systemic crisis in psychology

1 Introduction

The "ergatic system" is the basic concept of ergonomics, which was mainly used as an analogue of the man–machine system. However, there is a broader understanding of this term as a labour system in general where a man is opposed not only to a machine, but also to any labour object (Klimov 1988). This concept is more productive in theoretical Modelling as it will be shown below.

A lack of ordering and explanatory links between evidence in a scientific field is a typical problem for many disciplines of the humanities. The same is true in psychology as well as in organizational psychology. Back in 1975, Leontiev (1975), a prominent Russian and Soviet psychologist drew attention to the dangerous flooding with facts in psychological research, which makes it difficult to understand the psychological reality. After more than 40 years, the attitude to this trend takes the

form of an acute emotional reaction: Grand et al. (2018), when describing the state of researchers in the field of organizational psychology, speak of "languishing in obscurity". Thus, none of the basic concepts of organizational psychology (climate, organizational culture, leadership, justice, etc.) has common definitions and approaches. For example, Zohar and Hofmann (2012), referring to the analysis of a 25-year study by Verbeke et al. (1998), counted 32 different definitions of organizational climate and 54 definitions of organizational culture.

Science has tools for organizing facts, for example, classification, ranking, etc. However, these tools do not admit to explain the observed events, they only detect similarity or difference of observed qualities. And here functional ordering, identification of what function is performed by this or that observed phenomenon among others related to the selected field of knowledge, just as an explanatory, as well as predictive ability. A function is described through a set of its past and future states (meanings), and, therefore, can explain and predict. When studying the past states of the function, one understands why something has happened. Analysing future function's states, one predicts what may happen.

2 Methodology

The functional approach reveals itself as a system approach at the same time since any function is a form of interrelation within the whole: it shows in what favour it acts, for whom it gives a useful result, what it is connected with and why for. Any system is essentially a combination of functions to achieve a single goal—this interpretation of the system is well known. Anokhin (1980) stated a system as a set of elements selected in such a way that their interaction and interrelation are similar to cooperation aimed at obtaining a useful result.

The main methodological problem that a researcher faces here is reflexive: how to select reasonably elements (functions) that work for a single result, forming a single system, so that their conjunction looks like the mechanism of a working machine.

The principle of the unity (oneness) of the Historical and the Logical, first formulated by Hegel may serve as the base for solving this task. The process of the emergence and development of the system corresponds to the mechanism of its actual functioning. Functions that arise as a necessity to ensure the functioning of the system under different conditions then are saved as parts of its actual mechanism-this is the point of Hegel's principle.

Hence, when reconstructing the sequence of functions appearance (a history), the researcher thereby comprehends the mechanism of its functioning—logic. The following shows how it might look like.

3 Modelling

Let it be given two variables: S (Subject, actor) and O (Object, thing). They form bipolar structure S–O that demonstrates systemic property. It was described by Hegel as a relationship of "objectification—dis-objectification". The Subject when acting with an Object adopts its properties, is "educated" by the Object, and "disobjectifies" it in Hegel's terms. On the other hand, the result of the Subject's impact on the Object becomes the transfer of information about the Subject's properties to the Object: the Subject "objectifies", defines itself in the Object. The elements of the whole—the Subject and the Object—are interconnected and mutually determine each other as it takes place in any system.

The S–O structure is the simplest unit of purposeful activity, and this unit is a *system*. It is the prototype of all types of labour; therefore, it can be defined as the simplest ergatic system. The process of the development of its internal functions may look like this:

Assuming that a Subject can be divided in its physical mode one gets a collective Subject—a working team (shift personnel of a nuclear power plant, a crew of aircraft stewards, gas station operators, power system controllers, traffic management operators, a ship crew, a virtual organization, etc.).

Assuming that an Object in its physical mode can also be distributed, one gets a machine complex consisting of equipment units and forming the engineering component of an ergatic system (a refinery plant, a nuclear power plant equipment, a car-washing installation, the public utilities, etc.).

Then, the fact of the division of both Subject and the machine (Object) sets the reverse function—the integration of the divided whole.

For machine complex (Object) this problem is solved by engineering design and remains beyond the scope of humanitarian tasks unless industrial designing is involved in the project conception. The integration of a divided Subject is the main topic of this study.

The first and basic mechanism for integrating the collective (divided) Subject is a set of interrelated formal role prescriptions for performers what to do and how to interact with each other at every workplace, which is recognized as a formal role-based team structure. The organization's charter, the staff schedule, the set of job descriptions, the orders and instructions of the managers, etc. are the elements of this set.

At this step, the deficiency of such kind of integration is found as an inherent and unavoidable feature of a formal mechanism. All variety of labour activities cannot be standardized and translated into a set of process operations samples. The phenomenon of a "work-to-rule strike" highlights the major fact: when acting strictly according to prescribed rules it is impossible to act in productive and adequate working conditions way. Thus, it makes to create additional mechanisms to compensate for this deficiency.

The task of motivating an additional-role behaviour, fostering staff loyalty and involving them in the organization's goals is defined as a fundamental management

task. All types of this labour activity, compensating for the shortcoming of formal rules, are denoted by the concept of *extra*-formal activity.

Further examining of the basic integration mechanism of a divided labour activity finds out immediately that activity formalization has a deeply traumatic and frustrating impact on the personnel involved in the formal structures. Formal instructions block or restrict the basic psychological and social needs of performers. The rules constrain their spontaneous activity, prohibit free communication and eliminate any creative components of the work performance—decision-making, time perspective assessment and other psychological forms of orientation and interaction. At this stage, one can note that such psychological and social frustrations also generate compensation, but of a different kind. There arise also not prescribed (*non*-formal) types of individual and group activities that make it possible to compensate for psychological and social frustrations of performers. These functions are very diverse, and it would be too hard to list them all. The activities of socialization, adaptation, relaxation, as well as organizational, protective, integration, motivational, regulatory, control, evaluative, selective, communicative, therapeutic, etc. activities can be given as an example.

At this step of system functions reconstruction, one should admit the multiplicity of activities, which are simultaneously relevant for each performer and coming in intersecting planes as a fundamental peculiarity of the collective labour.

The closest consequence of such multiplicity is found at the next reconstruction stage: the collision of their goals—a conflict—is an unavoidable feature of organisational behaviour, a background of any manufacturing. Conflicts are yet possible within the formal field of production activities. Typically, you may identify the conflicts between operational and maintenance, operational and economic, design and production, etc. departments. Conflicts between formal and different types of informal and extra-formal activities are inevitable by default. It is fair to say that organization reality is a realm of various interests' conflicts that interact according to certain rules. K. Marx was the first who realized a system analysis of society and presented a conflict as the main drive of developing ergatic systems of any scale (see Turner 1974).

At this stage of "historic reconstruction" a fundamental fact can be found: when colliding with each other the goals change, die away, or lose their relevance; hence, there raises a necessity to maintain a stable dominance of the main productive activities to achieve the project results. This function sets the hierarchy between conflicting goals. It points to the main goal among all current conflicting goals and is recognized as a leadership function. The support of target orientation of joint efforts to overcome chaotic activity is revealed as another leverage to ensure the divided Subject integration. This duty is charged to the chief executive, whose real responsibilities are much broader and include other functions.

This modelling stage provides an opportunity to clearly distinguish the concepts of "management" and "leadership". Management is control of any social system including an organization. The leadership as target designation is only one of the functions being implemented in the control process. Many activities are realized at the same time, each of them is controlled by its target designation function. It

makes control of organization a complex and multidimensional process thus the identification of the leadership structure becomes a special scientific problem. The leadership function is a key to the effectiveness of the collective activity, especially when the labour tasks transformation is being in the process.

At this stage of modelling, one can find that the leader's conflict resolution activity forms a set of decisions—the behaviour samples for staff in similar problem situations that have no formal regulatory rules. This set of behaviour patterns is identified as organizational culture. The principal role of a leader in organizational culture creating is stated theoretically now.

Further study of the leadership function allows one to see that stable domination of certain goals attributes the typical features to the organization's culture and makes it specific. The concept of climate reflects the special features of organisational culture: there is a bureaucratic climate, a liberal, etc. It becomes clear at the same time that the number of various combinations of organization priorities is immense. Therefore, any typology of the organizational climate is relative and confined; moreover, it has no heuristic value—this conclusion is based on the model examination.

The informal component of the organizational climate combining various activities to solve the psychological and social problems of workers brings a significant psychological content to the climate, which often prevails over the labour content. It explains the substitute of the organizational climate concept by that of psychological climate in these cases.

At this step of reconstruction, it is possible to distinguish the concepts of organizational culture and organizational climate. This distinction is operational. The first one points to the essential features of organisational culture—its normative nature. The latter is discriminative, it identifies the specific form of steadily reproducing features of culture among other similar forms.

Appealing to philosophical formulas admit to clarify the relationship between both concepts and to define it as the relationship of General and Singular (Ilyenkov 1960). The General is rooted in the Singular as its essence, and the Singular is the concrete embodiment of the General. The relationship between the concepts of organizational culture and organizational climate is dialectical. It reflects the sophistication of their relationship more finely than popular formal-logical interpretation as the relationship between the whole and the part (Schein 2006).

At this step, one can find that the hierarchy of individual current goals determines a person's worldview and unique mentality just like the hierarchy of collective activities and their respective goals and values determine the "image" of an organization. There is an exact functional analogy between personality and the organization "character" (organizational climate). This well-known Schein's statement (2006) is adopted by the proposed model.

Organizational culture reveals its meaning as a mechanism for integrating a divided Subject under the conditions of incompleteness and deficiency of formal rules, as a team mentality. It has rational and irrational components (mythology); it contains semantic conflicts that give rise to protective mechanisms ensuring the integrity of formal, informal and extra-formal group Subjects and retaining their activities.

The point of accepting the common values by a group through overcoming semantic conflicts generated by simultaneously topical goals means achieving the group identity to ensure optimal group functionality. The group identity can be described as the definiteness of a complex function; it is functionally equivalent to personal identity.

An achievement a group identity marks the moment when the group has acquired the quality of an active and productive subject—collectivism. The concept of collectivism is not an ideological symbol, it has full-fledged scientific content. A collective is a Subject of an ergatic system, the same as an individual worker. A formal social group is opposed to a collective, it is not the Subject. A formal social group is a social community without functional abilities—such distinction can be made in this set of meanings.

The reconstruction of the "historical" sequence of the function appearance faces at the next step the function to ensure performer's motive to engage consciously in joint activities and to compensate the formal regulations deficiency and errors of co-performers at all levels. This function is identified as fairness, and its main forms (procedural, distributive, interactional, etc.) reveal their meaning as conditions for purposeful"combining" the efforts by partners of joint activity, making their participation in collaboration effective, efficient, and reasonable—as a kind of social rationality. The fairness is detected as another integration mechanism, but of a different type. The relativity of fairness as its basic feature can be explained at this point. Under different conditions of divided labour, the rational grounds for being involved therein are different; therefore, the fairness also cannot be the same.

Fairness acts as the only integrator of interactions that are not regulated by formal rules (spontaneous groups).

The formal-rules structure arises as a response to the need to integrate the labour division. Organizational culture comes as a response to the deficiency of formal structure to integrate common work by formal rules. Leadership springs from the need to organize a lot of simultaneously relevant goals. Justice arises to motivate purposeful behaviour wherever there is no formal or informal control of behaviour.

All these functions being united as a whole and operating together form an actual mechanism aimed to obtain the general purpose: to combine all performers facilities for useful results. They form the ergatic system. This integration reveals at the same time how this "device" operates, demonstrates its "logic".

The proposed model as a model of development has no final states, so exchanges, communications and group economics may be proposed and as another integration mechanisms.

4 Discussion

The main purpose of the presented Modelling of the ergatic system was the defragmentation of the organizational psychology field, and this task received a solution that is subject to verification.

The social system is for sure a kind of ergatic system, but at a higher level. It is the study subject of sociology, not organizational psychology. However, one may reasonably assume that the proposed model should, if not accurately predict the trends of social systems, but at least provide sufficient tools for a correct description of current trends in its development. Current social changes related to digitalization of society provide is a good opportunity to validate the proposed model.

Now we are witnessing an unprecedented growth of the possibilities to obtain a variety of information in all areas, of any quality and any level of generalization and processing degree. For example, national healthcare services can receive primary information, for example, on the number of COVID-19 cases in any city on any date. They also can get deeply processed information presented in the form of COVID-19 pandemic development models, which allow them to make decisions for the long term: for months and years.

Opportunities shape needs. The productive technologies are being transformed by integrating the special modules for obtaining relevant information from information providers. The functions of knowledge production are institutionalized, forming new participants (stakeholders) in the social division of labour—"knowledge-makers", the communicative technology providers, which get dominating positions in social life. At the same time, there is an exponential growth of social interactions of various kinds. The both phenomena create together some kind of a new sociality—the hybrid reality (HyR), in which various information processes play an increasingly important role, and new stakeholders in social interaction get enormous power and opportunities to influence critically social processes.

This singular point of social transformation has become the subject of expert analysis (Perko 2020). The author examined negative signs in social development trends related to digitalization and firstly drew attention to the fact that public control of new stakeholders in the division of labour is insufficient due to technology limitations. This leads to an asymmetry of transparency and accountability, to pathological development of the interests of new stakeholders, to the losses of the social system as a whole as well as of the individuals.

To mitigate these threatens the author invokes social responsibility (SR) concepts. The ISO 26000 standards (ISO 2010) are universally applied to all subjects in social interactions at all levels. An interaction model based on SR concepts has been proposed and examined on the example of an autonomous vehicle transport service and showed the realism and promising prospects of applying the concept to integrate the social system using new technologies.

Projecting this fruitful experience onto the concept of integration mechanisms of the ergatic system described above, we can consider it as the creation of a new formal-rules integration tool for a new structure of the social division of labour. We can assume further changes in the social climate, the emergence of new forms of targeting, etc. as ways of integrating the new social structure of stakeholders and improving the functionality of the social system.

5 Summary

The methodological principle of the unity of the Historical and the Logical has shown its productiveness. The performed function analysis proposes to solve two problems. The first is to arrange the field of organizational psychology, to put in order the phenomena of different quality and join them in a single whole—the system. The second is to explicate the operating mechanism that enables to control of ergatic systems of any kind more effectively.

The proposed model has the necessary concepts to analyse the general properties of social systems of other levels. The social changes of recent years are so grandiose that they force us to make assumptions about fundamental changes in social systems. However, the projection of evidence on the model of an ergatic system allows us to recognize that the functional core of the system, which supports its integration and efficiency, remains unchanged. This generally indicates the adequacy of the proposed model and the prospects for its further development.

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Hybrid Intelligence. Main Concepts and Application Scenarios

Alexander Ryjov

Abstract The purpose—Hybrid Intelligence is a cooperative collaboration between Human and Artificial Intelligence in solving intelligence tasks. The concept of Hybrid Intelligence originates from the ideas of William Ross Ashby, Joseph Carl Robnett Licklider, and Douglas Carl Engelbart. Fuzzy set theory, introduced by Lofti Zadeh, is a natural tool for describing and modelling Hybrid Intelligence. Fundamental problems of Hybrid Intelligence—modelling human perception and operating with perception-based information have been discussed in the report. Two application scenarios—personalization of human interaction with the digital world and evaluation and monitoring of complex processes have been discussed and illustrated, too. **Design/methodology/approach—**The results are based on system analysis, fuzzy logic, some mathematical and psychology theories, and facts. **Findings—**Hybrid Intelligence is a pragmatic aspect of intelligence technologies, and this concept could reply to the crisis of modern Artificial Intelligence. **Originality/value—**Hybrid Intelligence is a new formal model which could be a theoretical base for the implementation of the concepts like "automation of knowledge work" (McKinney), "augmenting human performance" (NSF), "human–machine symbiosis" (DARPA), etc., which have broad areas of applications. **Research/Practical/Social/Environment implications—**Hybrid Intelligence can help people comfortable and effectively interact with the digital world. It can be a base for developing systems for evaluating and monitoring complex societal and environmental processes for their better understanding, management, and optimization. **Research limitations—**The Hybrid Intelligence approach can augment a regular human performance in solving routine intelligence tasks but cannot substitute a genius.

Keywords Hybrid intelligence · Perception modelling · Personalization · Evaluation and monitoring complex processes

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1 Introduction

Many people see the expectations over Artificial Intelligence (AI) are becoming too inflated. The last decades have given us exciting results in AI (championships in Chess, Go, Poker, etc.). However, real business applications are still limited by photo tuning, low-quality chats, dangerous self-driving cars, and similar things. The question "What is AI?" is becoming actual and discussible again, like in the 1960-is…

Autonomous and self-sufficient AI in real business is still a dream. AI will indeed change everything, but not any time soon. Artificial Intelligence applications in actual tasks still depend on Humans.

Reverting to the 1960-is, we can see that AI fathers-founders discussed AI in different terms: AI as an "amplifier" of human's "Intellectual power" (William Ross Ashby), AI as "Man-computer symbiosis" (Joseph Carl Robnett Licklider), AI as "augmenting human intellect" (Douglas Carl Engelbart), etc.,—they thought about hybrid intelligence, not about independent one; about partnership manner, not about opposition.

Thinking in this paradigm, we can present all spectrum of intelligent technologies using two poles: pure Human Intelligence and autonomous Artificial Intelligence (Fig. 1).

We use human intelligence tools everywhere and over thousands of years; we are taking the first steps only in using Artificial Intelligence in everyday life. Moving from Human Intelligence to Artificial Intelligence is one of the recognizable trends for society (see, for example, Automation of Knowledge Work as disruptive technology № 2 in (McKinsey Global Institute 2013). This paradigm drives us to re-think the main problems of intelligence systems.

This note aims to discuss fundamental problems of Hybrid Intelligence and possible models of using this approach for everyday life.

The rest of the chapter is organized into four sections: the first will summarize related work; the second will formulate and discuss fundamental problems for Hybrid Intelligence systems; the third will present two scenarios for using this approach; finally, will tackle the debate and outline the future lines of research.

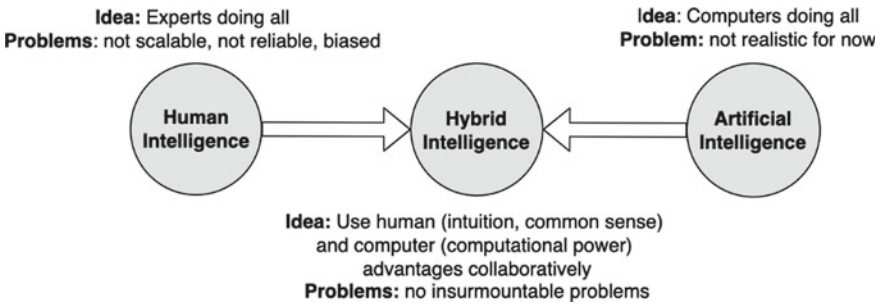

Fig. 1 A spectrum of intelligent technologies

2 Background

We can name the last decade as the time of Artificial Intelligence. AI and management, AI and leadership, AI and finance, AI and logistics, AI and creativity, AI and many other areas focus on several conferences, books, blogs, posts. AI has a broad spectrum of definitions; they cast themselves as many technologies that span many different things and can be described differently. This is not a good situation for science and engineering: we do not understand what AI is; as a result, we can see points like "Artificial intelligence has accrued some very bad reputation over the years" (Dickson 2017) or "Some industry experts believe that the term artificial intelligence is too closely linked to popular culture, causing the general public to have unrealistic fears about artificial intelligence and improbable expectations about how it will change the workplace and life in general" (Rouse 2017), etc. Authors see autonomous adaptive self-learning and self-sufficient intelligent systems as a future (the question is how far this future is?). Still, a more realistic way to solve intelligent tasks, for now, is a symbiosis of human and computer intelligence.

The idea of intelligent systems as a tool for augmenting human intelligence was first proposed in the 1950-s and 1960-s by cybernetics and early computer pioneers. The term Amplifying intelligence was introduced by William Ross Ashby in his classical work (Ashby 1956, p. 271). At the end of his book, he wrote: "Intellectual power, like physical power, can be amplified" (Ashby 1956, p. 272). The idea of human and computer symbiosis was formulated by psychologist and computer scientist Joseph Carl Robnett Licklider: "Man-computer symbiosis is an expected development in cooperative interaction between men and electronic computers. It will involve very close coupling between the human and the electronic members of the partnership" (Licklider 1960, p. 4). This idea was specified and studied by Douglas Carl Engelbart: "By "augmenting human intellect" we mean increasing the capability of a man to approach a complex problem situation, to gain comprehension to suit his particular needs, and to derive solutions to problems" (Engelbart 1962).

After this romantic period, we had tens of years of stagnation for human–computer systems. From our point of view, one of the fundamental problems was a massive difference between ways of perception, manipulation of information, reasoning, etc., for a human being and a computer. Boolean 0/1 logic is natural for computers but very artificial for people; work with uncertain information is natural for people but complex for computers. How can we organize the symbiosis of such two completely different subsystems?

A mathematical tool capable of providing an interface between human beings and computers—fuzzy logic—was introduced by Lotfi Zadeh in (Zadeh 1965). In (Zadeh 1975, p. 200). He wrote, "The main applications of the linguistic approach lie in the realm of humanistic systems-especially in the fields of artificial intelligence, linguistics, human decision processes, pattern recognition, psychology, law, medical diagnosis, information retrieval, economics and related areas." Fuzzy logic allows us to use perception-based descriptions of objects and manipulate them in a human-like reasoning manner in computer models.

3 Fundamental Problems of Hybrid Intelligence Systems

From a cybernetics point of view, Hybrid Intelligence means a new problem definition: how can we organize and optimize the synergy of human and computer intelligence components?

Following the concepts "Intellectual power amplifier" (William Ross Ashby), "Man-computer symbiosis" (Joseph Carl Robnett Licklider), "Augmenting human intellect" (Douglas Carl Engelbart), "Humanistic system" (Lotfi Zadeh) described above, we can present a principal scheme of Hybrid Intelligence like in Fig. 2.

Note that for natural sciences (physics, chemistry, etc.) and engineering, we will have a classical modelling system if we replace "Person" with "Measuring device" in Fig. 2. The principal point is that we do not have such measuring devices for many processes or objects in social sciences, politics, etc. We can measure the parameters of the processes using evaluations made by experts only.

For this scheme, we can formulate the following two fundamental problems:

- Problem 1 (Perception modelling): How do we describe real-world objects? Can we describe the objects by the most reliable and the most efficient way for further computing?
- Problem 2 (Perception-based computing): How can we manipulate perception-based information (for example, search or generalize)? Can we optimize these calculations?

These problems were studied and solved (Ryjov 1988).

