REFLEXIVITY AND DESIGN: ABSTRACTS PREPARED IN 2016-2017

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PREFACE

The Research Program in Social and Organizational Learning at The George Washington University hosts visiting professors for periods of several months or an academic year. In the 2013-2014 academic year, the Research Program hosted two visiting scholars. Both were Fulbright Scholars. Some of these abstracts were prepared by professors and visiting scholars associated with the Research Program. Others were prepared for panel sessions at conferences on cybernetics or systems science.

Abstracts 1, 2, 3, and 4 are from a meeting of the Policy Studies Organization DuPont Summit, held in Washington, DC, December 2, 2016. Abstracts 5-11 are from a panel on Reflexivity, Second Order Science, and Context at the World Organization for Systems and Cybernetics conference held at the Sapienza University in Rome, Italy, January 25-27, 2017. Abstract 12 is from an International Society for the Systems Sciences conference held in Vienna, Austria on July 9-14, 2017.

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AN EXERCISE IN THE DESIGN OF GOVERNMENT

Robert Knisely, J.D.

If the Internal Revenue Service does not have enough employees to answer the phone when people are preparing their taxes, the government is not able to work as intended. If the number of meat inspectors in the Food and Drug Administration (FDA) is not sufficient to do an adequate number of inspections of meat producers, the safety of the public is endangered. These are just two recent examples of lack of requisite variety (insufficient staff to handle the task required by law) in federal regulation. Many more examples can be found at the blog location given below. This presentation will consider "the design of government" which may lead to a discussion of "designing the design of government." How SHOULD the American government go about designing our laws and regulations?

A FRAMEWORK FOR DESIGNING FEDERAL AGENCY REGULATORY MODELS

Morris Bosin
Grant Thorton International Ltd.

Federal agencies use different types of regulatory models * to manage complex issues they are mandated to address. The models are designed to incorporate sufficient complexity and variety to match the complexity and variety of the problems/issues they face. The models are designed differently because of the different characteristics that define their particular milieu; and hence shape the regulatory model itself.

*Regulatory is used in the broad sense of management approaches.

In designing regulatory models four framing questions can be addressed in order to determine the basic design of the model:

- Who is the regulator? – The continuum ranges from one centralized regulator to dispersed regulators. This is often not a settled question. Depending upon one's perspective on the problem, it may be perceived as international, national, regional or local. The question of who regulates or manages the problem, is a function of how power to address the problem is dispersed. To illustrate: In the case of determining who decides on educational standards for U.S. students, the regulatory model is negotiated through collaboration between national, state and local governance; and the pendulum tends to swing in one direction or another based on the sentiment of the populace.

- What are the decision rules? What are the criteria that determine how the regulator designs strategies to solve the problem at hand? These alternatives include, but are not confined to:
  - ✓ Risk-based – Resources and strategies are designed to address the highest priority risks first – Illustration: The U.S. Border Patrol focuses their border protection assets at the Southwest Border where incidents of illegal activity are the highest
  - ✓ Equity based – Resources are allocated proportionately based on a total population metric: Illustration: Many categorical grants sent to states are prorated on a per capita basis
  - ✓ Stabilization based – Strategies are based on long-term sustainability of outcomes. Illustration: Federal Reserve monetary policies on interest rates and 'quantitative easing' are based on intended long term sustainability of the U.S. economy
  - ✓ Return on investment based – Strategies targeted toward maximizing return on a Federal investment. Illustration: NOAA's Marine Resources Programs designs fishery management strategies to balance short term return on investment by the domestic fishing industry with long term optimum sustainable yield of each fishery.

- At what level is the problem perceived and being addressed?
  - ✓ Technical

- ✓ Managerial
- ✓ Political
- ✓ Cultural

One of the key challenges in designing an appropriate Federal regulatory model to manage a public issue is that the model must incorporate a technical, managerial, political and cultural component. To illustrate, technical solutions to managing air quality have been stipulated by emission standards recommended by EPA scientists. The standards must be mediated, however, by: managerial considerations in terms of industry's ability to gear up for such standards; the political will of the current administration and Congress to pursue such standards; and the cultural context in which standards are accepted or rejected.

- What are the characteristics of the operating environment? – Is the environment stable and predictable; discontinuous, circular and complex, but in which deep patterns can be defined; or entropic with the possibility of discerning trends toward a disaggregated end state? Each cell in the table below requires a different regulatory approach. The LRV model design should consider the complexity of the management challenge, and the level at which the model is being applied

LRV Strategies	**Federal Regulator**	**Environmental Complexity**		
		Stable, predictable, amenable to comprehensive-rational management	Discontinuous, complex, circular, but underlying patterns may be discerned	Entropic - possible ability to predict progress toward disaggregated end state
Technical	U.S. Customs and Border Protection	Identify U.S. Customs and Border Protection auto mechanics training requirements based on features of new car models	Incorporate non-traditional feedback mechanisms and 'peripheral vision' to anticipate new developments in automobile technology that will shape future training needs	Develop exit strategies for auto mechanics who are unwilling or unable to keep pace with new auto technologies
Managerial	Food and Drug Administration	Recruit and train chemists, physicians and pharmacologists into FDA based on prevailing trends in new drug development by the pharmaceutical industry	Consult with drug manufacturers early in the drug R&D process to anticipate possible emergence of breakthroughs in new chemical entities	Re-envision role for FDA in protecting consumer safety in the event that the new drug review function is privatized
Political	Department of the Interior – Indian Education Program	Arrive at negotiated agreement between Federal, state and Tribal leaders on standards of learning in Indian schools	Build issue networks among Federal, state and Tribal leaders to capture and address emerging educational issues	Establish a regulatory model based on arriving at incremental agreements among stakeholders who cannot agree on long term educational goals
Cultural	Department of Health and Human Services	Leverage buy in from millennials in continuing to strengthen anti-smoking strategies	Develop a mediation mechanism in developing a shared solution to smoking issues among competing cultures – e.g., millennials, generation Xers and baby boomers	Since no single demographic culture exerts influence on smoking outcomes, rely on market forces to determine end state

Access to increasingly sophisticated information access, analysis and prediction increases the capacity of the regulatory model to absorb complexity. Regardless of the combination of characteristics that are appropriate for the regulatory model to address a specific problem, the level of sophistication of information access, analysis and prediction will determine the degree of variety absorption in the regulatory model.

FEASIBLE COST, REQUISITE VARIETY, AND PREFERRED TASTE: THREE DIMENSIONS OF "GOOD" REGULATION AND THEIR HIDDEN LAWS

Jason Jixuan Hu

What is in common for a "good" photographic image, a "good" organization, and a "good" society? Or, what is in common of a "good" camera, a "good" management team, and a "good" government? This paper identifies a three dimensional space in which we perceive what we mean by "good" in human affairs involving regulation or control. The three dimensions are Feasible Cost, Requisite Variety, and Preferred Taste. The attempt here is to construct a three dimensional measurement instrument, i.e. Organizational Efficiency Index (Cost-wise), Regulatory Capacity Index (Variety-wise), and Aesthetic Position Index (Taste-wise). The three dimensions are all about human limitations. Each describes something that we wish to do better but cannot for the time being. Together these indexes offer a 3-D perspective for us to observe and compare the development and evolution of any human organization – families, companies, governments, societies or civilizations. The progress of civilization means that over time, thanks to the accumulation of experiences and our capacity for reflection and critical thinking, we are able to raise our marks on these limitations.