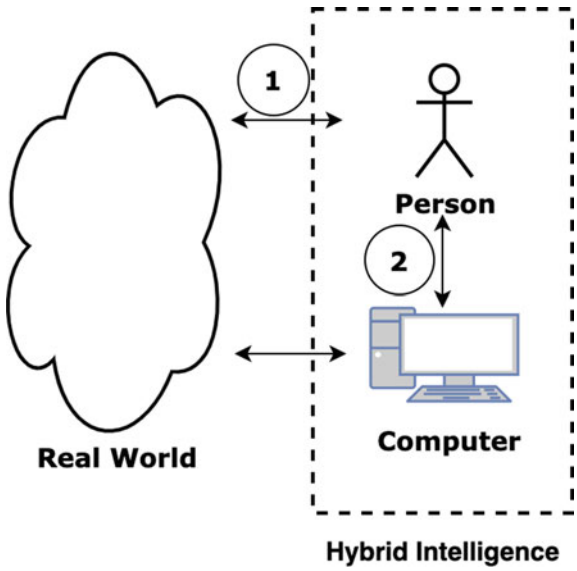

Fig. 2 A principal scheme of hybrid intelligence

It allows approving that the offered methods can be used in practical tasks and to guarantee optimum work of hybrid intelligence systems.

These results have a theoretical level. Where and how can we use this in practical tasks? Two possible frameworks are presented below.

4 Scenarios of Usage of the Hybrid Intelligence Approach

For now, we have tested two scenarios of using Hybrid Intelligence: evaluation and monitoring of complex processes and personalization of people collaboration with the digital world.

4.1 Evaluation and Monitoring of Complex Processes

A big part of "tasks that rely on complex analysis, subtle judgments, and creative problem solving" (McKinsey Global Institute 2013, p. 41) is evaluating the status and monitoring the progress of processes in business, economy, society, etc. Modelling and controlling these processes are very different from physical and technical ones. These processes are unique in the physical sense—a series of independent experiments is not possible; we cannot measure parameters like in physics—"measuring device" is a human being; we do not have adequate models like heat transfer equation—processes are described in natural language or the form of parametric dependencies, etc. As a result, we can conclude that classical mathematics is unsuitable for describing and modelling socio-economic processes due to colossal complexity, uncertainty, vagueness. Only the suitable mixes of computer intelligence and human intelligence can solve these problems.

Systems for evaluation and monitoring (SEM) allow the process of diverse, multi-level, incomplete, unreliable, and varying in time information about some process. Based on this type of information, SEM can monitor the process's status evolution and work out strategic plans of process development. These capabilities open a broad area of applications in business, socio-political problems, control of bilateral and multilateral agreements, healthcare, etc. (Ryjov 2013). Theoretical foundations and basic principles development SEM presented in (Ryjov 2013). Modern human–computer systems are developing in the direction of measuring biometrical data (eye movements, facial expression, heartbeat, etc.) (Perko 2021). These data can also be used in SEM in the future.

Having set up an SEM, we can solve two types of problems: direct and inverse.

The direct problem is to find all "critical ways" of the process. It means to reveal those elements of the process; the small change of which status may qualitatively change the status of the process as a whole. For a significant class of aggregation operators, we can calculate the degree of criticality for any element of the model; for all aggregation operators, we can use universal algorithms (like backtracking

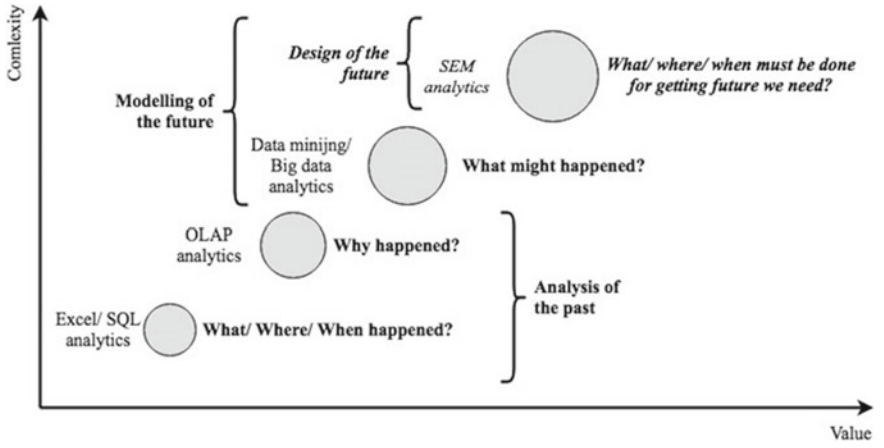

Fig. 3 SEM analytical capabilities

algorithms) to calculate the degree of criticality for any element of the model. That means that we can understand and measure the strengths and weaknesses of any element of the current process. This understanding is a base for developing a strategic plan to control the process optimally (Ryjov 2013).

The inverse problem is to find elements of the model which must be changed for reaching some given status of the target element of the model. For example, we can understand how to get a maximum effect for a given budget or achieve a given effect for a minimal budget. Examples of such tasks could be evaluation and increasing capitalization for startups, increasing an investment's attractiveness for companies, countries, and regions, improving the sustainability of a business, etc.

Comparison analysis of these capabilities with other analytical tools is presented in Fig. 3.

4.2 Personalization

Personalization is one of the most visible trends of applications of modern ITC, from the fashion industry to smart learning (Betts 2018; IBM 2018).

The overwhelming majority of such publications focus on more deep segmentation, customization of communications, etc. Here we use the term "personalization" literally to make the digital world personal for every person.

To reach this effect, we need interactions with the user for "calculating" his or her own semantic of used words and concepts. The user is formulating these concepts in natural language, and we model them by fuzzy sets, defined on the Universum of the values of the attributes. After adjustment of user's concepts based on search results, we have "personalized semantics" for all terms which particular person uses for

communications with digital sources (for example, “young person” will be different for a teenager and for an old person; “good restaurant” will be different for people with different income, age, etc.).

5 Summary

Self-sufficient autonomous Artificial Intelligence is still a piece of art (Chess, Go, etc.) with unclear business applications in the observable future. Many authors say about inflated expectations, hysteria, etc.,—actually about the AI’s crisis. Hybrid Intelligence provides a practical or pragmatic sense of the intelligence systems, and it is a reality.

The basic fundamental problems of Hybrid Intelligence are solved. We can develop robust and optimal Hybrid Intelligence. Several local issues are still open, and we hope to see solutions soon.

Applications of Hybrid Intelligence for various types of organizations (international, federal, corporate levels) and multiple types of problems (non-proliferation of nuclear weapons and materials, security, healthcare, microelectronics) were successfully developed and tested. Vision and understanding for new applications (natural and technological disasters management, smart city/smart regions/smart countries, smart learning for education, smart healthcare, personalization and optimization for social networks/information retrieval/other interactions of humans with digital world, etc.) are proposed and discussed. We will be happy to see new researchers and new applications in the nearest future.

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Modelling of Developing Socio-economic Systems Using Multiparadigm Simulation Modelling: Advancing Towards Complexity Theory and Synergetics

Natalia Lychkina

Abstract **The purpose** of this research is to examine model designs and approaches based on using modern paradigms and technological solutions in the field of simulation modelling of socio-economic processes and social forecasting that allow us to study complex dynamic phenomena emerging in the course of development of socio-economic systems.

Strategic management of the socio-economic system involves the analysis of structural changes and dynamic aspects of its development. The socio-economic system can demonstrate a specific dynamic behaviour in terms of development. While searching for effective modelling constructs, we are studying socio-economic systems due to several reasons, such as:

• the necessity of choosing and analysing of the development pathway while formulating a strategy;

• analysis of structural changes and dynamic complexity of socio-economic systems;

• the need to consider behavioural aspects of individual social behaviour and the activity of individual elements of a complex social system;

• the representation of self-organisation in social systems where the dynamic behaviour can be demonstrated spontaneously, depending on the internal structure and the influences from the external environment.

Design/methodology/approach—the processes observed in the society and socio-economic phenomena are similar to those studied in the branch of systemological sciences called synergetics. The chapter discusses the methodology and general technological approach to building simulation models describing such phenomena in socio-economic systems. A public system model is supposed to link the micro-level, where individuals (organisation) make decisions and act to the macro-level, describing the state, the basic structure and development of the system. All model variables are constantly changing for a long time under the influence of external and internal factors, thus transforming the structure and properties of the socio-economic system. Within the macro-level model, designs are produced utilising the

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aggregated system dynamics models describing the evolution and processes of development of social systems, the main elements: population, economy, production and social infrastructure, environment and other factors of social life. By describing microprocesses aggregated system dynamics models of socio-economic systems are complemented by agent-based models of individual social and economic behaviour of decision-makers, as well as describing the interaction between multiple social groups. The agent-based model allows investigating the individual behaviour of different groups of agents, the specifics of their adaptation to the changing environment, and how the processes of self-organisation influence the evolution and development of the socio-economic system as a whole.

Findings—This approach in building a multi-model complex based composite system dynamics and agent-based simulation models allows to investigate the dynamics and development of socio-economic processes through cyclical relationship of micro- and macro- levels in a socio-economic system.

Originality/value—The chapter gives an account of conceptual approaches to the formation of multi-model complexes of evolving socio-economic systems. The approaches are predicated on the provisions of the theory of complexity and synergetics, as well as the stratification methods of model complexes.

Research/ Practical/ Social/ Environment implications—A simulation model of the socio-economic system acts as the core of the procedure of strategic decision making in the think tanks, along with the monitoring system, data analysis, methods of generating scenarios, the technology of the scenario studies and analysing their results. Expert audit procedures and expert cognitive analysis are used for stratification, ontological design of simulated socio-economic systems, the formation of possible scenarios, reproducible on simulation models, and modelling "balance of interests".

Research limitations—The considered techniques of building the models of socio-economic systems have been developed and applied by the author of this chapter for building the dynamic models in the social sphere (health, housing, pension system), a regional system, the collaborative supply chain.

Keywords Synergetics · Complexity theory · Socio-economic system · Stratification · Simulation modelling · System dynamics · Agent-based modelling · Ontologies

1 Introduction

The development of the economy, the socio-economic development of the nation and its territories (regions), the business area, the elaboration and implementation of strategic development projects, the shifts in economic paradigms—all these

factors necessitate devising constructive approaches to insightful modelling of development and self-organisation processes within socio-economic systems by leveraging computer-aided simulation and modelling (S&M) technology, principles of synergetics and modern complexity theory.

Generally, the elaboration of a development strategy includes:

- Analysis of possible development pathways and identification of trends;
- Timeline-based attainability analysis for the formulated goals and assessment of the downside risks;
- Scenario analysis and search for effective development scenarios.

The strategy is understood as the temporal systemic development of a complex socio-economic system (SES), with coherent and joint development of its subsystems. Such development dynamics requires an analysis of the System's pathway from its current state towards the final goal (in the multiphase space of parameters), the long-term evolution of a complex SES. Development and growth are different categories. The development is understood as a qualitative change in the system, changes (transformation) in its structure, emergence of new structures and properties.

In the context of development, structural and dynamic complexity of SES demonstrate a number of specific dynamic phenomena, such as:

- Structural complexity. Complex (hierarchical, networked) and heterogeneous structure. Structural changes.
- Multiple causal relationships, positive and negative feedback links, feedback loops. Cause and effect are separated in time and space.
- Non-linear nature of the phenomena. Control via feedback links, adaptability. Multiple influential factors.
- Dynamic complexity (delays, non-stationary processes, varied speeds of processes) complicates the interpretation of the system's behaviour (interaction). Instability, wave-like processes in the system.
- Evolution and change in the direction of development, phase transitions. Historical dependency (path dependency).
- Development. Bifurcation of development paths and multitudinous development pathways.
- Decision-making rules (development scenarios) may vary over time. Conflicts between long-term and short-term decisions.
- Uncertainty, chaotic factors, stochastic processes. Uncertainty of the system development in time.
- Self-organisation, dynamic behaviour and new structures can emerge spontaneously. The internal organisation of the SES is rendered through self-organisation.
- Behavioural aspects and interactions of agents (irrational behaviour of economic agents, collaboration-competition, social behaviour).

Analysis of the SES development dynamics, the study of the dynamic phenomena of developing SES include a description of the *dynamics of its internal structure* (coherent development of subsystems) and the *dynamics of the external environment*,

as well as development management procedures through *dynamic scenario analysis.* So, in the course of development, modelling should consider such key criteria as the dynamic features of the system, the temporal changes of a complex system (CS) and its structure, the coherent temporal changes in its elements, the mechanisms generating new structures, connections and features of the CS.

The purpose of this chapter is a critical comparative analysis of conventional mathematical modelling used in economic and social sciences with basic approaches to computer-aided S&M for economics and sociology, while also considering and suggesting progressive approaches to S&M as applied to development processes within socio-economic systems from the perspective of complexity theory and basic provisions of synergetics, both gathering momentum in economics and social studies. The author proposes a general multi-paradigm framework for modelling of developing SES, while also delving into its basic structural principles.

2 Socio-economic System Research from the Perspective of Complexity Theory

As the conventional mathematical apparatus used in economic and social surveys is rather limited, it does not allow for appropriate rendering of above discussed dynamic phenomena in developing socio-economic systems. Economics has historically adopted a simplified approach, tending towards mathematical analysis, with models characterised by a limiting axiomatics as applied to the description of non-equilibrium processes (thus dominated by the economic equilibrium concept), micro-foundations and behaviour of economic agents at the micro-level. Researchers point out the fragmentation (the gap between macro- and micro-level descriptions) and static nature of models in economic theory and sociology.

Contemporary trends in economic theory (neo-institutionalism, evolutionary theory, behavioural economics, etc.) analyse endogenous factors in the development of the economic system, non-equilibrium processes, and postulate that the phenomena of economic life depend on the behavioural model of economic agents, while considering institutional structures as spontaneous self-organisation of agents. The concept of bounded rationality, the development of behavioural economics and economic sociology require the methods to be worked out for their hypotheses to be included in the models of socio-economic processes. Works on complexity economics note that to look at the economy, or areas within the economy, from a complexity viewpoint, would mean asking how it evolves, and this means examining in detail how individual agents' behaviours together form some outcome and how this might in turn alter their behaviour as a result (Arthur 2015). This requires modelling the main structural, institutional and behavioural characteristics of a complex economic system, and how the economic system develops over time with the agents' interaction as a prerequisite.

The search for appropriate model structures that would describe the development and self-organisation processes in socio-economic studies is based on transdisciplinary research in economics, sociology, and modern areas of systemology: the complexity theory and synergetics, as well as the trendsetting S&M methods and technologies that underlie Computational Economics (Tesfatsion et al. 2006), Computational Sociology (Squazzoni 2012), Agent-Based Computational Economics (Sociology), each of which attempts to provide insight into complex agent behaviour, dynamically represent the agents' behaviour, and demonstrate how general macro-system behaviour originates from realistic micro-structures and decision-making modelling.

The formation of computational economics and sociology techniques included a number of stages:

- research into macro-economic processes and establishing the principles of adaptation and evolution of macro-economic systems, based on the methods of system dynamics (Cavana et al. 2021);
- a "transition from factors to actors" by forming an agent-based paradigm with a view to building human performance models (Macy and Willer 2002);
- development of micro-foundations for global models and simulated Artificial Societies to populate micro-worlds (Epstein and Axtell 1996);
- as multi-agent simulation technologies keep evolving, it becomes obvious that agents themselves are rather sophisticated systems, adaptive and intelligent, which requires a model-based description of complex behavioural patterns for decision-making agents (Balke and Gilbert 2014).

However, neither descriptions of the dynamic phenomena of self-organisation, nor dynamic reconfiguration of structures, or interrelation between macro-, meso-, and micro-level representations have been achieved yet. Nor have relevant phenomena been adequately studied using S&M, with models being fragmentary so far (Paul et al. 2018). Interdisciplinary researches bridging economic and social sciences are still insufficient and lacking adequate model structures.

This shift towards the computer-aided techniques for economic studies facilitates transition from conventional economics towards systemised research from the viewpoint of complexity theory, further to transdisciplinary studies, a stepping stone towards other social sciences (sociology, demography, organisational sciences, etc.). The shift, both in terms of changing economic paradigms and applied research methods, as well as their analytical advantages, are summarised by the author in Table 1.

The complexity theory and basic provisions of synergetics provide theoretical and methodological background for the modelling of socio-economic systems development. As an auxiliary instrument for devising computer-aided SES models, synergetics allows us to study the evolutionary processes, the ability of a complex social system for self-organisation and development, to identify distinctive dynamic phenomena in evolving complex systems, such as self-organising and dynamically reconfigurable structures, with the new structures arising spontaneously, following the bridging decisions made by agents at the micro-level and stretched in time. A

Table 1 Theoretical and methodological basis for the research and modelling of the dynamic properties of socio-economic systems

	Conventional economics	Complexity economics
Economic paradigms	Neoclassical economics	Neo-institutionalism. Evolutionary theory. Behavioural economics. Economic sociology. Cognitive sciences
Theoretical and methodological basis	Economic equilibrium theory	Complexity theory. Economic dynamics. Sociodynamics. Agent-based computational economics (sociology)
Description of macro, meso, and micro levels	The gap between macro and micro-level descriptions	Interrelation of macro and micro levels. Emergence of the meso level in the description. Patterns stem from individual behaviour, and vice versa, individuals respond to macro-level patterns. Recursive loop
Micro-economics	Aggregated homogeneous agents	Diverse (heterogeneous) active agents
How agents make decisions	The principle of rationality The concept of rational expectations	Bounded rationality (mental models). Adaptation of agents. Strategies of agents (actors)
Interaction of agents	Not considered	Group dynamics, joint activities (networking, collaboration, competition). Orchestration and coordination of decisions. Collaboration strategies
Systemology	Theory of systems. Cybernetics (adaptive systems)	Subject-oriented environments. Systemic paradigm. Synergetics
Phenomena and patterns	Equilibrium Exogenous factors influence	Non-equilibrium dynamics. Development. Evolution. Self-organisation. Self-developing systems. Structural changes and transformations (endogenous influence). Dynamic reconfiguration of structures

(continued)

Table 1 (continued)

	Conventional economics	Complexity economics
	Statics. Negative feedback links	The dynamics of the internal structure and environment Positive and negative feedback links, circular causation. Multi-temporal processes. Non-linearity Uncertainty and chaos Self-organisation. Emerging behaviour. Bifurcation (alternative development pathways). Pathway dependence
Models / computational methods	Mathematical methods Econometrics	Non-linear dynamics. Algorithm-based (S&M) models (ABMS, SD). Hybrid approaches
	Regularities are known a priori	Regularities are revealed
	Mono models Fragmentary and unsystematic	Computer-aided modelling. Hierarchy of computational models. Set of models
Research methods	Estimation	Computational experiment (intelligence). Empirical research. Hypothesis testing. New regularities and knowledge are revealed and obtained
Anthropism	Social aspects are ignored in economic studies. Limited research tools for social sciences	Human self-developing socio-economic systems
	Controversy: Homo Economicus VS Homo Sociologicus	Convergence of economic and social sciences
Transdisciplinarity	Elusive. Models are not consistent	Transdisciplinary research. Models are semantically consistent
Complexity and development management	Separation of management issues and development issues	Dynamic development scenarios. Development management. Development strategies
The infrastructure of information and analytical activities	Decision support systems	Think tanks and cognitive centres. Convergence of technologies

new vision of the time and dynamics of self-organising systems is associated with the analysis of alternating conditions, both equilibrium and non-equilibrium ones, analysis of negative and positive feedback links, random effects, changes in the evolving environment resulting from the micro-level changes, as well as the now possible analysis of multi-temporal processes, multitudinous development pathways.

Experimental and scenario-based research enhance the approaches to development management (Knyazeva 2020), and we should leverage the system's ability for self-evolution, deploy management scenarios in time, figure out the time and points for management decision application in line with the system's inner abilities and its current state.

Conventional mathematical modelling does not allow achieving semantic consistency and unity between the many-sided model representations of different strata and descriptions of a complex system. Synergetics, in its turn, suggests a hierarchical approach to building interrelated models. There are plenty of philosophical generalisations on how synergetics may be applied in economics and sociology. However, advanced and proven model approaches (which would be based on the synergetics principles) are few and far between (Zhang 1999; Weidlich 2000). The present-day computer-aided S&M techniques open up such opportunities (Lychkina 2016).

The most illuminating S&M paradigms that have been applied in socio-economic research are system dynamics and agent-based simulation modelling. They demonstrate various descriptive possibilities for reproducing dynamic phenomena in socio-economic systems. Comparative analysis of simulation modelling paradigms is presented in Table 2.

System dynamics (SD) is based on the concept of flow stratification of the CS and conveys the idea that its structure, represented in the form of interacting flows and the interaction of multiple feedback loops within its structure, has a decisive importance in describing the dynamics of a system. This method was offered by the American scientist Forrester (2013). System dynamics is suitable for describing the evolution of a system (progress in a phased space), provides strategic insight into the system's behaviour, reflects slow processes and continuous time, allows for qualitative analysis and observation of the long-term pathway of the integral system development. SD enables considering co-evolution and coherent (joint) development of many subsystems, adaptation of the global system, dependence on the historical path, which facilitates reproducing multiple dynamic phenomena characteristic of macro-level complexity CS.

Cognitive analysis and expertise pave the way for elaboration of relevant models, which presupposes experts' awareness of the regularities at the system level, and the models are built from the top downwards. The expressive language of systems stock-and-flow diagrams is used to streamline expert interaction in the context of transdisciplinary projects. Models are built, parameterised and profoundly examined, using heuristics, methods of cognitive analytics and data analysis. However, SD demonstrates an aggregated approach, is limited in describing the behavioural aspects of heterogeneous agents, whereas mechanisms of self-organisation and transforming structures, and some other dynamic and behavioural aspects that are characteristic of

Table 2 Capabilities of simulation modelling paradigms as compared in the description of dynamic phenomena in socio-economic systems

S&M paradigm	System dynamics (SD)	Agent-based modelling and simulation (ABMS)
Subject matter of paradigm and structuring method	The concept of flow stratification (interaction of the most diverse flows) and the interaction of feedback loops	Identification of agent behaviour and interaction (specification)
Structure	The structure is unchangeable and determines the system's dynamics	Generated during simulation. Newly-formed structures emerge. Dynamic reconfiguration of structures
Adaptability	Adaptive properties of the system. The system evolves while in progress within the phase space	Adaptive agents (learning agents with changing behaviour)
Model building principles	From the top downwards. Aggregately. Globally. Structured problem	From the bottom upwards. Itemised. Locally. No global regularities known
Computer-aided modelling techniques	Diagrams. Cause and effect analysis. Causal maps. Stock-and-flow diagrams	Object-oriented programming
Analysis	Cognitive analysis Qualitative and quantitative analysis of the development (evolution) pathway	Mental models New phenomena studies

the micro- and meso-level complexity CS are poorly captured (implemented) through SD (Behdani 2012).