Three laws related to this three dimensional perspective are discussed: (1) Law of Limited Rationality: Any human brain functions with a long list of cognitive biases that need to be eliminated before reaching pure rationality, but the process of overcoming these biases demand resources (monetary cost and bio-cost (time, attention, stress and health). Since such resources are always limited, the rationality reachable will be always limited. (2) Law of Requisite Variety: If a system is to be stable, the number of possible states in its control mechanism must be greater than or equal to the number of states in the system being controlled (Ashby 1958). (3) Law of Preferred Taste: Human beings prefer their more pleasurable (subjectively definable) option when other aspects are equal within their scope of awareness.

THE LAW OF REQUISITE VARIETY AND ITS ROLE IN MANAGEMENT

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The Law of Requisite Variety was described by Ross Ashby in 1952 in his book, *Design for a Brain*. The law says that the variety in a regulator must be at least as great as the variety in the system being regulated. This is a very general law. It describes regulatory activities by businesses, government agencies, machines and individuals. When combined with George A. Miller's article, "The Magical Number 7 Plus or Minus 2," it is easy to wonder how human beings manage to cope with an increasingly complex society. Although the channel capacity of a human being is quite limited, versatility in conceptualizations is impressive. When combined with organizations that use the capabilities of many people and machines, the great variety of conceptualizations that human beings are capable of have so far been adequate to cope with great complexity. This paper will describe four strategies for amplifying management capability by combining organization with several fundamental types of conceptualization. As an example the paper will discuss the regulation of a country of several hundred million people.

REFLEXIVE MODELS OF COMPLEX ACTIVITY

Mikhail V Belov

Dmitry A Novikov

This paper presents methodological aspects of the reflexive models of “complex activity”. The unified formal model unit, named Structural Element of the Activity, and the procedure to form fractal hierarchies of these units, which describe complex activity as a whole entity, are introduced. We propose an approach to analyze the temporal and logical structure of complex activity (i.e., causing the fractality/hierarchies of the structural element of the activity), as well as generalize and identify six basic variants of the complex activity structures. The implementation of complex activity with the course of time and under uncertainty is analyzed. Different classifications of the structural element of the activity by several bases are suggested. An efficiency analysis of complex activity using the proposed structural element of the activity model is performed. The applicability of the structural element of the activity model is illustrated by examples: exemplar fragments of the activities of a large aerospace corporation, a local industrial enterprise and a large consulting company are presented.

REFLEXIVE GAMES OF THE HUMAN MIND: PEOPLE AS DOLLS AND DOLLS AS PEOPLE, PEOPLE AND AUTOMATS

Victor Borsevici

Anthropological and archaeological data corroboratively suggest that animism (i.e. human attempt to animate, or to attribute a soul to otherwise inanimate objects and concepts) is the earliest feature of human cultures. Dolls as cult objects play a special role.

There is not a big difference, as one may wrongly think at first glance, between the earliest finds of coarse stone or clay human and animal figurines, on the one hand, and modern electronic toys, such as Tamagotchi or Pokemon Go electronic characters, which have already generated a mass hysteria, on the other hand.

What is common between these stone, clay and electronic toys? And what is common between the earliest clay figurine of a thoughtful man and the well-known Rodin's Thinker? They all have one thing in common: the capability of the human mind to animate what is inanimate.

And what happens when we see a dancer who reproduces movements of a dancing robot? Or when we see a voter who "automatically" votes for his political leader and who behaves like a "political puppet"?

And what is the meaning of Walt Disney's famous Skeleton Dance and the modern concept of Disneyland in general, including the idea of a 'political Disneyland'?

This is a manifestation of something absolutely opposite and unexpected: the human ability to transform themselves into dolls – animate or inanimate objects.

A few centuries ago the great philosopher Baruch Spinoza, in his immortal Ethics, Demonstrated in Geometrical Order, in a number of wonderful "theorems" showed a human as an 'animated automat, driven by the laws of the mind'. And nowadays, another outstanding scientist Vladimir Lefevbre attempted to do the same in his "The Algebra of the Consciousness" based on his revolutionary theory of reflexivity.

What is in common between these two remarkable personalities, distanced from each other by several centuries, beside the fact that both of them belong to the same great tradition of Moses Maimonid, who became a link between Aristotle and modernity, as well as to the tradition of the first myth about "homunculus" – a clay Golem from Prague, who killed his creator?

The commonality between them is that one of them used the phenomenon of human reflexivity implicitly in his studies, by using the geometric (logical) method, while the other used reflexivity explicitly, by using the algebraic method. The latter defined reflexivity as a phenomenon whereas an individual has his own and the other's image in 'his head', and this other will also have his own and others' images in 'his head', etc.

Lefebvre's notation was a remarkable breakthrough in the field of mathematic modeling of reflexivity. For example, let's have two 'observing' subjects (X and Y) and one of many terms in this notation, e.g. Xyx. It means Xy imagined by X, whereas Xy is X as seen by Y.

However, in our opinion, under other conditions, this term can have another interpretation, whereas the term Xyx means X imagined by Yx, whereas Yx is an imaginary Y in X's head. For example, if X are 'Europeans' and Y are 'Russians', then Xyx is 'the imagined Europeans in the heads of the imagined Russians, as thought by the Europeans'.

It is noteworthy how concise and precise Lefebvre's notation is for the representation of reflexive images (which can be defined by computerized modeling or programs), in comparison to the very sophisticated and fuzzy verbal descriptions.

We offer to extend Lefebvre's notation by complementing the "observing subjects" with the "managing (controlling) subjects" and mark the latter with an apostrophe ('). For example, the term Xy'x will mean the following: subject X managed by subject Y as seen by X. In the latter case it is easy to imagine, for instance, a person realizing that he/she is managed (controlled) by Pokemon Go, or the European Union, realizing that it is managed (controlled) by its overseas partner, and so on.

Thus, our proposal to use the extended notation by Lefebvre enables us to describe and model reflexive systems and processes of conscientisation and management (control) with as many subjects as possible, both individual and collective, animated or imaginary. It also enables us to model their cooperation, conflicts and symbiosis within different social, economic, political and cultural interactions.

It seems that behavior of dolls and automats, sometimes, can be more human, than the acts and thoughts of human beings themselves.

THE EQUILIBRIUM IN THE SET OF REFLEXIVE STRATEGIES

Felix Ereshko

The ideas of the author concerning the reflectivity problem are based on the works of I.P. Pavlov, J. von Neumann, Y.B. Germeier, N.N. Moiseev, N.S. Kukushkin, V. Lefebvre, G. Soros, and V.E. Lepsky. In the classical papers by I.P. Pavlov (the 1904 Nobel Prize winner) and his followers, the theoretical postulates of the origin of conditioned and unconditioned reflexes were formulated and reflexive mechanisms were studied experimentally. A formal approach to describing the interconnection of the players viewed from the position of a perfect Observer follows [Y.B. Germeier]. The notion of an objective description of a game is used for this purpose.

George Soros's books were a second inspiration for the author. In these books Soros has developed the theory of reflexivity in application to economics as a whole and to stock markets in particular. Soros assumes that "participants' views form a part of the situation, to which they are related". They may influence substantially events and, in turn, are impacted by events. Such a mutual influence of participants Soros names "reflexivity". The present working materials contain the first formalized attempts of the author to study an insufficiently explored problem of reflexivity in the theory of decision – making. In this work descriptions of the reasonings of G. Soros and A.O. Cournot are proposed. The Soros model and a model of sharing a dynamic resource are briefly described. A reflective game model based on hierarchical games theory (Y.B Germeier) is investigated in more detail. In papers [Ereshko F.I., Y.B. Germeier] reflexive control was presented as a x(y), function – a response of the first player x to the probable control of the second player y.