Agent-based modelling and simulation (ABMS) (Bandini et al. 2009) demonstrates the complex behaviour of the active Decision Agents, and makes it clear that the structure of the System originates from the decentralised decisions made by the Agents over time. People in general and specific individuals, as well as organisations are active elements of the economic and social system. The agent behaviour, manifested both individually and collectively, is essential for the research into socio-economic processes. Agents (economic agents, social elements) can be represented on the following levels: (a) individual behaviour, multiple economic behaviours and social activities; (b) group dynamics, social interaction. Agents are also quite a complex system.

When in the market, economic agents may act rationally enough, but they will always lack information. They compete or cooperate, change their behaviour under the influence of changes in the institutional environment and strategies implemented by other participants. The actions of agents in the market are predetermined by their personal interests and individual behaviour, institutional influence, and the relations between the agent and the environment. If we refer to cognitive psychology or organisational behaviour, the research has proved that individuals are irrational, emotional

and have a mentality; their actions are governed by their own rules, actualising their own mental models. This domain gained significant momentum after the economic paradigm declaring the rational behaviour of economic agents pivoted on a limited mathematical apparatus was superseded by the concepts of bounded rationality of decision makers, with the ideas of a learning-based organisation, along with the search for descriptive methods to devise experience-driven intellectual economic and social agents. Agent properties change over time. Agents accumulate experience and knowledge, enhance their mental models, which guide them in making decisions. Agent-based models describe complex group economic dynamics: network-based organisational forms; cooperation, orchestration and arrangement of joint decisions; competition, strategies for actors and cooperation, etc.

In sociology, agent-based models facilitate studying social patterns based on social interaction between heterogeneous agents embedded in social structures. When considered within the society, an individual is not merely an economic agent maximising the utility function, but also a personality who has freedom of choice and exercises multiple individual behaviours. Different people will have multiple potential behaviours. The thrust of their activity is to some extent determined by 'passionateness', which varies across different social groups. The composition of social groups is changeable. It is affected by general socio-economic trends in society. Social sciences deal with such phenomena as the emergence of social and human capital, which are formed in the course of social interaction and social reproduction. Groups, institutions, and social structures arise. Therefore, at the SES micro level, we factor in the decisions and actions by individuals whose motives and norms of behaviour are characteristics of certain social groups, as well as the formation of various social configurations.

Such S&M techniques provide a remedy for the notorious descriptive contradiction between 'homo economicus' and 'homo sociologicus' (Brunner 1987) by elaborating human-sized self-evolving environments, deploying a platform for broad interdisciplinary research in the field of social, economic and organisational sciences. Today, agents can be specified by leveraging the achievements of the social and organisational sciences, and by analysing empirical data.

It is at the micro level where the processes of self-organisation are launched. Even though formed at the microlevel, social behaviour can trigger global changes in the social system. This enables us to observe and study the regularities and dynamics characteristic of the System as a whole. The agent-based model streamlines the research into individual behaviour of various agent groups, the specifics of their adaptation to a changing environment, the influence of self-organisation processes on the evolution and development of the socio-economic system as a whole. Thus, ABMS provides expressive possibilities in describing the behaviour of heterogeneous active agents and their interactions at the micro-level, self-organisation, dynamically reconfigurable (newly formed) and changeable structures, and other dynamic phenomena of CS. Models are built from the bottom upwards, the global system features are manifested through a computer-aided experiment, without being specified a priori when creating a model. Without ABMS, it would hardly be possible to reproduce most of the above-discussed dynamic phenomena that accompany evolvement

and self-organisation in socio-economic systems and are characteristic of micro-level complexity, namely: the multiplicity and heterogeneity of agents, complex behavioural patterns and their interactions, adaptive changes in the properties of the agents themselves, self-organisation and modification of structures resulting from the interaction of agents, etc.

Because S&M techniques are in essence experimental, they lay the groundwork for empirical research and pave the way for further research into and identifying new patterns and regularities in the CS behaviour. Computer-aided dynamic scenario analysis, deployed on a generalised SES simulation model, is applied as a tool for finding high-efficient development strategies.

The capabilities offered by S&M software enable elaborating complexes of models for various strata and descriptions of the CS, thus ensuring the semantic and informational consistency across the models.

3 General Multi-paradigm Framework for Simulation Modelling of Developing Socio-Economic Systems Based on Stratification Principles

Structural stratification of SES and interpretation of their interaction. Within the socio-economic system, the macro and micro levels develop together. This facilitates understanding of the entire phased development picture. The collective behaviour of agents affects the evolution of economies and the dynamics of social structure. Changing environments determine the behaviour of agents and interaction between them. Various layers of the SES are characterised by different degrees of organisation and nature of the dynamic processes occurring across different strata of the SES.

The Macro-level of the generalised SES model describes the state, basic structure and development (evolution) of SES, the co-evolution of various SES subsystems (population, demography, economy, natural and social environments, etc.). These are mainly slow processes.

The Micro-level deals with the behaviour of heterogeneous socio-economic agents and their interaction (in society and economic life), as well as the individual strategies of Actors, purposeful and active decision-making agents. The behaviour of agents is determined by their mental models. Normally, there are discrete time, events and fast processes. The dynamics of the micro-level layer demonstrates the changes in the number of agents, their features and decision-making rules, training and adaptation of agents over time influenced by other agents' behaviour and changing environment encompassing active decision-making agents.

It is possible to single out the meso-level, which demonstrates how interaction of actors generates social structures, institutions, and organisational forms. This is where an important phenomenon of emergence manifests itself through self-organisation and dynamic reconfiguration of structures, new structures and configurations. It is

an important dynamic phenomenon, when new structures keep appearing over time rather than one fixed structure.

Eventually, it is a recursive cycle: a cyclical interconnection of processes occurring at the micro and macro levels. Stratification-based approaches used for complex modelling of a socio-economic system are complemented by a peripheral interdependence between levels, a description of upward and downward interactions between levels. Downward interaction demonstrates how Agents change their behaviour depending on the conditions in the environment. Upward interaction demonstrates how the Agents' behaviour, the systemic qualities of society (collective organisational forms), the newly formed structures affect the evolution of the system as a whole. This allows overcoming the fragmentation in the description of the socio-economic system, and linking the macro- and micro-levels, with everything changing over time.

The considered approaches to stratification of a generalised dynamic model of development processes in socio-economic systems are implemented on the basis of the principles of a composite combination of the methods of system dynamics (SD) and agent-based simulation modelling (ABMS), a multi-paradigm approach to elaboration of an S&M array for SES. Compensatory combination of various S&M paradigms provides vast opportunities for combining micro and macro-level representations on the basis of a single model framework. Macro-level and evolutionary processes within SES are rendered through SD, and micro-level behavioural phenomena are rendered through ABMS. Interpretation of the interactions of socio-economic configurations is predicated on the causal analysis and dynamically expressed interpenetration of the phenomena occurring in different strata of the socio-economic system (Lychkina 2016).

The design of SES multi-model complex is implemented in line with the systems principles of and approaches to stratification, underpinned by a single model frame with extensive information and implicit links between models across various layers and ontological levels, and using multi-paradigm S&M environment by AnyLogic (https://www.anylogic.com). The major challenge is to devise a unified technology enabling assembly of model layers within the system and the formation of an ontologically complete domain model. The conceptual representation and scalable nature of the generalised SES simulation model requires decomposition of multiple submodels, structure descriptions, dynamic representations, and other constituents. Simulation models are conceptualised and structured on the basis of a stratified description of the problem and the system. *Stratification and methods of a stratified description for a problem and a system* (as a conceptualisation technology) enable devising large-scale and interconnected models, combined into a single model array, while preserving implicit relations between the models of the model array across various strata and levels of generalisation (aggregation). As a general principle of system-wide S&M, stratification reflects structured knowledge about the system, while providing a necessary tool to build up an S&M array for sophisticated SES, to work out the system phenomenon logic and to maintain implicit links between various models comprising the array of models. The stratified description of the modelled SES may be used for discussing and generalising a systemic problem, harmonising diverse views on the problem, supporting versatile representations (notation) of conceptual layouts. In

this work, I propose approaches to stratification of a multi-model array, including various ways to represent conceptual descriptions of a complex SES: cognitive, flow, structurally functional, informational, as well as other helpful visual graphic techniques (Lychkina and Morozova 2011). This facilitates the model construction at the concept phase, contributes to the audit procedures and streamlines transdisciplinary interaction among subject experts.

The author endorses the proven approaches to the construction of model arrays used across the social sphere (Lychkina and Morozova 2014, 2015), regional (area-specific) systems (Lychkina 2004) collaborative specialised projects (Lychkina 2022). Such approaches streamline extensive transdisciplinary research in economics, sociology, and management of organisational systems.

4 Conclusion

The author proposes advanced approaches to construction of multi-paradigm model arrays providing insight into the dynamics of development and self-organisation processes in socio-economic systems. The complexity theory and synergetics serve as a theoretical and methodological basis for the construction of simulation models. A general model framework is proposed and describes the dynamic phenomena that are characteristic of the micro and macro levels of the developing SES, as well as recursive and cyclical interactions between the micro, meso, and macro levels of the SES. The framework is underpinned by a composite combination of SD and ABMS paradigms of simulation modelling. The chapter outlines the principles of devising multi-model arrays of SES simulation models. The principles are predicated on approaches to stratification, and multi-paradigm S&M. The author regards continuously upgraded system modelling technology using ontological modelling (Idiatullin and Lychkina 2011), which provides semantic consistency and information exchange between diverse software conceptual and computer simulation models, thus forming a multi-model complex, along with further elaboration of techniques and tools for computer-aided dynamic scenario analysis based on a generalised SES simulation model as a prerequisite and accelerator for achieving substantial progress of this field of research.

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Part IV
Transdisciplinarity of Systems Sciences and Cybernetics: Developing Areas of Knowledge

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In today's world, structural and long-term transformations are taking place. The centralization of communication platforms, rapid expansion and use of artificial intelligence, along with major environmental, demographic, socio-political and economic shifts are impinging on major changes in our society. This situation demands empowering citizens to promote economic growth, sustainability, social justice and political stability. In particular, youth should develop capacities to think and act differently, which requires a major transformation of our education systems.

Decision-takers all around the world in public institutions and private organisations are recognising the complexity of issues (ecological, social, health, economic, energy, transport, migratory, etc.) and their interrelations. The underlying systems are intricately and intimately intertwined. The current narrative goes around economic competitiveness and focuses on supporting people to act in a digital and virtual economy leaving aside the enormous challenges humankind is facing, some of them existential.

In the last four decades events like Chernobyl, the Global Financial Crisis, the Gulf Oil spill, Fukushima's tsunami and the current conflicts and pandemic have shown the danger of this lack of consciousness about the potential planetary effects of man-made decisions. Decision-takers would benefit by using systemic approaches to cope with the complexity of these issues and ameliorate their impact on impending global crises. Crisis, in ancient Greek, refers to the breaking of connections.

Within the systems movement, a wealth of conceptual and methodological knowledge is being created that should help us in these tasks. The challenge for researchers and practitioners is to make everybody, especially young people aware

and knowledgeable of these foundations and proficient in their application. Cultivating cybersystemic approaches, with their related ontologies, epistemologies, methodologies, methods, tools and concepts provides ways of thinking and acting that enable the development of such a collective consciousness.

The aim of this theme is the cybersystemic exploration of distinct social areas and at the same time the search for connections, relations and transverse knowledge. What is makes education unique in society? What is special to education that requires receiving both holistic attention and the development of particular communication mechanisms? What makes it different to the economic or the transportation systems?

What can be said about the commonalities of these systems in different regions of the world? What can be said about their cross-cultural nature? How are they producing their unique hybrid realities? In all areas, it is necessary to avoid fragmentation by facilitating the alignment of people's purposes. What is unique about levels of self-organisation and self-regulation in each case? How are they addressing their interactions with their environments? What do their unique perspectives have in common? How to develop trans-disciplinary learning processes?

In a world increasingly requiring interactions, one of the challenges is facilitating self-organisation processes for the emergence of desirable values in societies and the creation and production of related policies from the most local to the most global levels. These are processes aimed at individual innovation as well as making more meaningful coexistence.

In this theme, we have invited contributors to join in debates to explore specific areas of people's wide variety of possible interactions, communications and relationships to make them more effective. Through the investigation of specific institutions and evolving technologies for each of these transdisciplinary areas, we foster discussions that guide, enable and facilitate interactions among existing, necessary and available resources to increase society's requisite variety to deal with challenges to areas at different structural levels in different cultural contexts.

It seems important to go beyond interdisciplinary approaches to develop a new transdisciplinary way of thinking and acting; a kind of indiscipline in which we must recover Aristotle's practical wisdom. WOSC 2021 has offered a platform for cybersystemic contributions to group discussions for collective synergy supported by state-of-the-art individual research.

Design Education as an Action-Research Project on Ontological Design: Educating Transition Designers

Hernán López-Garay and Daniel Lopera-Molano

Abstract The current system of design education continually reproduces a form of technical disclosure which constitutes an increasingly unviable way of dwelling in the present. Taking inspiration in so-called ontological design (Winograd and Flores 1986; Willis 2006) a Design Program (DP) was created at the University of Ibagué in the year 2014. The design of the program has been an experience in designing/unfolding an action-research project on ontological design education and practice. Based on the educational experience gathered in the 7 years of existence of this Design Program, an account will be given of how the action-research project on ontological design has developed an educational model that is weaving a system of relationships between the theoretical-pragmatic positions of ontological design and autonomous transitional design. This organic unfolding is aimed at educating transition designers involved in the transformation of communities fully inserted in a technical mode of revealing into communities that–driven by a care-full mode of disclosing–aim at constituting a dwelling environment (i.e. a harmonious being at one with the world) in the midst of the de-futuring anthropocene epoch of the present. This educational approach to designers is operationalized in an academic structure-process in which transitional design is beginning to influence applied research, transitional thinking and transversal training in the university as a whole. The research reported in this article could also be of interest to educational institutions, academics and researchers, in particular for those who perceive transitional design as a way to systemically deal with the crisis of the present. The paper is structured as follows. First, we state the case for the urgent need to change the education of designers. Next, we sketch the conceptual framework of an education program (a design program, DP) to prepare a new breed of designers able to see how design designs (ontological design) and consequently how current design, driven by a technical disclosure of the world, has construed a non-viable global system which by the first time in human history is threatening the survival of the human race. Hence the need to educate *transition designers*, that is, designers able to work jointly with the communities to drive away technical disclosure towards a *pious-poietic* disclosure of the world. In

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Sect. 4. a triadic cybernetic organizational structure is presented to accomplish the education of these designers. The reason for proposing such a structure has to do with the complexity, uncertainty and turbulence of the world that design itself has helped to construe. Only second-order cybernetic systems can help both, to navigate in such environments and to develop a more profound understanding of the challenges that as design educators we are facing.

Keywords Design education · Transitional design · Ontological design · Action research · Organizational cybernetics

1 Introduction

Victor Papanek (1972) is often quoted as saying that "there are professions more harmful than industrial design, but only a very few of them (…) designers have become a [social] dangerous breed" (p. 1). Now, considering design has played a paramount role in the construction of the modern world, Papanek's indictment of the design profession cannot be more alarming. In fact, "design is literally everywhere, from the largest structures to the humblest aspects of everyday life; modern lives are entirely designed lives" (Escobar 2018, p .2). But, what kind of world have designers helped to build? And how crucial has been the role of university design programs in educating this *dangerous breed*? Could this be reversed? That is to say, could we structure a university design program that prepares a new breed of designers, one able to contribute to the creation of a more harmonious being at one with the world?

It is in the context of these preoccupations with the design profession that the Design Program (DP) of the University of Ibagué (UI) sees the light in the year 2014. Its mission: Educate a new breed of designers able to comprehend, as Fry (2009) points out, that we live in a world that is taking away futures for ourselves and non-human others, and that design is highly implicated in this *defuturing* process. Therefore, this education must be of such a nature as to facilitate learning to learn a way of thinking/designing in the world that can help contest the negation of the world.

2 Background

The DP´s curriculum profile to educate this new breed was inspired by design theorists and practitioners such as Arturo Escobar (2012, 2018), Tony Fry (1999, 2009, 2010) and others who assert that it is cardinal to rethink design and design education entirely anew. Current design programs focus on reinforcing Cartesian rationalist instrumental design education and practice (the type of design that Papanek is much concerned with). What is urgently needed, however, is to foster a new design practice, one founded on non-Cartesian (dualistic) ontologies. An example is the initial

proposal of ontological design made by Winograd and Flores (1986), and later developed by Anne-Marie Willis (2006), Arturo Escobar (2012), Clive Dilnot (2015), Tony Fry (2017), Alfredo Gutiérrez-Borrero (2016), Madina Tlostanova (2017), among others. The key assumption of ontological design is this: "…when we create the objects and contexts that surround us, we are in fact designing our very selves. In other words: first, we design our tools, and then they design us in return. This feedback loop is ontological design's central idea…when we are speaking of ontological design, we are speaking of defining a systematic, creative approach to designing being, existence, and reality itself (Fraga 2020). Accordingly, ontological *design* is a design that *discloses new worlds*, and therefore is becoming a historical tool for "reimagining and reconstructing *sustainable worlds* (…).

Now, how all this connects with transition design?

…entire societies must transition toward more sustainable, equitable and desirable long-term futures …these transitions will require intentional, systems-level change. We see evidence of these memes in the large number of transition-related initiatives springing up around the world, and the rise in the number of tools and knowledge sets aimed at understanding complex systems and systems problems. Transitions Design focuses on wicked problem resolution as a strategy for seeding and catalysing positive, systems-level change and societal transitions toward more sustainable, long-term futures. (About Transition Design, https://transitiondesignseminarcmu.net/).

What the principles of ontological design make us aware of is that these transitions towards more sustainable futures require designers to be conscious of how design has contributed to creating who/what we are in the modern world. Now, this awareness is crucial to formulate the key question transition designers have to make: "Can design, understood ontologically, play a constructive role in transforming entrenched ways of being and doing toward philosophies of good living that ultimately equip human beings for a mutually enriching existence with each other and with the Earth? (Escobar 2017, p. 47. Free translation).

3 Methodology

The question Escobar is making in the previous quote is not rhetorical. It is an invitation to join the rank and files of those who are beginning to explore, from the design world, how to cope with the grave global–local crisis we are facing. The historical crisis of the present requires *ontological design* to be not just another type of design but an evolving field and an action-research project undertaken by various universities, design programs and design practitioners and educators around the world. In this connection, three fundamental research questions are guiding the DP since its inception in the University:

Q1. How is the present world constituted by a dominant rationalistic instrumental design?

The way this research question is undertaken by the DP is not only theoretically but also by teaching and applying such design with a critical eye to uncover how

modernity's One-World ontology works and, in particular, how it prevents the manifestations of a *pluriverse* of socio-natural configurations and the development of communities' autonomy (Escobar 2018). Accordingly, researchers-practitioners in the DP seek to uncover how each design (in a given situation) may be counterbalanced to help client communities, organizations, and individuals resist rationalistic design and/or find ways of re-existence (Banguero-Camacho and Giraldo-Díaz 2017).

Q2. How design has become imbued with a rationalist instrumental mentality?

It is clear that unless we understand the historical emergence of design itself and it's becoming a dominant constitutive force shaping the current world, we will neither comprehend Papanek's indictment nor we will have a clear picture of what should be the profile of the new breed of designers the DP needs to prepare. In López-Garay and Molano (2017) we trace the historical emergence of design to the gradual vanishing of *tékhne* and the rise of *technique*. The former was a mode of disclosure in ancient Greece being characterized by a respectful, *care-full* mediating bringing forth to presence. The latter heralded the emergence of a new mode of disclosing driven by a will to disclose whatever is the case as things in themselves, unfounded beings, available to be manipulated at will, for the sake of control (Heidegger 1971). Let us call the latter a *technical* disclosure (or *modern technique*). Thus, **design emerges as the thinking/acting that discloses being in a technical mode**. And in so doing, design has unfolded a thinking path and a world propelled by the will to control the bringing forth of existence, the creative force of life.

Concretely, *modern technique* is a mode of revealing in which entities increasingly show up only as resources to be optimized; entities lacking intrinsic meaning which are thus simply optimized and disposed of with maximal efficiency. Heidegger (1954, 1971) calls such mode of revealing *enframing*. Advanced modern technology embodies such revealing, as well as the culture and economy that have created it. Together they have promoted an understanding of the world and other humans as a mere *standing reserve* and have thereby formed a culture of technicity (Thomson 2001).

Q3. Is design's future a future of a care-full opening of infinite possibilities of being?

The unfolding of Q1 and Q2 is helping the DP to contemplate possible future scenarios for design and the constitution of the world. A critical observation of the field of design (López-Garay and Lopera-Molano 2017) shows the field is reaching a critical historical juncture: One path is paving the way of the field towards facilitating the full realization of modern technique in the form of technological *posthumanism* i.e., the view that through technological devices humans may enhance indefinitely not only their physical capacities but also their intellectual and psychological ones (not to mention the efforts of biology for achieving someday the genetically designed immortality). For what purpose? What is the driving force behind this unlimited technological self-augmentation? Thomson (2001) gives us an answer: For no other purpose than the will to power, that is, the sheer will-to-will. The other path is giving rise to a type of design thinking which awakes to what is most essential to human beings: *care-full world disclosing* (Escobar 2018, p. 112). Consequently, we could say design is returning to its historical roots in *téckhne*.

The DP has embarked itself in the preparation of *transition designers*, those who will help to steer design activity towards care-full world disclosing rather than towards enhancing technological posthumanism. Put otherwise: we are educating them to become care-full world disclosers rather than enframers.

Inasmuch as the DP is educating transition designers to work with the communities to disclose enframing and non-enframing technical worlds, this means they will be charged, first and foremost, with accompanying regional communities to free themselves from the stronghold of a dominant, technological and defuturizing way of being in the world, to begin to walk the path towards a careful, non-controlling and *pious poietic* revelation of relational pluriverses.[1] This is how the DP will respond to Papanek's indictment of the design profession, by helping to repair the social and natural fabric destroyed by technological design. However, as already explained, for this educational effort to go forward, the DP has become an ongoing action-research project driven not only by the three research actions enunciated above (Q1, Q2, Q3)[2] but also by a fourth action that is a consequence of the other three: an adaptive organization to accommodate and facilitate the continued development of the other three actions. In the next section of this article, we will sketch the main ideas behind such an organization.

4 An Academic Structure in Transitional Design

Let us now describe the adaptive organization that can foster the education of transition designers. However, in this article, we are arranging these structures more consciously and are putting forward a proposal. Such a proposal has to take into account the fact that it has to operate in the context of the university which houses the DP program. In as much as the organization of this university is in itself on the verge of an important organizational transformation, we are proposing for the DP to harmonize with this transformation which is fully described in a document entitled: *La universidad necesaria* (Orozco and Reyes 2021). This document presents the design of a new university, capable of facing the complex problems of the current era. The core of this proposal is a triadic organizational structure composed of Research

[1] Here we are specifying what we mean by careful in "care-full world disclosing". Pious, in this writing, is endowed with a polysemic meaning. On the one hand it signifies the sacred. The sacred, in a religious sense, is usually related to one crucial characteristic of the divine: Its mysterious presence. However, and as if covered by a veil, the mysterious never reveals itself completely. Pious poietic disclosing of the world is a mode of revealing, distinctive of tékhne (see question Q2 above in the main text) whereby what is brought to presence is never revealed completely, thus leaving its background rich in infinite possibilities.

In the present article we locate the origins of design in the vanishing of tékhne and the emergence of technique. The latter, as we recalled, is a mode of revealing in which entities increasingly show up only as resources to be optimized, entities lacking intrinsic meaning which are thus simply optimized and disposed of with maximal efficiency.

[2] A concrete example that is evidence of progress in these three actions can be found at the following link: https://repositorio.unibague.edu.co/jspui/handle/20.500.12313/1750.

Institutes, Think Centres and Training Schools. And as said before, the PD's adaptive organization aims to fit into this triadic structure. Accordingly, it will be composed of three main elements, namely: A Transitional Design Think Centre, Research and Creative Institutes and a Design School.

4.1 The Transitional Design Think Centre

A primary function of this Think Centre is to research what is conceptually central to the DP, namely, the idea of the need to promote a transition from technocentric ontological design *to pious poietic* centric design. Another important function is related to what we may call the *politics of design.* Designers must study the impact on our regional communities of governmental policies designed with a technological perspective of the world and how these policies design us as post humans. Giving advice to the policy makers and raising citizens awareness of how technological design affects their lives is another function of the proposed Think Tank.

The third vertex (Fig. 1) is concerned with Alter Design (López-Garay and Molano 2017) and, in particular, with its central subject of *design-others* (*alter* in Latin means the other). Theoretical and comparative research on pluriverse disclosing and design-other manifestations in the original peoples of Latin America is helping us to reveal these alter designs. In this regard, we should mention that a new field of transdisciplinary studies is emerging (Escobar 2012, p. 58), and the Think Centre could make part of this field. Let us explain. DP transition designers, in their work with the communities, have to conduct a dialogue between different knowledge and cosmologies, particularly with those who still preserve the original attitude of openness that invokes other worlds. What we mean by dialogue has to do with the effort participants have to make to understand the perspectives and conceptions of each other. Now, since this dialectic does not seek to conquer the other but to find oneself, by listening to the other, to see oneself reflected, a specular property

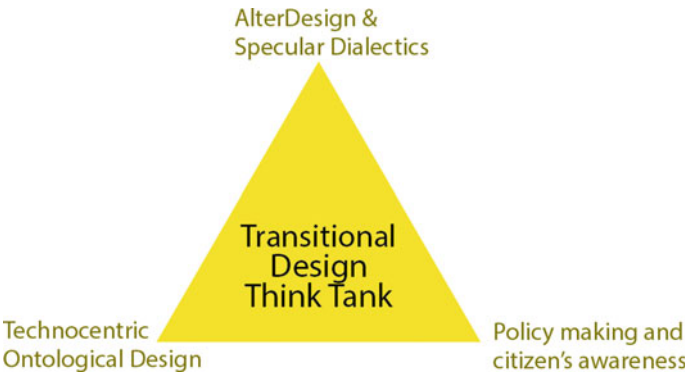

Fig. 1 The general theoretical structure of the transitional design think tank

emerges from the encounter between the dialoguers. If we understand listening as the accompaniment of another, then this act has *specular properties* because it seeks to create a reflection.

In short, the main objective of the Transitional Design Think Tank is the theoretical study of problems related to the transitional opening and the declaration of alternative conceptual paths from and beyond design.

4.2 Research and Creation Institutes

While the Think Tank is in charge of a continuous process of theoretical reflection on design-others and proposals of alternative conceptual paths for transition design and the politics of it all, the Institute has teachers-researchers in the field making practical applications and building knowledge anchored to the territory together with the stakeholders, which are the regional organizations, communities and individuals. This applicability is framed in co-constructed challenges that are oriented to the fulfilment of a mission in the territory. Concerning the Think Tank, this means that it is not only enough to maintain constant reflection on an issue that theoretically shows ways for the future, but it is necessary to put them into action and continue learning from them; that is why Institutes in Research and Creation are required.

Three primary activities (Fig. 2) of these institutes are teaching research-applied in transitional design, research and dialogue, by way of social projection, with the surrounding communities. Let us briefly explain each one: Social projection refers to the ongoing dialogue with regional communities in respect and consideration for their ways of understanding their situation, of attending to it and of requiring or not accompaniment by the University. In this sense, what is of interest is everything

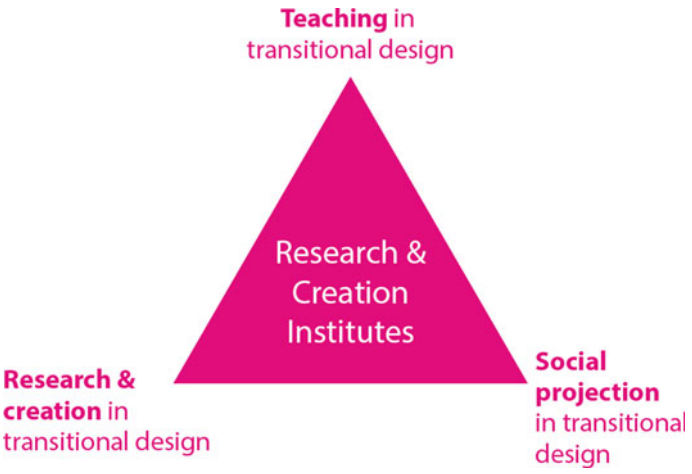

Fig. 2 General academic structure for the research and creation institutes

gained from the speculative dialogue concerning other forms of creation, beyond the academically valid. In this, their ways of seeing/bringing to presence worlds must be respected, therefore, their involvement requires constant ethical, critical and aesthetic training. Consequently, it is articulated with the teaching in research-applied to the required creation processes, but not only in the methodological field but also transversal to the attitudes of the transitional designer.

4.3 The Design School

The idea of the Design School broadens the view and action of the DP with which this article began and inserts it in a dynamic system of university organizational structure that favours and facilitates its integral operation together with stakeholders of the region.

From the above, it is clear that the internal academic structure of the Design School contemplates professional training in Design, with a transitional approach. This is its first aspect. The other two, which complete this new triad, are the transversal training in transitional design and the complementary training in design (Fig. 3). By transversal training, we refer to the deployment of institutional capacities to radiate in the different schools (i.e. Engineering, Management, Economics) and other academic areas of professional training of the University, the development of knowledge, skills and attitudes in design that are essential for all professionals today. Certainly, these capacities are oriented towards situated, dynamic, participatory and, above all, world-opening transformation. If the DP had its origin in 2014, the University of Ibagué has already begun to radiate this offer to other undergraduate programs under the

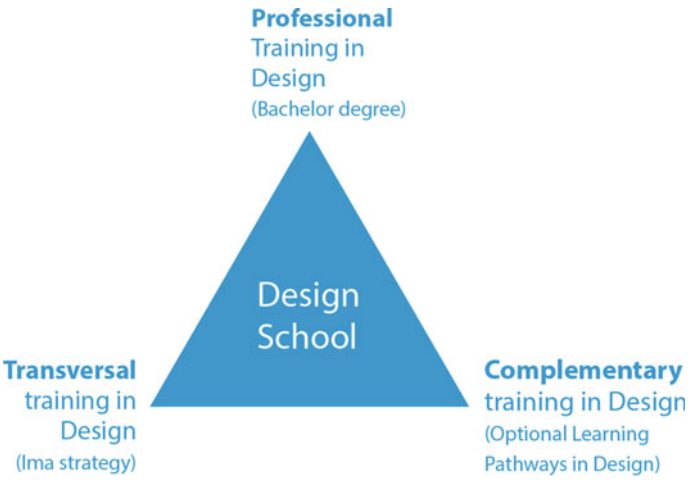

Fig. 3 General academic structure for the design school

Ima strategy. We call *Ima* to the transdisciplinary training strategy that has as its fundamental basis Design and the question of Transition. In the current semester, we are working on this with students from different approaches to Engineering, Economic and Administrative Sciences.

Finally, there is a complementary training in design with a transitional approach. In this sense, the University has created the strategy of Optional Learning Pathways that allow students to take modules or courses on topics of their interest that do not necessarily constitute a path for their professional degree but are also relevant to them. What is planned is the creation of several Optional Routes in Transitional Design organized according to particular topics of interest to the region and with global validity.

4.4 The Entire Academic Structure as a Transitional Design System

The purpose of this section is to present how each triadic unit (Think Tank, Institute and School) has been proposed to provide feedback to each other; and at the same time to explain how each of the three triadic units relates to each other, constituting what we could call an Academic Structure in Transitional Design for the *Universidad de Ibagué necesaria.*

In principle, each triad that composes a unit must have its form of feedback that allows understanding the result of its direct action and making corrections as a first-order learning system. Likewise, each Unit must evaluate the results and interpret what they mean in the light of the Unit's purpose, to establish improvement processes, which implies second-order learning. Finally, there is a team that is in charge of observing the complex functioning of the general academic structure to the purpose and applying changes that allow it to creatively address its units and forms of relationship so that the desired results emerge (Fig. 4). This implies third-order learning.

Each triadic unit is represented by a primary colour to symbolize that each unit is a system in and of itself and holds interrelations with the other units. It also highlights the idea of the primary activities of the system. The possible interrelationships between the units are:

- Orange: The Think Tank provides the Institute with a conceptual understanding and possible alternative paths for addressing a transitional situation to be designed. The Institute provides the Think Tank with the applicability of these concepts and alternatives in a real context through a design process that is also characterized by its rigour and systematization towards the co-creation of relevant knowledge to address common challenges.
- Green: The Think Tank provides the School with a constant environment of conceptual reflection that, from its abstraction, manages to deepen on current situations allowing to provide relevant, current and autonomous knowledge and

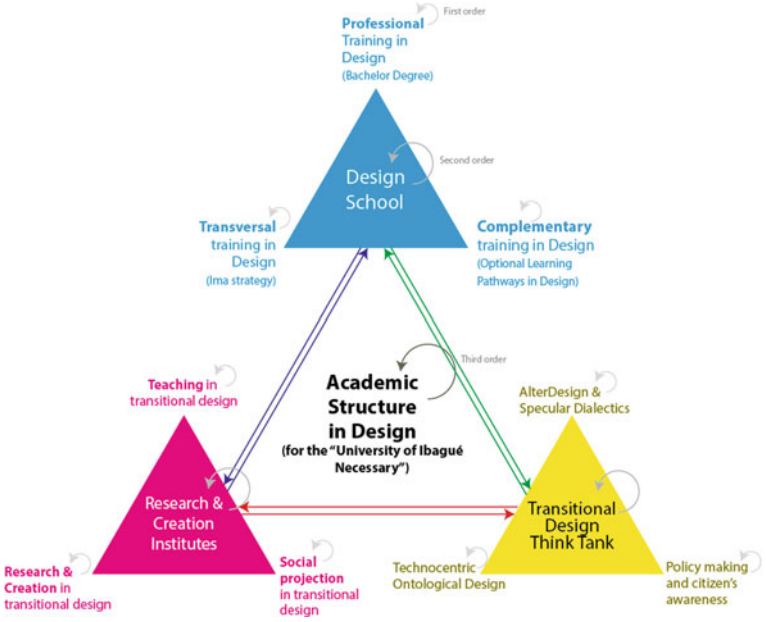

Fig. 4 Academic structure in transitional design

practices. The School of Design provides the Think Tank with the pedagogical context for the formation of new transitional designers under the ideas and positions that are constantly under reflection and discussion, as well as the context in which the specular dialogue makes sense and generational purpose.

- Purple: The institutes are made up of the University's teachers and the schools are made up of the students. The teachers lead and support research that is not only contexts of practice but is also real inputs for training. Likewise, the formative practice in the transitional design itself becomes a process of pedagogical research-action. The School of Design offers the context of professional, transversal and complementary training in transitional design and the institutes offer the real research processes where knowledge, skills and attitudes make sense for transformation. The teacher is updated as they act in and together with stakeholders of the territory, and the student is nourished by these experiences and supports them with challenges, projects and formative exercises.
- Black: The conjunction of all three will be able to address regional missions with a global approach through discourse and practices in transitional design.

Finally, we include in this prototype system amplifiers and attenuators in the relationship with the main external context for each Unit. As can be seen in Fig. 5 the relationship of the School with the external sector involves understanding the needs and interests of potential and current students to attenuate it to a viable and controllable curriculum offer. On the other hand, for example, the characteristics of

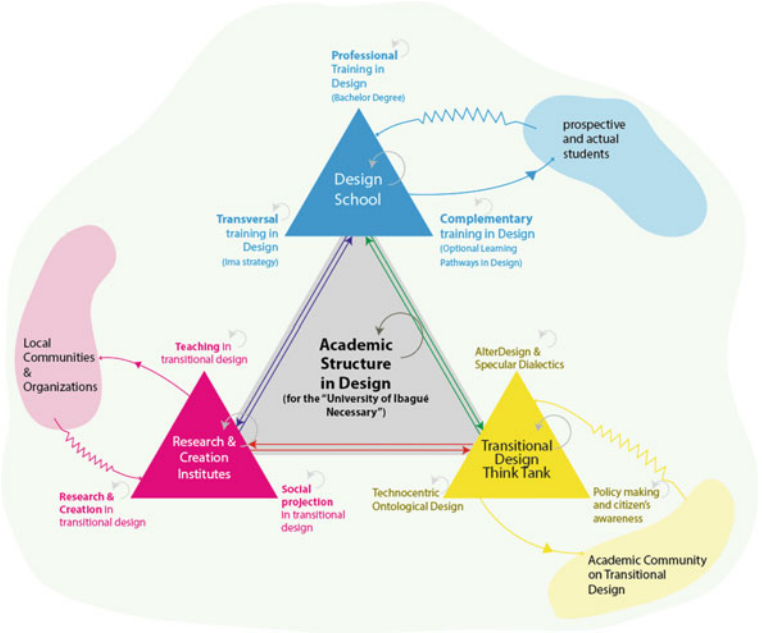

Fig. 5 Academic structure in transitional design and its relation with some of the main external agents

the offer with its possibilities and successes must be amplified to the majority so that they can consider studying it.

In the case of the Think Tank, the main external context is the academic community itself in transitional design. There, we will also be able to give examples of how it is necessary to attenuate the variety, especially because this implies making decisions not only about the approaches but also about the questions so that they make sense and enter into a coherent dialogue with the three central elements of the Think Tank and the regional challenges from which these concepts operate. Likewise, it is possible to amplify the use of a concept such as Alter Design to nurture other discourses and approaches of the academy with a variety of applications beyond the University.

In the case of Research and Creation Institutes, the context is local communities, companies and governmental organizations. A large number of challenges present in the context requires reduction mechanisms that involve prioritizing and organizing under missions, as contemplated in the Universidad necesaria proposal. At the same time, the Institutes must be able, for example, to amplify the variety of their research products, making them applicable in other contexts and obtaining satisfactory results that can, to a certain extent, be replicated.

Thus, the system is conceived within a broader context with which it interacts.

5 Conclusion

In this article, we have presented the preliminary outcomes of an evolving action-research project on transition design education and the cybernetic organizational model to support it. Although we recognize that these results are specific for the DP of *Unibagué*, and that comparative research with similar DPs in other universities will have to be undertaken, nonetheless we think the results may serve for triggering debate and reflection on the urgent need to change the education of designers. An important by-product of this project is that it could influence and inspire other disciplines and pedagogical areas of the University not only to innovative ways of organizing the educational function but also the importance of transitional design as a vital competence required to tackle the complex problem situations of the present.

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Socio-Humanitarian Technologies of Education of the Future: Philosophical and Methodological Basis

Ekaterina Machina, Denis Zhurenkov, and Artem Poikin

Abstract **The purpose**—This chapter is devoted to the problem of integration of value-purpose orientations of education and human-subject orientation in the context of transition from a technogenic to a socio-humanitarian civilization. **Design/methodology/approach**—The study aims to investigate the philosophical and methodological foundations of socio-humanitarian technologies in education in the twenty-first century. The chapter considers objective, subjective and meta-subjective approaches to the organization of education in the information society. The problem of ethical systems in the context of future education is investigated. The concept of the study is based on modern philosophical and methodological approaches, which focus on self-developing poly-subjective environments. Post-non-classical ontologies of educational processes are considered and an interdisciplinary approach is used as a system of knowledge integration on the research topic. **Findings**—The conclusions of the research form the initial basis for the development and implementation of socio- humanitarian technologies of advanced education. It is assumed that it is possible to successfully solve some challenges of education through the development of socio-humanitarian technologies, consolidation of society in the establishment of certain multicultural ethical values. The influences of modern technologies and digital platforms on education are taken into account. The chapter substantiates the necessity of socio-humanitarian training of educational specialists. **Research limitations**—The main limitations of this study are connected to the subjective nature of many of the used concepts and with a low level of evidence.

Keywords Education · Post-non-classical rationality · Reflexive-active environments

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1 Introduction

The increasing pace of social dynamics and the formation of a knowledge economy substantiates the importance of the individual, the inseparability of knowledge, culture and values. The education of the future is focused on the person, assumes dynamic communication platforms, a self-developing educational environment, spaces of trust, mutual respect, and culture. In modern society there is a return of interest in ethical norms and universal values as basic paradigms of personal and social development, taking into account the needs of students (Office for national statistics 2020). The value of financial well-being as the main motivation changes to the value of happiness and harmony with oneself. Proceeding from this premise, a hypothesis is formulated about the socio-humanitarian approach as a basic one for the education of the future, the technologies of which are to be formulated, developed, organically connected with scientific and technological progress, the development of technosphere, virtual realities. Thus, the study of socio-humanitarian technologies of future education from philosophical and methodological positions seems relevant for the development of a new transdisciplinary approach to education.

2 Philosophical and Methodological Foundations of Education

In this study, education and educational technologies are considered from the perspective of the subject of education (both teacher and learner), the development of knowledge organization culture, the corresponding learning process (Rubtsov 1991) the problems of hidden knowledge, which is inextricably linked to the subject of knowledge. Based on this approach, we hypothesize the development of education in the context of the subjective approach through the change of scientific paradigms. The changes of the last decades in scientific research are connected with the development of the philosophy of science (Stepin, 2005) and the corresponding development of scientific rationality–from the paradigm of classical scientific rationality to non-classical, and then to post-non-classical scientific rationality.

In the context of the classical scientific paradigm, the idea of knowledge was formed as a "subject-object" and within the framework of the activistic approach (Umpleby et al. 2019). Knowledge was defined as true through the application of certain criteria unrelated to the tools of knowledge acquisition and the subjects who generated the knowledge, it was considered as an "object". The human subject was viewed as a link in the process of information processing. The philosophy of such education was positivism. Limitations of this approach applicable to social systems (Ackoff and Emery 1972), the problem of information quality, not only quantity, were realized closer to the end of the twentieth century, but some of the characteristics of the educational practice of this scientific rationality are still in place today. For education in classical scientific rationality, formal results (high grades) are a priority, rather

than understanding the information being taught. The basic approach in education is functional. It is important to transfer the necessary knowledge to the student, "top-down", without regard to feedback, the student in such a system is the object of learning.

Knowledge in the context of non-classical scientific rationality is formed in the paradigm of "subject-subject" and subject-activity approach. The subject of knowledge actively assimilates information, creates, constructs the surrounding world. And knowledge is considered together with its subject (Turchin and Joslyn 1990). Personal motives, worldview and experiences are viewed as phenomena and categories that influence educational activity. Therefore, the role of direct communication between teacher and students becomes important. Communication not only creates new knowledge and culture, but also gives understanding of information at new rational and sensual levels (tacit, hidden knowledge). Students' self-organization and interaction is strengthened and the role of humanities subjects increases. The educational process is built on the interaction and feedback of the teacher and students.

The post-non-classical type of scientific rationality implies a correlation of obtained knowledge about the object not only with peculiarities of means and operations of activity, but also with peculiarities of subjects. The "subject-self-developing poly-subject environment" paradigm ("subject-metasubject") becomes basic (Lepskiy 2016), and the basic approach is the subject-oriented approach as a development of the subject-activity approach with increased attention to subjects and their environment (Lepskiy 2018a). The radicalism of philosophical constructivism is softened, the emphasis on communicative processes of the subjects shaping reality is strengthened. Freedom is thought of not as possession and control, but as an equal partnership with another subject, and with what is in the external environment-nature, values and culture of others. The orientation on creative activity and self-development of the individual as part of the development of the collective as a whole is strengthened. The communication space of the learning process goes beyond the network interaction and becomes an environment. Channels of exchange of information, culture, ethics are both verbal and non-verbal (including non-informational, virtual). Communication between the teacher and students is based on equality and constant interaction. The formation of the educational process is based on the goals formulated in the process of communication with students. Motivational and other soft tools of involvement of students in the educational process are used. Communication is built on the harmonization of personal and public interests and benefits. The systematization of approaches and parameters of scientific rationalities in education is presented in Table 1.

The preservation of the human being as a multitude of discourses and incarnations (real and virtual, rational and psychical, explicit and implicit), the importance of security of the human subject in the modern educational process actualizes the ethical and ecological problems of education, the socio-humanitarian dimension of the future education.

Table 1 Comparative table of approaches to educational activities in the context of scientific rationality paradigms

Comparison parameters	Classical scientific rationality	Non-classical scientific rationality	Post-nonclassical scientific rationality
The purpose of educational activities	Achievement of educational goals, progress	Learning to learn, self-development	Creative activity and self-development of the individual and the collective
Functions of education	Control - execution	Organizational-stimulating - self-organizing	Socio-humanitarian, communicative - self-developing
Adaptability to change	Closed systems, retrospective	Open systems, homeostaticity	Open reflective-active environment, future-oriented
Communications system	Vertical communication channels (top-down)	Vertical and horizontal connections (networks)	Environmental communications (general communicative target space)
The role of an educator	Execution of functional responsibilities, problem-setting, student involvement in educational decisions not present	Interaction and discussion of the educational process with students, feedback on their activities, communication is not limited to the educational context	Shaping the educational process on the basis of goals formulated in communication with students, motivational and other “soft” tools of involvement in the educational process
Role of the student	Executive	Self-management	Communication and harmonization of personal and public interests and benefits
Dominant methods and approaches	Operational, functional, “knowledge-oriented” approaches Repetition, external stimulation, negative feedback	Activity-based, semantic, "understanding-oriented" approaches Dynamic means of providing information, internal stimulation, positive feedback	Reflexive-active, strategic, “meaning-oriented” approaches Communicative and reflective activities, strategic goals, ethical environment
Basic interaction paradigms	Subject-object	Subject-subject	The subject-polysubjective environment

Note We have combined the qualitative characteristics of the three types of scientific rationality to provide a more complete view of the differences in the basic parameters of each educational system

3 Ethical And Environmental Issues In Future Education

Considering the revealed subject orientation of society and human development, the formation of education should be inseparably connected with ethical notions, adequate to post-non-classical scientific rationality.

In the context of classical scientific rationality, ethical regulators were outside the framework of activity and are not focused on by the subjects of activity. The basic reference points are goals, and the dominant ethics can be represented as an "ethics of goals", including the ethics of "the end justifies the means". The ethics of goals is organically linked to the dominance of the activity-based approach, which prevents communication and cooperation between subjects. In collectives of students established predominantly "vertical ties" social structure. Ethics of goals generates a desire for competition, conflict, aggression.

In the context of the ethical system of non-classical scientific rationality, it is assumed that ethical regulators are focused on the specificity of "subject-subject" relations. The activity of subjects is based on an ethics of "ends–means". This means teaching through activity not only their goals but also relations to other subjects, consequences for them of actions committed by the subject, reflections of the potential and real forms of communicative activity. This ethics can also be formulated as "communicative". The values of the means of activity condition the value of the goals and achieved results. The teacher's methodological educational guidelines influence communication with students and vice versa. This kind of ethics contributes to the communication of subjects, the establishment of horizontal network connections in social structures, which finds a place in pedagogical technologies.

The dominant ethics of post-non-classical scientific rationality is the ethics of subject's freedom from the position of its self-limitation for full mutual respectful interaction with other subjects, who also see their freedom as a means rather than an end. Soft motivational mechanisms are involved, triggering the processes of creativity, formation of values, interests, strategic goals. To understand the dominant ethics of post-non-classical scientific rationality, it is important to introduce the concept of a strategic subject (Lepskiy 2018b). It is a subject included in some meta-subject (family, group, section, school, etc.), identifying itself with this meta-subject and regulating its activity (activity, communicative, reflexive) taking into account its influence on the meta-subject. Ethics in the context of post-non-classical scientific rationality is not universal or holistic–it is like a mosaic, made up of different ethics of its constituent subjects. These are the ethics of family values, the ethics and norms of society, religious practices, etc. It is important to note that the ethics of strategic subjects is fundamental to the improvement of educational mechanisms. It is assumed that the three scientific rationalities are stages in the evolution of science, but they are not alternatives, they complement each other and involve convergent use. This logic applies to ethical systems as well. Generalized conclusions on ethical systems by stage of scientific rationality are presented in Table 2.

Ethical approaches in the educational environment are one of the bases for the formation of new educational technologies - ethics as an environment, includes

Table 2 The dominant ethical systems in the three types of scientific rationality

Classical scientific rationality	Non-classical scientific rationality	Post-nonclassical scientific rationality
The ethics of "goals"	Ethics of the Goal-Means	Ethics of "strategic actors"
Utilitarian values, selfish ethics	Ethics of subject relations, communication ethics	Ethics of strategic subjects of self-developing environments (includes communication ethics, ethics of goals)
Self-interest above all	Personal self-development above all	Principle of "ban on egoism" - when pursuing personal interests, do not violate the interests of the public group to which you belong
Competition, confrontation	Competitiveness	Cooperation

cultures, religions, values and meanings of the subjects included in the general educational environment. Therefore, the development of common ethical approaches in education, research tools to work with the ethical environment seems to be a relevant issue in the context of education of the future.

Environmental issues in this study are considered in the context of limiting the destructive trends of modern education. Virtualization and digitalization of education are not only promising mechanisms of learning that can solve many problems but also manipulative tools to influence the processes of understanding the world, information assimilation, communication, socialization and individualization. The rigidity of many educational practices, algorithms of thinking and behaviour in social networks and on the Internet can have a negative impact on the subject of the educational process. Therefore, it is important to raise the issue of ecological educational technologies. Environmentalism is about overcoming neuroticism, fears and aggression. Educational culture should be based on socio-humanitarian technologies, shared by the public meta-subject (family, school, city, country), it should formulate material and spiritual values that correspond to the vision of the future in society. Strengthening the vector of ethics and culture in education solves the strategic goals of mutual understanding and respect of the involved subjects, educational communications.

On the other hand, modern digital educational technologies can help integrate culture, ethics and the educational environment using modern media technologies, virtual games and educational spaces. From this perspective, technology is seen as a means to help shape students, not to replace the teacher with a "chatbot". The learning space is a space of communication, but the personal relationship between teacher and student can carry more than just the transmission of useful information. It is self-reflection in the process of communication with the teacher, and the manifestation of tacit knowledge, hidden mental processes. The space of ethics and culture supports the development and expands the student's "I"-world and develops not only thinking but also personality. These technologies can be based on the reflective-active types of educational activity that need to be formulated and developed.

4 Educational Technologies of the Future

Within the framework of this research, we will consider self-developing poly-subjective reflexive-active environments (Lepskiy 2018c) as a promising technology of future education in the socio-humanitarian context. This technology is human-oriented, takes into account the correlation of knowledge with the subject and its value-purpose structures. The connection between internal and external educational goals coincides with ethical norms and cultural values. In these environments, combinations and interactions of subjects realized on various forms of media with natural or artificial intelligence (Saveliev et al. 2021) are acceptable in the context of the development of educational technology in the future. The formation of environments of active knowledge can allow solving the problem of informatization of education and the increased information load of students.

Self-developing reflexive-active environments create conditions for the integration of individual, group and social knowledge. Communications of the educational process in self-developing environments are formed by a system of ontologies: support, support, development, construction and implementation of knowledge. They are focused on the educational environment as an open system, on the interaction of society, business, representatives of culture and science, the state (customers of education together with parents). The active external environment actualizes the elements and their structure within the ontologies.

The theoretical tool of socio-humanitarian technologies of education is communicative game technologies, reflexive-active games. The concept of reflexive games (Lefebvre 1986) is supplemented by the context of person-centred reflexive-active environments.

In the space of interactive educational activity, subjects not only have to acquire knowledge and formulate new knowledge, but also be aware of this process. Interaction in the humanitarian sense (ethics, culture, values) is important. The formation of a picture of the world and reality comes, therefore, from a mutual desire to interact with other subjects. This technology requires improvisation, methodological flexibility, interdisciplinary knowledge for the efficiency and safety of the educational actions of the teacher.

This kind of educational technology is a concept, a theoretical model for the development of applied socio-humanitarian technologies, laying the general principles of education development. This technology is described in detail in the works of Lepskiy (2018a, 2019).

The paradigm of "knowledge" in education is supposed to be supplemented by information, activity paradigm of non-classical scientific rationality, as well as culture, ethics, personal and community-oriented development as the specifics of post-non-classical scientific rationality.

5 Conclusion

New types of knowledge and cognition require a new language for communication, education and related scientific research. Increased demands arise for the integration of diverse fields of knowledge. The spaces of culture and ethics as an environment for student interaction require teachers to have new knowledge and skills based on transdisciplinarity, complexity theory and psychology. Game models of management development. The role-playing and organizational-activist games are replaced by the technology of strategic reflexive games. The latter are related to studying, modelling and organizing subjects and multisubject environments, where the value, cultural and ethical orientations of the subjects, their reflections and worldview are considered. Self-organizing educational environments as a socio-humanistic technology is an attempt to describe the interaction between the subject and the educational environment based on environmental communication models, which exclude the clash of interests and conflicts.

Focusing on the interests of each student will require a period of restructuring of consciousness, which can lead to both a favourable outcome and the rejection of this type of education. We can conclude that it is necessary to develop and implement socio-humanitarian technologies in education. Theoretically, this approach will provide creativity, freedom and fullness of personal development, ethics of trust and acceptance of different points of view, development of culture. The subjectivity of received experience and knowledge is not less important than their simple transfer. The modern development of socio-humanitarian technologies is in its infancy, while their research is simply a methodological reference point, rather than a ready-made technology for implementation in the educational process. New educational methods and practices that take socio-humanitarian technologies into account will require great effort from the scientific and pedagogical community, which is worth the expected result.

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Practical Wisdom for Addressing Contested Problems

Raul Espejo and Clive Holtham

Abstract **The purpose -** to discuss higher education as beacons of epistemological transdisciplinarity, contributing with methodological developments in the domains of their concern, to address problems of practical and ecological significance in today's societies. Most significantly discuss relationships of decolonisation. **Design/methodology/approach -** Discussion of higher education relationships with external institutions, active stakeholders and local communities, review of sustainable development with the wider environment and inclusive justice focused on relationships within the university. **Findings-originality -** Discussions show that universities should be more than centres for the development of disciplinary knowledge; they should be beacons of epistemological transdisciplinarity, contributing with methodological developments in the domains of their concern, to address problems of practical and ecological significance in today's societies. **Research limitations -** This paper offers conceptual discussion of relationships, however it does not explore in practice higher education processes for the creation of purposes and the necessary changes towards decolonisation. These clarifications require managing reflexive interactions, which were beyond the scope of this research.

Keywords Higher education · Stakeholder relationships · Purposes · Values · Change process · Decolonisation

1 Introduction

The modern university as envisaged by Humboldt (Günther 1988) aimed at holistic education of a society's elite. However, this dream was soon undermined by the

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ongoing prioritisation of discipline-based excellence in research, which has increasingly provided a barrier to systemic approaches. Universities prioritising disciplinary knowledge without wider practical wisdom are unable to address the most pressing problems of societies globally (Giroux 2021; Daniels et al. 2021). UNESCO's International Commission on the Futures of Education (2021), p. 60, challenges higher education to set loftier aspirations:

"Values such as respect, empathy, equality, and solidarity must be core to the mission of universities, colleges, and technical institutes in the future.

Higher education must foster ethics and support students to be better and more capable citizens with greater awareness of their civic and environmental responsibilities.

Higher education must also be socio-culturally relevant.

Appreciation of cultural diversity, a commitment to defend human rights, and intolerance for racism, sexism, classism, ethnocentrism and discrimination in all forms must be key educational objectives.

Higher education that advances such values and principles goes beyond the confines of lecture halls and virtual spaces.

It is ever-evolving in its content as it empowers individuals to better versions of themselves, to take strong value systems forward, and to transform their environments."

This chapter addresses the shortcomings of disciplinary fragmentation by exploring relationships within universities and with their stakeholders over time. The overall aim is to increase universities' embodiment as problem solvers, through action, with people in a changing environment. In today's world this action cannot remain detached from the values and concerns of the people responsible for their constitution. Furthermore, we visualise universities creating their domains of action through interactions with desirable stakeholders and responding to the challenges of environmental performance, inclusion and fairness. What are the required *resources* and who are the stakeholders, whether students, administrators, sponsors and others, creating, regulating and producing their purposes and values and are responsible co-creatively for the development of their capabilities to make things happen? In effect we are talking about the resources producing the organisational system of the actors above.

2 Background

The authors have developed a conceptual framework (Fig. 1) which starts from the articulation of often ambiguous values by different stakeholders (social, academic, state, localities) and how those values shape, both positively and negatively, the three key outputs of higher education (HE); namely skills, knowledge and practical wisdom (Aristotle and Crisp 2014). Focussing then on the pedagogic design process (Goodyear 2005) leads to viable, as far as possible, non-hierarchical HE structures, aimed at holism and the inclusion of stakeholders through the creative design of their

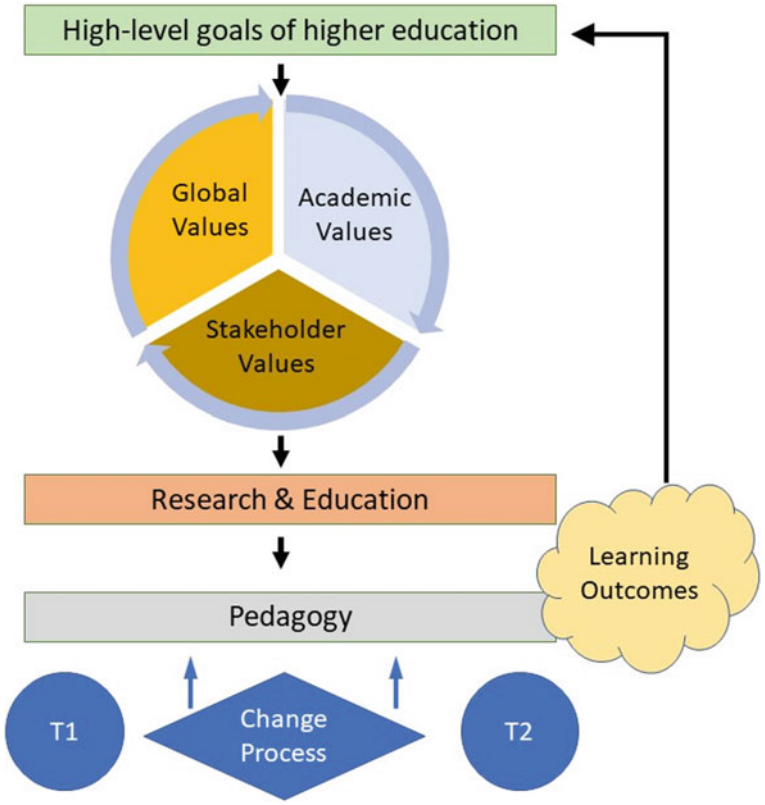

Fig. 1 Framework for systemic policy and practice for universities

relationships. Such a situation often starts from a resistance to significant change, particularly where resources need to be devoted to the infrastructures of change itself; too often taken for granted in universities.

3 Methodology

3.1 Summary Graphic

We have evolved a framework which sets out to join up systemically multiple layers of university policy and practice, emphasising areas and connections which have often in our view received too little attention (Fig. 1). Each institution needs to make their own decisions about levels and connections; what we do here is to provide illustrative generic examples.

In relation to global values of higher education, we suggest three that have been relatively neglected but around which there is now growing interest:

Active citizenship, including relationships with external institutions, active stakeholders and with local communities:
Sustainable development with their relevant wider environment through necessary relationships for ecological sustainability
Inclusive justice focused on relationships within the university, aimed at respecting its participants.

In relation to sustainability, UNESCO (2017) has explicitly identified 8 key competencies for education, and one of this explicitly identifies systems thinking as an essential competency.

"Systems thinking competency: the abilities to recognize and understand relationships; to analyse complex systems; to think of how systems are embedded within different domains and different scales; and to deal with uncertainty."

Figure 2 represents a typical example of academic values, set out in the UK by a National Committee of Inquiry into Higher Education (1997).

Figure 3 illustrates an example of state stakeholder values, which can be found from Kenya (Constitute Project 2010). Figure 4 summarises a traditional framework for both research and education derived from Aristotle and Crisp (2014).

Academic Values (Dearing, 1997)
Pursuit of truth
Share knowledge
Freedom of Thought
Rigorous, reasoned argument
Listen to alternative views
Impact of own views on others
Commitment to ethical implications

Fig. 2 Academic values (Dearing, 1997)

Fig. 3 Stakeholder values

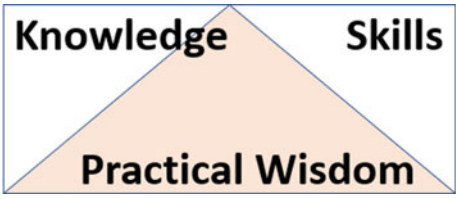

Fig. 4 Research and education

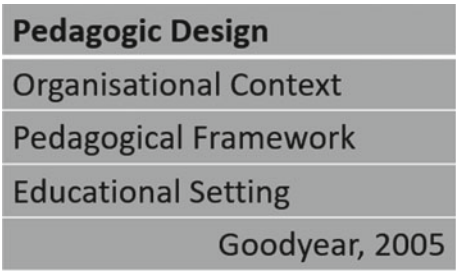

Fig. 5 Pedagogy

Figure 5 summarises a helpful framework for linking strategy through pedagogy to learning outcomes as provided by Goodyear (2005), who argued that pedagogy was too often opportunities and constraints of specific educational settings.

3.2 Stakeholders

Despite summarising key goals of the United Nations, these are typically contested problems, in all of which a university could and should excel in terms of solutions,

but in none of which (in the UK at least) is there much indication of high prioritisation by institutions generally. Systemically, these problems are highlighting interactions that need attention to connect actively universities to their enabling and contesting environments. In fact, these are interactions shaping a university's flexible and liquid boundaries enhancing its capabilities for action (Bauman 2000; Espejo 2008) in its local and more global development environment.

Who are the University's stakeholders? The boundaries of an organisational system, such as a university, go beyond those emerging from the formal institution. In the context of this chapter, we consider stakeholders all those contributing actively to the relational construction of its purposes. Stakeholders are those producing its relevant environment, in particular those stretching the university and relevant society in both directions, including local as well as far-flung students and people in society. Stakeholders include participants contributing to the construction of its purposes and building up its cohesion as well as those providing context to the University (Espejo and Reyes 2011).

What is the meaning of its activities in the external world? For instance, considering the history of UK higher education, its colonial connection with far- flung cultures and societies makes necessary to consider in today's institutions issues of decolonisation of their programmes and interactions with those who have made possible and supported their development over time.

Two aspects are significant to support this meaning creation processes. How did the relationships of a HE institution evolve with those stakeholders that constituted their students' body over time? How did these relationships shape the institutional purposes and to what extend the aim now is to make this institution a truly decolonising institution? What are the implications of this purpose for the curricula of the institution? Is the envisaged curricula consistent with the interactions that the HE institution is building with external institutions?

Universities need to see themselves not only as centres for the development of disciplinary knowledge; but as beacons of epistemological transdisciplinarity (Nicolescu 2014), contributing with methodological developments in the domains of their concern, to address problems of practical and ecological significance in today's societies. Most significantly universities should construct relationships of high performance in their operational environments, whether locally or globally. These are relationships that recognise that *these* students, whether they are local ones or come from far-flung places, belong to *this* particular university, these students are part of communities that affect them as persons and through them they construct their university. Beyond the particular disciplines of their interest, we think that they need to understand the transdisciplinarity of their participation in institutions that have a wider responsibility. We think that they have to increase their social responsibility. This focus on interactions with the wider environment is possibly a trigger to understand them beyond the disciplines represented in their curricula, becoming sensitive to the environmental issues that impinge into their adaptation to this wider context. Hopefully, university students, academics and administrators will develop an appreciation of issues that go beyond their local and disciplinary knowledge interests into a deeper grasp of the university's environment, widening their disciplinary concerns,

which may help them to see the university as an operational contributor to this wider environment. We are proposing a significant change towards developing the students' and with them the institution's citizenship in the context of their operations.

The above are reflections inviting collective thinking upon the university's identity. Stakeholders are invited to see institutions as entities that beyond being knowledge centres, that belong to local, regional and global communities, require social responsibility and inclusivity in their environments. It is proposed to consider embodying universities as viable systems that create organisations, with resources and interactions, necessary to overcome disciplinary fragmentation and develop capabilities to respond to the challenges of their wider environments. The change implications of this vision of higher education are significant.

Active citizenship, a sustainable environmental development and production of respectful just interactions are three areas that should shape the twenty-first century university. These are relational changes to address the "wicked" problems faced by universities as parts of society generally and as contributors to enable their wider social impact. This is synthesised in the Practice V as advocated by Painter-Morland et al (2016) as "beyond curricula" and summarised below:

Practice V: Systemic Institutional Integration

"Integration of sustainability in existing and new core, cross-disciplinary curricula, supported by an institutional commitment that influences all aspects of the institution. It involves creating a systemic capability distributed and nurtured throughout the organization, which creates the impetus towards change in students, faculty, administrators, the institution as a whole, as well as organizations that hire its alumni."

Clarification of purpose has implications in the mission of higher education. Beyond its traditional functions of teaching, training, research and study, all of which remain fundamental, it is necessary promoting development of the whole person and the training of responsible, informed citizens, committed to working for a better society in the future. We are arguing that higher education also has a contribution to make to the solution of major problems of global, regional and local importance (poverty, homelessness, worsening inequalities, environmental degradation, etc.), and promote development, the sharing of knowledge, solidarity, the universal respect of human rights, democracy, equality of rights between women and men and a culture of peace and non-violence. Together with several other statements about higher education (Orozco Silva and Reyes Alvarado 2021) we are stressing strongly its cultural, ethical and operational missions, which, are of the highest priority for education in general.

However, clarification of purpose is more than policy-makers' statements of missions and goals for the university. This clarification requires managing the *reflexive interactions* between participants focused on the university's longer-term concerns. These interactions require balancing the views of external and internal stakeholders, creating stable meanings for their behaviours through effective, well resourced, communications (i.e. creating eigen behaviours). Purposes evolve from the communications and appreciations of these external and internal stakeholders. The university's leadership needs to manage the interactions between those viewpoints

contributing to the university's identity. These are stakeholders that as their interactions evolve in time, will emerge as parts of the external and internal environments creating the university as an organisational system with its own identity. *Reflexivity and conversations* will contribute to the clarification of their roles. We expect that the university leadership will shape them over time. Through steering their interactions, some stakeholders will turn up producing its curricula and some others will *stretch* the university with meanings originating from its environment. The university's purposes emerge from these conversations, which are driven by values such as those proposed in Fig. 1. These are values to which we expect policy makers will be committed as they steer stakeholders' conversations. Academic values, such as pursuit of truth, sharing of knowledge, freedom of thought, rigorous, reasoned arguments, listening of alternative views, impact of own views on others, and commitment to ethical implications and state social values, such as rule of law, democracy, human dignity and human rights, good governance and sustainable development, are proposed as drivers for stakeholders' interactions. These stakeholders will contribute with education and research activities, as well as with practical wisdom, towards the production of desirable curricula, environmental sustainability and equitable relationships. In these processes, initially of perhaps loose conversations, we may expect that the structuring of the university will take place and make progress. Those producing the curricula, those focused on the sustainability of the external environment and together those producing a just organisation, will become increasingly well established and through their reflexive interactions will support the production of identity for the university. It is in these interactions that we expect that the university's meanings will evolve. An important role of these policy makers is to balance the contributions of internal, curriculum producers, with those responding to the environmental stretching of the university in the creation of its meaningful contribution to society.

The challenge in the creation of practical wisdom for addressing contested social problems is the management of a change process, from, what today appears, a disciplinary educational establishment to a socially integrated transdisciplinary university that is well grounded in the current needs of society today. Above we have described the production of a university that goes beyond the utterance of artificial goals, weakly connected to organisational processes, into one that is grounded in increasingly refined communities of potential students and, external stakeholders well-articulated to the needs for sustainable development. Whatever outcomes emerge these are grounded in conversations and reflexions, that should be well supported by resources. Overall this is the outcome of a structuration process (Giddens 1984) and not of arbitrary statements by those in positions of power in a university.

Related to Fig. 1 the emphasis of the above discussion has been in processes of active citizenship and environmental sustainability. Additionally, we have hinted that universities will structure systems that produce inclusive justice. This requires, in ethical terms, giving to everyone what they deserve, particularly people in an organisation deserve mutual respect and relationships that recognise their worth and avoid unchecked controls. The new university does not permit managers abusing their power. Interactions in organisations need to be driven by *caring networks* underpinned by regulations contributing to the emerging curricula and the sustainable

development of the university in its environment. These networks are necessary for the structuration process towards the embodiment of a robust organisation. Stakeholders' participation in a university need to go far beyond unchecked interactions, unilaterally producing statements of rights and responsibilities. In a systemic organisation structure that obliterate what people deserve as an outcome of weak interactions are unjust. The argument is towards performance recognising that what each one deserves is beyond unilateral statements of wishful thinking but the outcome of balanced interactions throughout the organisation, pursuing, as argued before, well constituted purposes. This is driven by ethical considerations starting from policy makers, but integrating stakeholders, towards a collective of people sensitive of the system's longer term. In the end justice emerges from properly regulated interactions, reflecting the values and purposes of the organisation in a wider environmental context.

4 Change

The overall argument of this chapter is that existing universities, including business schools, have been historically driven by internal and external fragmentation (Espejo 2008) which have limited their capacity for change towards an integrated holistic university. All the above arguments support this integration and perhaps the most difficult part of our argument, is to highlight the transformation of these fragmented universities into systemic universities. In the last part of this chapter, we discuss briefly this change toward the necessary university, only initially identified in the lower part of Fig. 1. The development of relationships, introduced in this figure, and further explored throughout Sect. 3, is necessary to explore the implications of this chapter to higher education. This extension would require discussing the issue of viability (Beer 1979; Espejo and Reyes 2011).

However, at this stage we will concentrate in the issue of change. Within the discipline of management there are literally hundreds of theories of change, with even more from the social sciences more widely and from humanities. A very large percentage of management theories of change are concerned with hierarchical organisations whose leadership are seeking incremental or radical changes in the way other people work or are organised. One of the key features of contested changes relating to citizenship, sustainability and inclusive justice is that these leaders are themselves a key obstacle to change, so there is internal and external pressure on these leaders to change more or less unwillingly. Their evolution towards heterarchical structures is a challenge for them. This is a core area in political science, which examines resistance, revolts and revolutions, unfortunately, much less so in management.

It is of interest that a recent powerful approach to socially stimulated change does not derive from a business school, but rather from education faculty closely engaged with indigenous communities in Canada (Stein et al. 2021). Table 1 is a concise summary which strongly highlights a menu of approaches to change which is rarely, if ever, articulated so clearly in most universities' strategic documentation. In the

Table 1 From Stein et al (2021) This table is reproduced verbatim from a document which is open access under the terms of the Creative Commons Attribution-Non-commercial-No-Derive License 3.0

Approach to reform	Approach to decolonization in higher education	Implications for practice
Regressive reform	Decolonization is a dangerous threat to institutional values	Actively work to impede/challenge/reverse decolonization efforts in an effort to protect existing systems of privilege and inequality
No reform	Decolonization is not a desirable (or perhaps even legible) project	N/A (ignore calls for decolonization or otherwise deny their relevance)
Minor reform	Decolonization is increased access to existing institutions and promised benefits, inclusion into mainstream	Transform institutional policies and practices to provide additional resources to indigenous students and faculty so as to equip them with the knowledge, skills, and capital to excel according to institutional standards; celebrate Indigenous perspectives; offer intercultural competency training to non-Indigenous staff, faculty, students
Major reform	Decolonization is recognition, representation, redistribution, reconciliation, redress	Center and empower communities and perspectives; ensure more equitable processes of resource distribution in consideration of systemic, historical, and ongoing marginalization/ dispossession/subjugation/occupation
Beyond reform	Decolonization will likely require "the end of higher education as we know it", because existing institutions are so deeply colonial	Mitigate harm, redistribute resources, create and protect spaces for decolonial engagements in the short-term; in the long-term, mobilize what might be possible beyond what is currently imaginable and viable within existing institutions of higher education

UK, for example, there has been much institutional effort devoted to being eligible for the Race Equality Charter, which can certainly not be categorised as "beyond reform" and in most cases barely qualifying as "major reform". Stein et al. highlight that, as with all the other levels of decision and prioritisation in our Fig. 1, even the change process itself is very far from objective and is indeed value laden and contested.

Regarding decolonisation, Table 1 provides a useful introduction to contested change.

Supported by our exploration of relationships, the issues of viability aspects of decolonisation can be further developed.

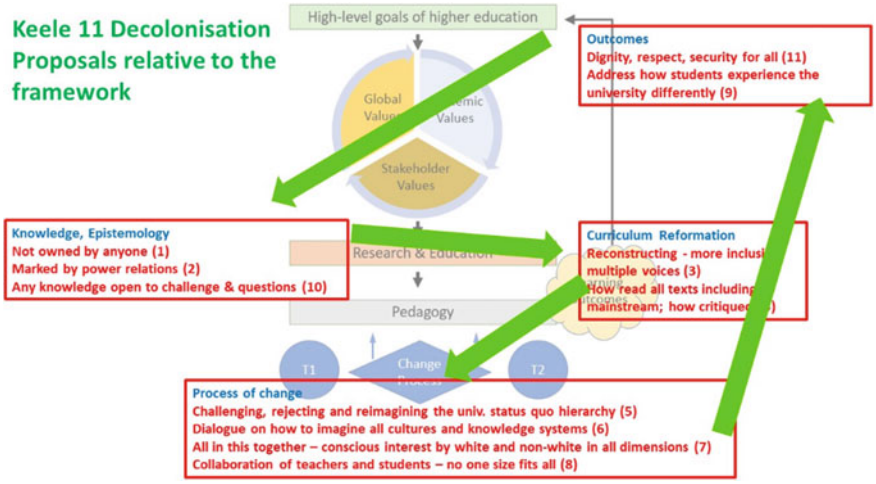

Fig. 6 Testing the Fig. 1 framework with a worked example

5 Testing the Framework with Reference to Decolonisation

In order to examine the potential value of the framework, a "worked example" is provided in an important area of contestation within higher education, which relates to decolonisation. A collective at Keele University (Keele University SU et al. 2018) produced an eleven-point action plan on decolonisation. In Fig. 6 each of the 11 points of the plan (using original numbering) has been condensed by the authors and they have made judgements on how they could be applied to Fig. 1. It can be seen that the points are relatively evenly spread across the seven components of Fig. 1, thus avoiding wholesale gaps in coverage.

Despite this being a relatively low-grain test of the framework, it suggests that it is possible to apply it as a lens on how far typically separated aspects of higher education functions do (or do not) hang together.

6 Conclusions

- 19 th and 20 th century universities were not designed to address wicked problems and have proved themselves unable to do to. Both whole systems and individual institutions need reformation, or perhaps, more appropriately, transformation (based on values as explored in Fig. 1 and the arguments of the chapter, grounded on producing relationships that articulate purposes and meanings for active citizenship, sustainable development, inclusive justice), but the most likely initial progress to be made is by bottom-up institutional initiatives through exploring global, academic and state structural and complexity management changes.

- Bottom-up can succeed - the tiny and short-lived Bauhaus provoked international reform of design education, for example
- Universities have privileges (critic of last resort, ability to experiment) which in times of crisis need to be activated.
- The crucial consideration is that we are proposing a university that is driven by relationships of trust and respect between internal and external stakeholders as well as of collaboration among all of them. This is a non-hierarchical university with values of citizenship, ecological respect for the environment and fairness. This is a tall order but one that needs to be taken seriously by universities in a time of climate change. Hierarchical, non-inclusive universities should be superseded by heterarchical universities demanding change.

This chapter combines a study of historical evolution intertwined with the academic and societal results of inabilities to address, let alone solve, wicked problems. We focus this study in relationship changes. We believe this contribution is important for policy-making at institutional, national and global levels.

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The "Peer-To-Peer Sharing Economy" Systems Age: Algorithmic Trading, Market-Makers, and "Postcapitalism"

Jose Rodolfo Hernandez-Carrion

Abstract **The purpose**—today's economic challenges call for a new way of looking at the world. This contribution looks for providing a systems theory vision that let us identify future economic scenarios from new perspectives. Wishful thinking limits our ability to accept a systemic vision of all economic systems working together, from a global or a planetary view. This new economy is associated with the "peer-to-peer sharing economy" and the new market-makers can be only found if you look hard for it. The Russian and Chinese economies can be characterized as capitalism of state monopolies challenging global markets all over the world with new markets and competition approaches. All of them work with algorithmic trading models and even hybrid reality is an ongoing process. **Design/methodology/approach**—this research focused on integrating economic concepts based on a selective literature review and providing world political and economic examples to integrate trajectories. This research questions if the world follows a path where everybody will be dominated by private or public hierarchies according to nations both with capitalism or state systems. This research was carried out to balance the perspective on how different models seem to be more of the same, achieve similar goals and results from different starting points. Either in capitalistic, socialist, or communist societies, algorithm markets are designed to reclaim a government presence and proper regulation. Platforms owned by shareholder corporations and funded by significant venture capital still drive the growth in China and United States. **Findings**—without us noticing, we are entering the postcapitalist era with changes to come in information technology, new ways of working and the sharing economy disrupting markets. At the same time, labour and work are questioned and an uncertain future is faced and exposed in the chapter. This is a call, in the end, not to arms, but to economics. Postcapitalism, a rising concept introducing new forms of human behaviour, should be considered, and conventional economics should be recognised as relevant being able to include the new peer-to-peer sharing economy international models and other market makers approaches. Also, demographic, and fiscal timebombs are urgent tasks to be designed to decarbonise the world for achieving sustainability models

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of production and consumption to protect the environment. **Originality/value**—the research is beyond the state of the art and literature did not provide any work aiming to connect future trajectories of capitalism, socialism, and communism yet (beyond Marx's predictions). The trade-off that emerges will be related to achieving transparency and open access to all information versus implementing the use of cryptography. Even more, the future does not seem to be different in the postsocialism or postcapitalism economic systems as the Orwellian predictions in the novel "1984". **Research/ Practical/ Social/ Environment implications**—computers can be set up by the corporation platforms following hidden private or public interests, a danger to consider. The chapter will provide new insights for thinkers to connect common needs of economy, society, and environment from an international perspective, connecting world global market-makers. **Research limitations**—predicting the future cannot be a scientific task, only possibilities are considered. This chapter represents a new beginning for a systemic vision of the world economy that will be followed in the future for further research to demonstrate and improve findings.

Keywords Sharing economy · Peer-to-peer · Platforms · Future · p2p economy · Postcapitalism

1 Introduction

The world and the economic world are changing. We must recognize the shift from a world of rationalist predictability to one characterized by ambiguity, unpredictability, and fuzzy logic… even hybrid reality is an ongoing process everywhere in which artificial intelligence technology is gradually introduced as an active stakeholder by using reasoning to execute real-life and economic activities. Most economists keep defending the pre-crisis ideas of rationality and efficient markets without considering what is happening in the planetary economy. We face problems of re-balancing public and private interests that will be confronted if Western democracies would balance the challenge from a different model of capitalism, rising in the East, the so-called "capitalism of state". The Russian and Chinese economies can be characterized as capitalism of state monopolies challenging global markets all over the world with new markets and competition approach.

Tobias ten Brink (2014: 41) explained how China has an overarching goal of creating national flagships ("national champions") for industrial development and upgrading, while also increasing, transnational influence. Thus, the activities of such corporations are politically shielded and supported by the Communist party. Consequently, the state leadership is interested in maintaining close connections with new corporate locations and markets. The state subsidizes and provides loans for initiating raw material extraction projects or acquiring technologically intensive foreign companies. With the help of Chinese policy banks and other financial institutions, there is typically a financial advisor standing behind large Chinese enterprises. A new generation of start-ups or unicorns (Alibaba, Lenovo, Xiaomi, Huawei, or TikTok)

that have been selected under an ambitious government program aimed at fostering a technology industry that can compete with the US Silicon Valley corps (Amazon, Apple, Microsoft, Alphabet, or Facebook).

Capitalism will not be abolished by forced-march techniques. It will be abolished by creating something more dynamic that exists, at first, almost unseen within the old system, but which will break through, reshaping the economy around new values and behaviours (Mason 2015). Mason discussed the existential threat posed to capitalism by the digital revolution arguing that the present digital revolution has the potential to reshape utterly our familiar notions of work, production, and value; even to destroy an economy based on markets and private ownership. "Postcapitalism" is possible because information technology has reduced the need for work; second, information is corroding the market's ability to form prices correctly; that is because markets are based on scarcity while information is abundant. And third, we're seeing the spontaneous rise of collaborative production: goods, services and organisations are appearing that no longer respond to the dictates of the market and the managerial hierarchy.

Cockshott et al. (2010) analysed what would be necessary to convert a capitalist economy like the EU into a socialist one. They concluded that, after a phase of transition, the economy would still be capitalist, but the ownership role of individual capitalists would be greatly reduced. The economic disruption would have been to the financial sector where the profitability of stockbroking and investment banking firms would drastically decline. In the planning economies like the Chinese and the Russian ones, the state aristocracy, while prone to corruption and the private use of state resources, was only able to personally consume a small portion of the surplus. This contrasts with the situation in mature capitalist countries where a large share of surplus value ends up funding the personal consumption of the upper classes. Disruption is happening now in all economic systems all over the world.

Today's economic systems' defence mechanism is to create monopolies, or giant tech companies, on a scale not seen in the past 200 years. In the new rising "peer-to-peer sharing economy" that can be considered as an umbrella of the new disrupting global economic change, some big corporations as *Uber* or *Airbnb* (also called "unicorns") intermediate controlling supply and demand reaching the whole planet as market-makers for creating new services in the "platforms neocapitalism" (Hernandez-Carrion 2021). Internet-enabled sharing platforms have achieved rapid global expansion building information pseudo-monopolies over national and local economies. Users and consumers supposedly benefit from cheaper and more convenient choices as a result of more 'pseudo-competition' even if face risks due to the lack of consumer protection and liability rules. As the biggest information product in the world today, Wikipedia is made by volunteers for free based on the capture of all socially produced information that exposes "official and accepted trues".

2 Research Question and Methodology

Recent studies have highlighted the increasingly intense competition faced by incumbent firms in several industries connected directly to platform neocapitalism and the new "peer to peer" or "P2P" sharing economy. The research purpose is to connect the consequences of the new disrupting phenomenon, to both capitalism and socialism future projections, which dilutes countries on a planetary and accelerated scale, unimaginable at the beginning of the present twenty-first century. As the platform economy grows, first there is a review of economic literature to balance its impact for prospecting the future (always should be considered from a triple perspective including economy, society, and the environment). Disrupting online marketplaces are founded on the belief that everybody should be part of the global market and national economies implement policies for purposes related to security and economics.

The working class, in the post-capitalism era, mutates. It is not just the working class in a different guise; it is networked humanity', 'networked individuals', visible by smartphone immersion. And the research question is if the world follows a path where everybody all over the world will be dominated by hierarchies and if they will be essentially different according to nations or economic systems. This research was carried out to balance how different models seem to be more of the same, achieve similar goals and results in the near future.

3 Literature Review: A Herculean Project to Connect the Selected Diverse Dots

Today's challenges call for a new way of looking at the world economy. The revolution that occurs in the nascent "digital economy" and the misnamed "collaborative economy", brings a new way of organizing the economy in different political regimes either capitalistic, communist, or social democrat. Future scenarios that seem to drive us to what some authors have already redefined as "Turbo-Capitalism" (Luttwak 1999), "Capitalism 3.0" (Barnes 2006), "Capitalism 4.0" (Kaletsky 2010), or even "Super-capitalism" (Reich 2007), among others, pointing to new winners and losers in the new global economy sometimes without considering the fundamental roots of capitalism or this economic model as the only one.

Rapid digitization across the board has changed the way we work and purchase services, leading to the rise of the "sharing economy" and the so-called "gig economy". Already famous P2P companies such as Uber or AirBnB have made it possible to exchange assets and work "part-time" or "on-demand", creating alternative scenarios for generating income while the "welfare state" is being dismantled in Western economies. Even in communist regimes, like Cuba which depends on tourism, we found a similar situation, AirBnB is a top reference for finding accommodation competing with hotels and traditional house or rooms supply offers.

In the new economic scenario, there will not be more contradictions between capital and labour, reflecting a "post-capitalism" new system (Sassower 2009; Mason 2015; Srnicek and Williams 2015) without traditionally considering labour as an independent factor and being reclassified for new purposes and by different terms. The end of employment, or work, characterizes the new period have been remarked by Srnicek and Williams (2015): "Inventing the future: postcapitalism and *a world without work*", or Sundararajan (2016): "The sharing economy. *The end of employment* and the rise of crowd-based capitalism".

The paradigm shift can be summarized as: "It changes everything"; a similar meaning reflected in the title of the book of Robert B. Reich (2007): "Supercapitalism: The Transformation of Business, Democracy, and Everyday Life". The principles of inclusiveness could be the core of many collaborative projects, driving growth and prosperity, embedded in marketplace business models. Yet, it remains unclear whether, on balance, these platforms are leading towards a more sustainable world (Rifkin 2011; Rosenblat 2018; Schneider 2018; Wang et al. 2020).

On the positive side, a new economy is born with greater potential efficiency in the use of goods or resources, generating other forms of remuneration for new demands for goods and services. From the dark or negative side, we have a new capacity for exploitation that nullifies previous advances in terms of protecting human and workers' rights; We can now speak of new forms of "labour exploitation" and recovery of old practices now rescued from legality by regulators that mark a new generation in their ambitions and practices. The regulation "on-demand" solution is a hobby that hides what is really happening. Governments need to be aware of what is happening and be able to design their policies following real needs.

Companies like Uber, Just Eat, Glovo, Deliveroo, etc. have been catalogued as the "race to the bottom economy" and "the industrial revolution of our time". Online platforms are used as the tools to manage work in multiple sectors and "collaborative" work cannot be accurately distinguished from other forms of employment in a framework of generalization of "false entrepreneurs"; Work reconsidered as informal, "on-call", temporarily disappears, or other forms of temporary work that reconstruct the entire framework of labour law, providing excuses to create regulations protecting companies (the world upside down, we could say). The reform of the markets and the mirage of the maintenance of capitalism block fundamental issues such as competition and the remuneration of entrepreneurship, for example.

Being quite concise, the sharing economy has recently become a popular umbrella to construct for a wave of new renting, leasing, bartering, and pooling services linked to different aspects of life, including lodging, transportation, work, leisure, and fashion (Bardhi and Eckhardt 2012; Botsman and Rogers 2010; Frenken and Schor 2017; Plewnia and Guenther 2017, Netter et al. 2019). The Silicon Valley success stories of Airbnb and Uber have catalysed a vibrant sharing economy discourse, participated in by the media, incumbent industries, entrepreneurs, and grassroots activists. Within this discourse the sharing economy is framed in contradictory ways, ranging from a potential pathway to sustainability, to a nightmarish form of neoliberalism (Martin, 2016).

From the deep dark side, Makris (2018) considered that turbo-capitalism is conceived as a state of power risk and popular self-catastrophe. Therefore, the agony of hegemonic power paradoxically, ironically, and eschatologically expresses the abyssal power of human agony in the age of silent masses and trans-politics. In Arendt's terms, both cannibalization and carnivalization of hegemonic power signal the ontotheological advent of the post-totalitarian world of mass society and "*worldlessness"* (Makris 2018:109), where one will share no things, institutions, or systems of meaning.

4 Debating the Future from a New Peer-To-Peer Sharing Economy Perspective: Algorithmic Trading, Market-Makers and Post-Capitalistic Societies

We're surrounded not just by intelligent machines but by a new layer of reality centred on information. Following Paul Mason (2015), the great technological advance of the early twenty-first century consists not only of new objects and processes but of old ones made intelligent. The knowledge content of products is becoming more valuable than the physical things that are used to produce them. But it is a value measured as usefulness, not exchange or asset value. In the 1990s economists and technologists began to have the same thought at once: that this new role for information was creating a new, "third" kind of capitalism -as different from industrial capitalism as industrial capitalism was to the merchant and slave capitalism of the seventeenth and eighteenth centuries-, the new "cognitive" capitalism.

Hybrid reality (HyR) is an ongoing process everywhere in which artificial intelligence (AI) technology is gradually introduced as an active stakeholder by using reasoning to execute real-life and economic activities. In the HyR model, interaction asymmetry between stakeholders is identified, possibly leading to pathological behaviour and AI technology learning corruption (Perko 2021). Future communication and scenarios will be a conjunction of AI and HyR; even more, Self-Organized Linguistic Systems (SOLS) are a theoretical framework for the creation of self-generated artificial languages, emergent and dynamic alternatives to contemporary synthetic conlangs (Gonzalez-Rodriguez and Hernandez-Carrion 2018).

The new economy associated with a massive online exchange of information opens the "peer-to-peer sharing economy". New market-makers create and control a whole sector in a global approach, including all countries or economies either with capitalism or communism regimes. Chinese capitalism of state monopoly model challenges global markets all over the world, disrupting traditional markets and even capitalistic competition approaches. New platform corporations work using "algorithmic trading models" that let them influence price determination processes, while the algorithm is kept in "secret" as it represents the core of the business and value creation, driving to monopoly situations. The state aristocracy is now formed

by these huge international corporations that create country regulation according to their economic interest in a post-capitalistic kleptocratic system.

Prior to the emergence of sharing-economy platforms, the governmental intervention was the natural solution proposed to market failure in traditional peer-to-peer businesses. For example, safety concerns about drivers and information asymmetries about the distance or cost of a ride were alleviated in part through driver screening and metered fares by taxicab regulatory agencies. Safety and quality concerns could have led to inefficiently low levels of peer-to-peer exchange in other markets as for very short-term rentals of residential housing units (Sundararajan 2016). Other authors proposed instead a "new cybernetic socialism" (https://wiki.p2pfoundation.net/Towards_a_New_Cybernetic_Socialism), the discussion centred primarily on the technological and economic aspects of a new and viable non-capitalist project possibilities (Cockshott and Cottrell 1993).

The procrastination and wishful thinking limit our ability to accept a systemic vision of all the systems working together, from a global or a planetary view. This new economy is only found if you look hard for it. There is, alongside the world of monopolised information and surveillance created by corporations and governments with diverse political visions, a different dynamic growing up around information: information as a social good, free at the point of use, incapable of being owned or exploited or priced, only available for the government, etc. Perhaps transparency would be the new rule, to ensure that information is available and that can be used to measure the authorities' performance and to guard against any possible misuse of powers. Trust is considered the new currency of the p2p economy.

In the end, pluralistic principles from different perspectives offer a theoretical justification for regulating the "peer-to-peer sharing economy". This is because the pluralistic theory does not endorse free-market and hands-off policies; rather, it requires state intervention and regulations to preserve existing choices (the traditional services), embeds and balance diverse values (not only autonomy), protects individuals from discrimination, shelters them from employment exploitation, and protect consumers and other businesses from strategic and opportunistic behaviours. The new debate could be if we reform the old economic system as we used to do, or create "a cleaned new one" with new rules and imagination.

Either in capitalistic, socialist, or communist societies, the new sharing economy and algorithm markets reclaim a government quality presence and proper regulation. Today's algorithmic trading (also called automated trading, black-box trading, or algorithmic (algo) trading) uses computer programs that follow a defined set of instructions (an algorithm) to place a trade. The trade, in theory, can generate profits at a speed and frequency that is impossible for a traditional human trader. People, or algorithms they create, determine what is shown and how. Platforms owned by shareholder corporations and funded by significant venture capital still drive the growth of the sharing economy today in China and United States. These platforms can shape markets according to their interests using algorithms to "match" supply and demand or connect customers to producers placing prices and market properties.

Computers used to be set up to steal in the trading markets and now the Internet galaxy (cyberspace, AI, big data, machine learning, etc.) can be set up similarly by

the platforms following hidden private or public interests. Most algo-trading today is high-frequency trading (HFT), which attempts to capitalize on placing many orders at rapid speeds across multiple markets and multiple decision parameters based on pre-programmed instructions. Similar approaches can be related to cyberterrorism and cyber-attacks in peace and war situations. Transparency seems to be the only way to guarantee access and opportunity to citizenship. Open or supervised software and algorithms seem to be the only way to guarantee justice and equality from the new market-makers (the so-called "unicorns" or big companies that control all the related transactions in their peer-to-peer sharing economy intermediation) and governments should respond by defending and protecting citizens' rights and security.

5 Summary

Anderson (2015) defended that dialogue among some well-known cypherpunks, i.e., persons who advocate for the use of cryptography and similar methods to achieve political and social change. Cryptography is the ultimate non-violent means for direct action; a way of providing privacy for the public and forcing transparency in government. The conversation was held among Julian Assange (editor-in-chief of WikiLeaks), Jacob Appelbaum (founder of Noisebridge-San Francisco and researcher for the TOR project), Andy Moller-Maguhn (Chaos Computer Club and European Director of ICAAN), and Jérémie Zimmerman (cofounder of La Quadrature du Net).

This research was carried out to balance how different models seem to be "more of the same", achieving similar goals and results from different starting points. Marx imagined information coming to be stored and shared in something called a "general intellect" -which was the mind of everybody on Earth connected by social knowledge, in which every upgrade benefits everybody. Information and trust are the coins of this new century, being key elements for the new "digital" economy challenges. It is not just another model or alternative economy, as many point out; rather than that, it seems that it will constitute the general model or the new economic paradigm (Hernandez-Carrion 2021).

Finally, postcapitalism was a concept about new forms of human behaviour that conventional economics would hardly recognise as relevant. Economic theory is far away to be able to include what should be relevant in the new peer-to-peer sharing economy. Demographic and fiscal timebombs are urgent tasks as decarbonising the world if we believe in politicians. Moreover, machines soon will surpass and perhaps replace many human beings. The big question is what is going to happen with so many people… Are we able to design a new brave world or we should be pessimists about the future, as in the time of Robert Malthus?

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Systems Engineering Approaches and Tools for Redesigning the Higher Technical Education System

Denis Shpotya and Alexey Romanov

Abstract Nowadays, in software, electronics and automotive industries, it takes 1.5–2 years for a new product to appear, although it takes 3 or even more years to develop new space instruments. The update of higher education system standards is even more conservative. It takes 10 or more years. Because of this, graduates come into the industry with outdated knowledge. Thus, the problem is to synchronize the processes of updating technologies that ensure the creation of innovative products with educational programs. It can be solved by changing the paradigm of products creation based on the synthesis of deep and interdisciplinary educational, scientific, innovative and production activities with the model-based systems engineering software and methodological tools.

The existing model-based systems engineering (MBSE) Software (SW) tools based on the Systems Modelling Language (SysML) are complex and expensive. This chapter raises the question, "Is it possible to make use of MBSE SW and methodological tools available to a wide audience of users?" To answer this question, the following MBSE approaches and tools were researched: Quality Function Deployment (QFD), House of Quality (HoQ), and SysML. Consequently, five methodological tools were developed for application during space instruments design and development life cycle stages. Tools are based on SysML, QFD, HoQ improvements and synthesis, and expressed in theoretical and practical algorithms.

The theoretical algorithm determines "What" (input and output data) and "How" (by using which systems engineering (including MBSE) tools are methodically analysed at the certain space instruments life cycle stage. The practical algorithm automates the development of SysML diagrams by using data structured in HoQ models and widely available SW. It reduces the time to develop and update SysML requirements diagrams from several days to some minutes and enables implementation of SysML SW by many users. Altogether, the obtained results constitute the software and methodological toolkit (SMT) called "improved Quality Function Deployment for improved House of Quality".

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To disseminate the obtained results, educational materials were created and validated during lectures on systems engineering. Lectures were supplemented with seminars and practicum. Practicum was focused on the design and development (D&D) of nanosatellites in the MBSE paradigm as the single project. The results showed that the developed SMT makes it possible to implement the life cycle of the cyber-physical system in the MBSE paradigm in a cost-effective way and a short time—in 6 months, students developed, conducted synthesis and flight tests of CubeSat-format satellite prototype and prepared the project documentation. In addition, students were motivated to study science, technology, engineering and math disciplines, MBSE tools, and become transdisciplinary specialists.

In addition, developed SysML requirements models were applied to examine the "Preliminary Design" product life cycle (PLC) stage of different space projects. Such application allowed quick assessment of project results, identifying non-compliance with requirements, conducting beforehand all necessary corrections and generating correct new product documentation. Taking into account the mentioned advantages of the obtained MBSE SMT, it can be concluded that its usage improves the quality and accuracy of current projects and speeds up the planning process of future analogue projects by up to 60%. Consequently, projects (their life cycle stages) can be realized faster by 5–10%.

These results allow to recommend for all interested in the innovative D&D of systems to initiate:

- formation of educational programs based on the project approach and MBSE paradigm;
- preparation of MBSE materials for online and offline teaching of students and teachers;
- development of domestic widely available software for the development of integrated SysML models with HoQ models that assures synchronization with CAE/CAD/CAM systems;
- support these recommendations for the implementation of the above-mentioned research results at educational organizations of different levels.

The future research is focused on the application of the developed MBSE methodological toolkit during design and development with numerical modelling and operation of several CubeSat satellites.

Keywords Systems engineering · MBSE · Paradigm · Methodological toolkit · SysML · QFD · HoQ

1 Introduction

MBSE modelling languages and approaches such as SysML, QFD, HoQ are critical during the D&D of hardware (HW) and SW devices. SysML is designed to increase the management efficiency of information about system requirements, functions,

physical characteristics. SysML supports specification, design, verification and validation. SysML was proclaimed as a basis for development of digital twins, machine learning and artificial intelligence. QFD approach provides a framework for translating input data (e.g. customer requirements (CR)) into prioritized output data (e.g. engineering requirements (ER)); HoQ—is the graphical language and the method of QFD. QFD and HoQ application reduces: (1) the risk of incorrect interpretations of CR; (2) the D&D costs of HW/SW by 60%; (3) the number of technological changes by 30–50%; (4) and warranty claims by 20–60% (Wolniak 2018).

But the research and development of modelling languages go on for decades, and their introduction gets into conflict with their drawbacks and psychological inertia of people to work as they got used to. As the result, MBSE artefacts are not recognized officially and developers are not interested to develop besides the official document its non-official SysML or HoQ model "copy".

This reality preserves decision makers from an understanding of MBSE technologies benefits, from investments in their research and development, education of the corresponding MBSE and IT specialists. The second point is crucial for the further MBSE (SysML, QFD, HoQ) scientific improvements and development of the enabling SW. Therefore, unless a higher technical education system of the RF will not be redesigned with the focus on the single project approach implemented in the new systems design and development paradigm based on the synthesis of scientific, innovative, production activities with MBSE software and methodological tools, the industrial digitalization will mostly continue: to reproduce inefficient D&D document-based approach based on the separate product life cycle stages, and to introduce technologies of the "yesterday"—non integrated and separately used CAE/CAD/CAM IT systems.

Augmentation of the current document-based approach with MBSE SMT that can be used by a wide audience of users from academia and industry will open to decision and policy makers short- and long-term benefits of the MBSE paradigm and make them support the corresponding redesign of the higher technical education system. To create conditions for such augmentation, at this point it is required to illuminate or compensate barriers that prevent potential users from using SysML, QFD and HoQ.

For this main purpose, the research goal was set to develop the MBSE SMT based on SysML, QFD and HoQ so that a wide audience of potential users from academia and industry can effectively apply during D&D stages. To achieve this goal, the following tasks were set: (1) identification of SysML, QFD, HoQ drawbacks; (2) development, verification and validation (V&V) of solutions that overcome drawbacks.

The remaining parts of this chapter are the following: identification of drawbacks of SysML, QFD, HoQ and SW tools for their usage, research findings, summary and conclusions.

Table 1 The SysML drawbacks (shortlist) that prevent its application by a wide audience of users. *Source* Romanov and Shpotya (2020)

№	Statement of the drawback	SysML	SW
1	SysML requirements diagrams (model) development and its update require hours or weeks, and SW tools that support SysML are very expensive	✓	✓
2	SysML diagrams are not effective to track all relationships of requirements	✓	
3	In the RF there are no teaching materials on SysML and its implementation	✓	

2 Identification of Drawbacks of SysML, QFD, HoQ and Software Tools for Their Usage

The surveys (Tower 2013; Cloutier and Bone 2015) of more than 400 respondents showed the increase in the number of companies that practise MBSE. The most frequently used MBSE SW tools were: MS Visio (57%), Sparx Enterprise Architect (44%), IBM-Rhapsody (24%). MS Visio allows the creation of customized graphical shapes. MS Visio (Professional version) does not possess SysML libraries, but it has Unified Modelling Language (UML) libraries (SysML is based on UML). MS Visio Professional cost approximately 8 times less than the cheapest SysML SW tool from Dassault Systems, IBM, Siemens PLM (price analysis was done in 2020). Universities of the RF that have partnerships with Microsoft grant MS Visio licenses for free to their employees and students. In this way, MS Visio corresponded to the requirement of wide availability and was selected as the primary SW tool for the methodological tasks of this research. The following drawbacks related to SysML were identified (see Table 1).

Our research showed that MS Excel can be a QFD (HoQ) SW tool that is available to a wide audience of potential users and consequently the following drawbacks related to QFD, HoQ and MS Excel that prevent their wide application during D&D were identified (Table 2) (Romanov and Shpotya 2020).

According to J. Koski analysis of QFD and HoQ modifications, UML diagrams transmit information more efficiently than HoQ models (Koski 2003). The leading QFD experts Stansfield and Mazur posted online that they would like to unite model-based design with QFD (Stansfield and Mazur 2016). Correspondingly, two assumptions that must be investigated were made: (1) SysML requirements diagrams compensate the drawback № 4 from Table 2; (2) HoQ (its improved version) model compensates the drawback № 2 from Table 1.

3 Research Findings

Sections 3.1–3.5 reflect research developments and their V&V (Romanov and Shpotya 2020).

Table 2 The QFD, HoQ and MS Excel drawbacks (shortlist). *Source* Romanov and Shpotya (2020)

№	Statement of the drawback	QFD	HoQ	SW
1	The QFD model is not oriented on the D&D of space instruments according to the SysML approach and requirements of regulatory and technical documents	✓		
2	QFD model stages (HoQ) do not generate input and output data, and at the same time, they cannot be implemented without them	✓	✓	
3	The HoQ method does not consider correlations of output parameters (e.g. technical requirements) when prioritizing them		✓	
4	The limited number of parameters (20–25) can be effectively analysed and managed in the HoQ model (often there are more)		✓	
5	There are no HoQ model templates in the MS Excel and the existing templates from "qfdonline.com" allow to build 4 HoQ models with a given set of fields, and it is not suitable for D&D of space instruments			✓

3.1 Improvement and Development of the HoQ Method and Templates, Specification of the QFD Model

To quantitatively consider expert estimates of output parameters correlations during their prioritization in the HoQ model, the classical HoQ prioritization algorithm was synthesized with the ranking weights of output parameters obtained with the analytical hierarchy process (AHP) method.

To realize space instruments D&D as a single project according to the QFD and SysML approaches, user needs and RTD requirements the classical QFD framework model was specified in terms of the number of stages and their purpose. The specification was called "improved QFD" (iQFD). 5 new iQFD model stages were obtained. Figure 1 represents the specified iQFD model in comparison with the classical QFD model. Transitions between iQFD model stages were expressed in mathematical terms:

$$iQFD = iQFD\left(\overrightarrow{UN_p}; \overrightarrow{iHoQCR_m}; \overrightarrow{iHoQFR_n}; \overrightarrow{iHoQDR_k}; \overrightarrow{iHoQLP_l}; \overrightarrow{iHoQLC_t}\right),$$

where $iQFD$—is a complex function that depends on the quantitative ranking of user needs $\left(\overrightarrow{UN_p}\right)$, quantitative prioritization by the new iHoQ algorithm of output parameters: CR $\left(\overrightarrow{iHoQCR_m}\right)$, engineering requirements to functions $\left(\overrightarrow{iHoQFR_n}\right)$ and to structures of HW/SW $\left(\overrightarrow{iHoQDR_k}\right)$, RTD requirements to a project or a product life cycle (its' stage) realization order $\left(\overrightarrow{iHoQLP_l}\right)$, RTD requirements to documents that must be developed during project or a PLC (its' stage) $\overrightarrow{iHoQLC_t}$.

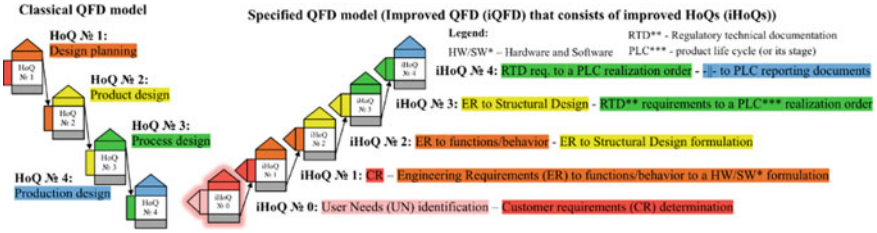

Fig. 1 Simplified conceptual illustration of the QFD and iQFD models (developed by the authors)

To overcome the drawback № 5 from Table 2, 5 iHoQ model templates were developed in MS Excel. They allow to save up to 20% of time efforts spent on D&D of new iHoQ models (expert estimation).

3.2 Development of Algorithms for the Generation of the Input and Output Data of iQFD Model Stages

To unify UN, CR and ER generation, systems engineering and MBSE tools were analysed. Consequently, a unified algorithm for generating these types of data was created. It was called "improved Quality Function Deployment for improved House of Quality" and was divided into 5 parts: (1) **Input**; (2) **Output**; (3) **Correction upon feedback**; (4) **SW tools**; (5) **Data generation** in accordance to the iQFD model by using systems engineering and MBSE tools that were divided into 3 groups: A) **Data acquisition:** context diagram, interview, survey, brainstorming; B) **Qualitative analysis:** verbal analysis of system requirements, work and product breakdown structures, SysML models, SWOT analysis, N^2 diagram, Kano model; C) **Quantitative analysis:** AHP method for ranking, iHoQ method for prioritization.

Afterwards, the unified algorithm was specified for its application at 5 iQFD model stages. Each specification included (1) the formalized physical meaning of the iQFD stage; (2) the proposed iHoQ model structure; (3) the framework for implementing SE and MBSE tools at the selected iQFD stage.

3.3 Creating a Method of Automated SysML Requirements Diagram Development and Its Update

Analysis of MS Visio functionality showed that it allows the creation of graphical shapes based on the data from external text document (e.g. an official document with requirements in the table form in MS Excel). By considering this functionality, there were developed 4 algorithms of actions that describe how: (1) to develop a database of requirements that can be synchronized with SysML shapes in MS Visio, (2) to develop libraries of SysML shapes, (3) to automatically develop and (4) update SysML requirements diagram. Consequently, these algorithms were united into a

single method. Method's verification and validation showed that by using it a person can develop and fill in with data (with absolute compliance with data source) 300 new SysML requirements shapes in some minutes. By the classical manual approach such tasks may require days or weeks and there is a very high risk that the final result will not completely comply with the initial data source.

3.4 Synthesis of the Research Developments into a Single MBSE SMT and Their V&V

Research developments were V&V during the analysis of requirements of different design aspects of the CubeSat "Mayak". Mainly, specified algorithms that reflect iQFD model stages and combines in themselves proposed iHoQ and SysML methods helped to obtain and model: 2 UN, 6 CR (Fig. 2), 22 ER to functional parameters and 27 ER to HW and SW of the CubeSat "Mayak", and also RTD requirements. The iHoQ algorithm allowed to obtain different ranking orders and to increase the contrast of output parameters prioritization weights by two and more times compared to the results obtained by the HoQ algorithm. The last iHoQ benefit allows identifying critical requirements.

An additional V&V of the developed SysML RTD requirements diagrams (model) was conducted. First of all, the top-level SysML package diagram was developed. This diagram reflects the end-to-end structure of the "Preliminary Design" (PD) PLC stage, its sub-stages and the list of top-level documents that must be developed at these sub-stages according to the open RF standards (see Fig. 3).

Further, this top-level diagram was decomposed into SysML requirements diagrams that describe RTD requirements to documents that top-level documents include in themselves. These diagrams were applied to inspect whether the results of the "PD" stage of several space instrument projects comply with RTD requirements or not. Their application made it possible to complete inspections in 2 hours instead

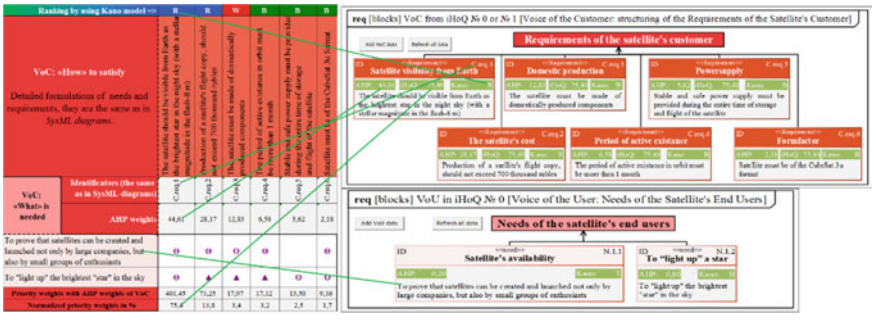

Fig. 2 The synthesis of the iHoQ № 0 models with the SysML requirements (UN and CR) diagrams *Source* Romanov and Shpotya (2020)

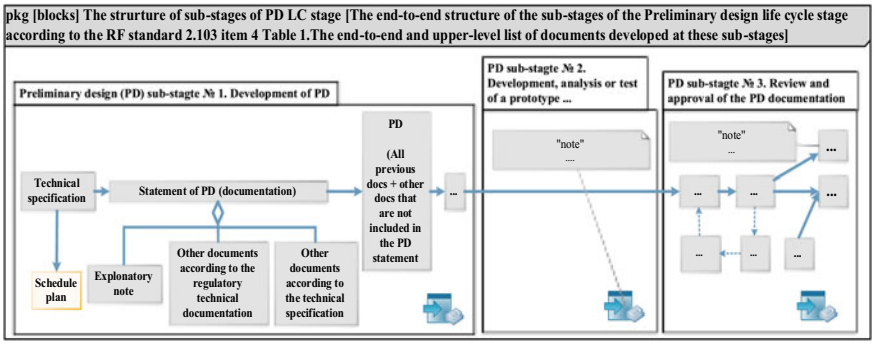

Fig. 3 The illustration of the top-level diagram of the SysML RTD requirements model *Source* developed by the authors based on the open RF standards GOST 2.103 and 2.119

of days or weeks and to identify 5–10 results' non-compliances. Usually, when in the due date of project results submission to a customer non-compliances are found it means that the developer of a space instrument fails to submit a project, and he is obliged to pay a serious financial compensation to a customer. Consideration of the fact that the application of SysML requirements diagrams helps to identify non-compliances and to decrease the labour costs during SysML requirements diagrams development means that such MBSE (SysML) tool, approach of its practical realization and application save developers' financial resources and speed up D&D. Also, their application during the project's planning decreases the planning time of PLC stages of new analogue products by approximately 60%.

Finally, both assumptions were investigated and confirmed by the synthesis in MS Excel of the iHoQ model with the SysML requirements diagrams into a single workspace (see Fig. 3).

3.5 Research Developments Verification and Validation During the Educational Process

To promote the proposed MBSE software and methodological toolkit educational materials were developed. They were used for teaching how to D&D nanosatellites and technical devices in the MBSE paradigm as a single project. The teaching showed that even after one day, students understand the proposed MBSE SMT and how to start using it in their daily work (Shpotya and Romanov 2019).

4 Summary and Conclusions

The opportunity of a wide audience of users from the education system and industry to augment the design and development processes implemented in the current document-based paradigm with the MBSE software and methodological tools will lead the way for the formation of the government request to redesign the higher technical education system with the focus on the MBSE application, research and developments. This in its turn will allow achieving official recognition and dominance of the MBSE paradigm over the document-based paradigm. But today in the RF and other countries the available software based on MBSE tools (especially SysML) are expensive and complex. That is why this research was focused on the development of the MBSE software and methodological toolkit available to a wide audience of users.

As the result of this research were identified widespread SW tools for SysML (MS Visio Professional), and QFD (HoQ) (MS Excel) usage, their drawbacks, and developed, V&V new solutions. Specifically:

1. The iHoQ algorithm was created. It allows obtaining different ranking orders and higher contrast of output parameters prioritization weights if compared with the classical HoQ algorithm.
2. The iQFD model was proposed. It allows design and development of space instruments and systems according to UN, SysML approach and requirements of regulatory and technical documentation.
3. The method for automated SysML requirements diagrams development and update of data in them was created by using widely available software tools MS Visio and Excel. V&V of the method proved that it reduces the labour costs for these processes from several days to hours and minutes.

   Validation of the developed SysML requirements models proved that their usage reduces labour costs: a) for the inspection of project results' compliance with the RTD requirements from several days to several hours, b) for the planning of PLC stages of analogue products by up to 60%. Also, their application maximizes compliance of project results with RTD requirements by 10%.
4. The unified algorithm for generating input and output data for the specified QFD model stages was developed. The algorithm is based on the synthesis of systems engineering (including MBSE) approaches and tools (SysML, QFD and HoQ) with MS Visio and Excel SW tools. iHoQ model templates were developed in MS Excel.
5. The single MBSE software and methodological toolkit was created. It was implemented in MS Excel. It is based on the iHoQ model and SysML diagrams synthesis as the single working area. SMT's validation proved its effectiveness in data communication from the iHoQ model by using SysML requirements diagrams and tracking all relationships of requirements by using the iHoQ model.
6. Educational and methodological materials for teaching the developed MBSE SMT were created. Their application allowed in the short period (6 months)

to complete a project: develop, conduct synthesis and flight tests of the nanosatellite prototype, and prepare the project documentation.

Successful V&V of the research results allow to conclude that the obtained MBSE SMT: (1) improves D&D quality of new products; (2) speeds up the implementation of the D&D of analogue products by 5–10%; (3) allows to overcome (compensate) the identified SysML, QFD, HoQ drawbacks; (4) can be applied during D&D of technical devices by a wide audience of users from industry and education.

Its wide dissemination and application will form the ground for the soonest necessity to redesign the higher technical education system that in its turn will accelerate and enable a smooth transition from the systems' design and development in the document-based to the model-based systems engineering paradigm. Therefore, it contains the scientific, technical and economic feasibility for its widespread integration in the agenda of higher technical educational organizations with the purpose of further transfer in space and other industries.

These results and conclusions allow recommending for all interested in the innovative D&D to:

- create educational programs based on the project approach and MBSE paradigm;
- create MBSE teaching materials for online and offline education of students and teachers;
- develop domestic widely available software for the development of integrated SysML with HoQ models that can be synchronized with domain-specific models of CAE/CAD/CAM systems;
- application of this research results at educational organizations of different levels.

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Embodied Pedagogies, the Arts and Reflexive Systems in Enactive Management Education

Osvaldo García De la Cerda, Mary Ann Kernan, and Clive Holtham

Abstract This chapter stems from the convergence of two independent efforts to develop and research pedagogy which can prepare individuals to enact with high responsibility and creativity in complex situations. The main design questions are: How does a human being cope with complexity and uncertainty to take care, in different domains and contexts, of the human activity system for which he/she is responsible? And what transformations to the traditional business education programmes are necessary to meet this challenge? The shared long-term aim is to change the traditional curriculum by expanding the boundaries of our understanding of problem situations as a human activity in which technical matters intertwine with belief, desires and emotions.

Our findings are drawn from a primarily qualitative study of the pedagogical design and outcomes of the interdisciplinary Masters in Innovation, Creativity and Leadership (MICL) launched at City, University of London in 2010. We focus on the lived experience of the students, especially the first cohort to complete the final module, *Creativity and the Creative Industries* (CCI); and relate our analysis to the CLEHES process, a strategy of learning developed by García De la Cerda et al. (2018).

Building on the work of Beer (1994), Maturana and Varela (1987) and Espejo (1996), García and his collaborators configure CLEHES as a nurturing technology to enhance enactive management which treats humans and organisations as activity systems with six ontological dimensions: body (*cuerpo* in Spanish), language, emotion, history, eros and silence (García De la Cerda and Saavedra Ulloa 2006; García De la Cerda and Orellana Muermann 2008; García De la Cerda 2009; García De la Cerda and Laulié Cerda 2010; García De la Cerda and Saavedra Ulloa 2016;

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García De la Cerda 2017; García De la Cerda et al. 2018). CLEHES involves three strategies of observation (García De la Cerda et al. 2018):

- Self-observation
- Observation of interactions, conversations and dialogues
- Observation of an organisational network.

We conclude that there is considerable potential in further exploring the six ontological dimensions, O Technology and CLEHES (García De la Cerda et al. 2018) to better understand the necessary conditions for arts-based HE pedagogy in management and professional education.

Keywords Creative management · Complexity management · CLEHES enactive laboratory · Embodied and arts-based management pedagogy · Interdisciplinary business school pedagogy

1 Introduction

This chapter presents findings drawn from a primarily qualitative study of the pedagogical design and outcomes of the interdisciplinary Masters in Innovation, Creativity and Leadership (MICL) launched at City, University of London in 2010. The authors review evidence for the lived experience of students in the MICL, especially the first cohort to complete the final module, *Creativity and the Creative Industries* (CCI), in 2012.

Our inquiry aimed to explore the explanatory potential of strategy of learning developed by García De la Cerda et al. (2018), the CLEHES process. Building on the work of Beer (1994), Maturana and Varela (1987) and Espejo (1996), García and his collaborators configure CLEHES as a nurturing technology to enhance enactive management which treats humans and organisations as activity systems with six ontological dimensions: body (*cuerpo* in Spanish), language, emotion, history, eros and silence (García De la Cerda and Saavedra Ulloa 2006; García De la Cerda and Orellana Muermann 2008; García De la Cerda 2009; García De la Cerda and Laulié Cerda 2010; García De la Cerda and Saavedra Ulloa 2016; García De la Cerda 2017; García De la Cerda et al. 2018). CLEHES involves three strategies of observation (García De la Cerda et al. 2018):

- Self-observation
- Observation of interactions, conversations and dialogues
- Observation of an organizational network.

Although CLEHES can be characterised as a ‘technology’ or a ‘tool’, its application by García relates to a systemic worldview. In his work with political and organisational leaders, primarily in Chile, CLEHES has typically been applied to situations of pain, rupture, breakdown or conflict. An ‘O Technology’, CLEHES is ‘circular, interactive and dynamic’ (García De la Cerda et al. 2018, p. 8). Self-observation via

Table 1 The six dimensions of CLEHES (adapted from García De la Cerda et al. 2018)

• Body (C): The body learns in the situated situation; learnings are installed and live within it and are triggered from it. The body gives presence and moves in a specific way in interactions. This builds an understanding of movement and the body in organisational transformation processes
• Language (L): It is possible to open or close conversations through language, but we can also hold missing conversations (opportunities) in the drift of experience. Each human being has their learning of this kind; but every organisation also has its learning, and dances internally and externally through language
• Emotions (E): Emotions are intertwined with language to configure conversations. Emotions inhabit the body and give direction, intention and strength to conversations. Because of this, emotions bring rhythm to human interactions. It is not the same conversation if a human being is feeling fear or joy: in this sense, emotions can open or close a learning process
• History (H): History is of key importance as it configures identity and nano identity, which are expressed in conversations. It is informed by experiences, expertise, practices and learning. In this field human beings can recognise sources of trust and distrust, historical pains and missing conversations; but, more, identity is the consequence of the observer that constitutes their world
• Eros (E): Listening with eros is the disposition to build and design with others. It is the potential to create new routes, (re)design interactions and conversations. It brings a certain possibility of enacting and affects situations. Opening and promoting eros in conversations surfaces new opportunities to be explored
• Silence (S): Silence allows the discovery of missing conversations. Looking at these allows the observation of human practices and habits, but also enables the observation of how silence operates as a critical factor in the structural dynamics of the organisation and its environment

the six CLEHES dimensions is an essential first step. The six dimensions can be summarised as in Table 1.

García's Enactive Laboratory explores these dimensions through modules called RIHPLA, Reingeniería Humana para la Acción, translated into English as 'Human Re-Engineering for Action' (García De la Cerda 2009; García De la Cerda and Laulié Cerda 2010). Its creative and reflective processes incorporate artistic experiences and analysis as 'episodes of the quantum observer transformation process' (García De la Cerda et al. 2018, p. 9), and include creative writing, modelling, theatre composition and acting, scene design and choreographic arrangements, body observation and dance. Since 1994, the programme has reached over 80,000 international and Chilean participants, ranging from students to the heads of major public and private-sector organisations (García and Salazar 2013). Most often with Boards of Directors, O Technology also uses syntenaction, a pragmatic tool to enact the bodily pains of situations situated to resolve complex conflicts in human activity systems while taking care of those involved (Tejos 2016). By enhancing 'observation of orthogonal interactions' (Espejo 2003; Zúñiga 2010) and individuals' 'listening with eros', the process offers teams and organisations the capacity for 'a continuous dance through ruptures and collisions', which enables 'a set of favourable consequences such as creativity, trust, cohesion, collaborative work, cooperation and solidarity' (García De la Cerda 2009, p. 1336).

The aims of this chapter are therefore both epistemological and ontological. We seek to contribute to current debates about arts-based inquiry and pedagogy while also acknowledging conceptual debates about both the arts as knowledge (Eisner 2012; Young 2001) and the challenges in organisational and management learning which seek to promote deutero learning (Bateson 1972; Argyris 2012). We aim to align our final discussion to the work of other scholars who have taken up the CLEHES approach, including Atkinson (2008), Figueroa (2014) and Scholte (2017). The chapter concludes by asking whether the MICL offers an experience consistent with the elements of the CLEHES strategy, and therefore promotes the conditions similar to the Enactive Laboratory as a 'ludic and creative space' (García De la Cerda et al. 2018, p. 6) in which participants build the capacity to 'listen with eros', 'reflect' and 'embody the context to redesign it and refresh decision-making practice within it' (García De la Cerda et al. 2018, p. 3).

2 MICL Case Study

This section summarises the educational experience offered by City's interdisciplinary Masters in Innovation, Creativity and Leadership (MICL) since 2010, especially the *Creativity and the Creative Industries* (CCI) module first delivered in 2012. Consistent with established methods of phenomenological and mixed research methods (Van Manen 1997; Knight 2001), this analysis draws on the transcripts of contemporary interviews and student coursework, including reflective reports; the thematic and metaphorical analysis of assessed individual artefacts; and associated MICL documents, including External Examiner reports. The analysis of the students' arts-based assignments and reflective writing sought codes for embodied experience and metaphors (Hatch and Yanow 2008). Recognising the role of the researcher in the relationship between 'the referent, the symbol, and the interpretant', the process embraced the personal and emotive nature of these sources as data, seeking to '[generate] the conditions for new telling questions and for fruitful discussion' (Eisner 2012, p. 8). Comparative mixed methods data include a self-efficacy study (Bandura 1997) with subsequent MICL cohorts, with questionnaires completed at the outset and conclusion of the taught modules. Direct quotations from the students' work are not included here for reasons of confidentiality.

2.1 MICL Student Journey

City's Masters in Innovation, Creativity and Leadership (the MICL), based in the Bayes Business School (formerly Cass), is an interdisciplinary programme, which includes subject specialisms drawn from across the University's Schools as defined in 2008 (see also Jones et al. 2017). The core taught modules have remained unchanged since the programme was launched: *Creative Writing* (School of Arts), *Creative*

Problem Solving and *Leadership and Delivering Innovation—Turning Ideas into Action* (Business School), *The Psychology of Creativity and Innovation* (School of Social Sciences), *Leading Creative Design* and *Technologies, Creativity and Innovation* (School of Informatics), *The Law, Creativity and Innovation* (School of Law), and *Creativity and the Creative Industries* (School of Arts).

The programme embeds values which act as a shared language to discuss and manage behavioural expectations of the MICL community as a whole, including the teaching staff and alumni: Open-mindedness, Encouraging diversity, Co-operation, Risk-taking, Leading and following, Grit ('Ability to keep moving forward when the going gets tough'), Stretching ('Getting comfortable with paradox, metaphor and apparent chaos') and Active involvement ('Showing up, taking part and engaging in constructive dialogue with colleagues') (Masters in Innovation, Creativity and Leadership 2010).

The individual modules build distinct and shared vocabularies. Formal examples include the descriptors used in psychometric measures, the results of an individual creative leadership profile (Perspectiv 2021), and a range of concepts including creative problem solving, climate and culture (Isaksen et al. 2011), Janusian thinking, single and double-loop learning (Argyris 2012), and design thinking processes (e.g., Lockwood 2010). Less formal phrases also become a shared student vocabulary, including VUCA, comfort zones, wicked problems, Hippos (for blockers of organisational innovation), and start-up concepts (e.g., 'iterate to innovate').

2.2 Student Cohorts

To be eligible to join the programme, candidates are expected to have at least five years of professional experience. Since 2010, the cohorts have ranged in size from 15 to 30. As outlined in more detail in Jones et al. (2017), their prior qualifications, professional ambitions and subsequent achievements have been widely varied. Most chose the MICL having first considered an MBA or other more career-focused programmes. The programme was launched as a part-time two-year programme, with a largely UK and European cohort in 2010–2012. The cohorts' destinations for the years 2012 to 2019 showed a predominance of senior, entrepreneurial, innovation and design roles, with the most frequent job descriptions including the words 'Manager', 'Director', 'Head', 'Consultant', 'Innovation', 'Founder' or 'Co-Founder', 'Lead', 'Service', 'Product', 'Strategic', 'Learning' or 'Board' (Masters in Innovation, Creativity and Leadership 2020). The programme's satisfaction ratings and average earnings after graduation are among the most successful of the Bayes MSc cohorts.

2.3 Reflection and Embodiment in Learning Design

In addition to interdisciplinarity, reflection is a consistent assessment element in each MICL module. Reflective processes are introduced during the induction period, including a personal visioning of their MICL goals; a mutual introduction session, in which the students present one another's background and aims; and a non-assessed group 'dérive' which calls for 'learning by walking about in a group, observing, noticing and conversing' (Masters in Innovation, Creativity and Leadership 2012, derived from Debord 1958; Kernan et al. 2021). The students are introduced to reflective models, sources and processes, and the reflective assessments take a variety of formats including journals, sketchbooks, portfolios and reports (Kernan et al. 2021). The Creative Writing module calls for daily individual writing practice. Arts-based reflection processes are further reinforced at the start of the capstone CCI module in Term 2 as an invitation to the students to develop a daily practice of as artful journalling to promote intuitive thinking (Holtham and Dove 2018; Kernan et al. 2021) and support their arts-based assessments.

Embodied learning was also a design principle of the MICL. During the programme, the students write, read aloud, make, explore, design, collaborate, analyse, perform, and make and display an artefact. In the CCI module, the students participate in body percussion and rhythm exercises led by professional musicians, complete physical acting exercises involving characterisation, the voice, the breath and movement, visit the Science Museum's Wonder Lab to experience excellence in interactive design, and share a choreographed dance experience in a London Park linked to a musical and poetic commentary.

2.4 Arts-Based Assessments

The students frequently cite the power of one of the first modules, *Creative Writing*, in establishing trust and coherence across the group. In this module, the students draft, share and give feedback to one another on short examples of narrative prose and film scripts, which frequently draw on their own life experience. Over the ten weeks of the module, the tutors draw on their experience as published writers and teachers to comments on the students' evolving writing skills.

In the Term 2 *Creativity and the Creative Industries* (CCI) module, the students build on this experience to develop, plan and deliver an assessed group performance, 8–10 min in length, to the class and the MICL teaching team. The other, equally challenging assessment is to design and display a personal artefact to reflect their MICL journey and to complete and submit an associated summative reflective journal. The module supports the students to succeed in these assignments through a series of arts-based workshops, which offer embodied encounters with art, music, acting, dance, improvised comedy and biofeedback.

It is clear from their feedback that almost every MICL student experiences both personal resistance and fear of failure in the *Creative Writing* and CCI modules and considerable gains in confidence through their experience of these modules. This pattern is evident in the students' responses to a self-efficacy questionnaire completed between 2014 and 2019 at the start and end of the taught MICL modules. The full-time students were asked to rate their confidence in 'Applying ideas in my work informed by how dancers, artists, comedians, actors and musicians work' (Kernan 2019). Their 2017–18 students' pre- and post-assessment average responses (out of 10) were Pre 4.33, Post 7.75; and the 2018–19 students' were Pre 3.4, Post 8.4. The questionnaire's free text questions elicited contrasting, often emotive descriptions related to their prior expectations (Pre) and experience (Post) of the CCI workshops and assessments:

> 'What might each of these experiences be a bit like, and/or how does the idea make you feel?'
> '3. Joining in a music workshop with a string quartet': Student 1: Pre 'Beyond anxious'; Post 'Notion of working together, in synch—teamwork!'
> '8. Developing and presenting an artistic artefact': Student 2: Pre 'No good'; Post 'A great experience, difficult to know where to stop' (Kernan 2019).

Their willingness nonetheless to embrace the programme values and engage with these processes has generated some exceptional work, both individually and in groups, in many cases at a level consistent with Masters students who specialise in the creative arts as Masters students.

Analysis of the metaphors evoked by the 2012 CCI artefacts showed recurring themes including connection, growth, the book and knowledge, and boxes to be opened and explored. Others explored aligned metaphors, including unlocking, thresholds and doors; illumination, insight and 'light at the end of the tunnel'; play and puzzles; magic, fairies and mystery; perception and a Janus head; and values, time and balance. Further analysis showed that the 2012 artefacts also evoked a range of physical senses, including touch, smell, sound and taste as well as vision; and invited the viewers' embodied and emotional responses, including, in order of frequency, touch, curiosity, perception and empathy, including in response to an oil painting which incorporated the central figure from Munch's *The Scream.* That these responses were intended by the students is confirmed in several of their journal entries, including explicit exploration of the roles of metaphor in perception and of family, education and work in shaping personal identity.

2.5 Student Experience

The thematic analysis of the 2012 students' summative reports on their MICL experiences indicates both emotional impacts and career shifts. The main recurring descriptors used included these positive terms, in order of frequency: 'collaborate', 'trust',

'climate', 'leader', 'acting', 'craft', 'learn', 'try', 'group' and 'confidence'. Descriptors that were used less frequently, most often related to the start of the MICL, indicate stretching or unsettling experiences: 'unsettled', 'vulnerable', 'stretching', 'forced' and 'nerves'.

The students' written accounts confirm that the MICL's teaching and assessments encouraged these students to share their ambitions and values and engage in 'stretching' learning which moved beyond their previous learning and behaviours. Comfort zones, journeys, career shifts, the arts, flow and reflection were common themes, including setting goals to continue with both artistic and reflective practice.

3 Discussion

This summary table reviews to what extent the learning experience offered by the MICL might map onto the 'six ontological dimensions' as configured by García De la Cerda and Saavedra Ulloa (2016) (see Table 2).

Table 2 Indicators for the students' experiences on the Masters in Innovation, Creativity and Leadership with reference to the six dimensions of CLEHES (García De la Cerda et al. 2018)

Body	Consistent with the García De la Cerda et al. framework (2018), the arts-based workshops in the CCI module allow the students to actively explore their physical responses to physical and artistic art practices, including facilitated activities related to their own physical experience and performance
Language	The programme modules consistently refer to the MICL values, which act as a shared language to discuss and manage behavioural expectations of the MICL community as a whole. The individual modules also build both formal and informal vocabularies which the students have often employed to enunciate their learning and present these insights to others, including in their performances and artefacts
Emotions	The students' written accounts as well as the MICL self-efficacy study confirm the emotional journey they experience in the MICL, especially in the arts-based modules
History	The learning processes of the core MICL modules establish both trust and openness within each cohort. Students frequently cite the power of one of the first modules, Creative Writing—a module rarely found in leadership degree programmes—in establishing trust and coherence across the group. They express their identity as part of the MICL in their shared language for the organisational and behavioural climate required for innovation and in their analysis of their experience on the programme
Eros	Underpinned by the environment of 'listening with eros' (García De la Cerda 2009, p. 1336) established during the Creative Writing module, the MICL's combination of narrative, visualisation and goal-setting consistently supports the students to develop both personal and interpersonal insights and to explore different routes in their careers. They also report ambitions to continue to explore their artful capabilities, which were in almost all cases not previously encountered as an adult, and to encourage others to share similar insights at work and at home
Silence	The MICL promotes silent practice through embodied individual and group activities, arts-based learning and making, and reflection

We conclude from this that the MICL can be said to share elements of the 'Enactive laboratory' as defined by García De la Cerda et al. (2018, p. 3). The MICL also equips its students to explore their capacity to be 'enactors' through direct experience of 'embodied effective way[s] of knowing' and 'choreographed performance' (2018, p. 3). Although still rare within the business school curriculum, the emphasis on the body in CLEHES is consistent with a growing literature and practice which analyses the role of arts-based methods in identifying innovative and creative approaches to complex human and social conditions as well as in organisational and management learning and leadership development (e.g., Adler and Delbecq 2018; Anderson 2008; Ludevig 2016; Turnbull James 2011), in addition to others analysed in the journal *Organizational Aesthetics*. Also echoing the CLEHES model, other commentators have emphasised the overriding role of acknowledging and responding to grief and other emotional experiences through organisational and leadership conversations, especially in the context of the Covid pandemic (Petriglieri and Maitlis 2019; De Smet 2020).

The findings of this chapter also touch upon how best to define and explore questions of human of learning and development, including in our own future cross-cultural research collaborations. The authors acknowledge our own tensions related to the distinct learning environments in which we teach, and the potential through future collaborative and comparative projects to better understand organisational development and Business Schools as activity systems. The traditional business school curriculum is more and more subject to criticism in North America and Europe, especially in the context of the shifting demand for online provision (Chowfla 2022; Moldoveanu and Narayandas 2019), while at the same time the rise in business school applications overall since 2020 and the growth of the MBA in China evidence the continuing perceived value of business-school qualifications (Friedman 2021). More extended and comparative studies would be needed to explore the broader questions of what we understand by 'education', 'learning' and 'knowledge', and what these are for; and how best to balance a bottom-up approach, self-management and self-government within organisations, including universities.

We see considerable potential in further exploring the six ontological dimensions, O Technology and CLEHES (García De la Cerda et al. 2018) to better understand the necessary conditions for arts-based HE pedagogy in management and professional education, and to develop ourselves and others as learners and teachers.

The paradigmatic title of this article is an invitation to search for new ontological views and epistemologies in order to develop ourselves and others as learners and teachers and to explore multiple, quantum educational spaces (Turner 2021).

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