Logical consistency of the task of decision - making demanded the addition of a set of auxiliary conditions concerning the information interaction of the players. A solution to the possible contradictions was found in a way of introducing the notion "first player's right for the first move" and the condition, that while choosing the concrete values of his controls the first player already knew the concrete choice of the second player, and the first player utilized his advantage in the manner of a dependence strategy of behavior x(y). If the situation differs from the one mentioned above, and the first player has no advantage in obtaining the information, then the use of the strategy x(y) can be considered logically consistent only as a hypothesis of the first player. Our further consideration is based on exactly such a description of the participants in the decision making process: we admit that every participant acts within the framework of some of his conceptions of the intentions, objectives and actions of the other participants and obtains information about his decisions a posteriori, i.e. after the act of decision-making and after the action has been accomplished. In this context his conceptions might be far from the real situation. In further speculations we are on the side of an abstract Observer of the events and describe their possible evolution. Unlike I. Newton we, as Observers, let players make up their hypotheses.

So, let the first player assume a hypothesis about the second player's payoff function, g(x,y) calculate the optimal response function for the second player yopt(x)= arg max g(x,y), and then calculate his optimal choice xopt=arg max f(x, yopt(x)).

The second player acts quite similarly, then calculates his optimal choice.

Denote the pair of the optimal player's payoff in this case as Reflex –solution.

If the players' hypotheses prove correct, then the calculation of the players' choices is described similarly. As above, this pair of the optimal player's payoff is called a Realsolution.

Then we discuss the question of how far the Reflex –solution may be from the Realsolution, depending upon how much the players err while hypothesizing about each other's objective function.

CONSTRUCTION-DECONSTRUCTION RECONSTRUCTION FRAMEWORK: A METHODOLOGY FOR INTERDISCIPLINARY RESEARCH

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This article is an attempt to cope with challenges arising when research activities are carried out within an interdisciplinary group (i.e. a group composed of researchers trained in different disciplines). While many issues could potentially emerge in such a context (e.g. Newell, 2001, and Youngblood, 2007), I target only one: the overspecialization process within disciplines that harms the group communication. This may result in isolating subgroups of people with similar background or misunderstanding the goal to be achieved by the project as a whole. An explicit methodology shared across disciplines may help in overcoming such a problem (although it may not be sufficient). Due to the characteristics of communication processes, I argue that such a methodology needs to be capable of dealing with reflexivity. Therefore, the methodology also becomes an interdisciplinary problem.

I have found in N. Luhmann's systems theory (1995, 2012), E. Morin's complexity thinking (1992, 2005) and (Malaina, 2015), G. P. Shchedrovitsky's methodological studies (1966, 1988) and L. Althusser's philosophical position about science (1990) the inspiration - and the first steps - to pursue such a research path. The methodology shall unfold as follows. Theories are constructed within a disciple. Then, they may also be deconstructed in specific ways towards a new reconstruction that fits the totality of the phenomena to be assessed by the interdisciplinary group. I propose that the operations of deconstruction and reconstruction shall map the phenomena into three layers: (i) a physical layer composed by material things and connections, (ii) an informational layer related to symbolic classifications, relations and exchanges, and (iii) a regulatory layer involving decisionmaking procedures, rules and relations. In the reconstructed form, the interactions occur between elements of the same layer and across different layers. The phenomena are then constituted of (and not reduced to) these layers. This multi-layer approach was described in similar terms by Midgley (1992) and was also employed in computational, agent-based studies that I co-authored with Künhlenz (2016).

As a theory itself, the proposed methodology can also evolve in overspecialized paths. At the same time, because the methodology is also a theory, it can always be assessed in the same way through meta-analysis. The proposed framework then needs to follow its own propositions to indicate the conditions that avoid overspecialized evolutionary paths.

A SILENT REVOLUTION IN REFLEXIVITY

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In the last decades the overall science system has made a very strong movement towards higher levels of complexity across various dimensions of research processes. This sharp increase has been widely described and is by and large accepted by the scientific community. What remains largely unnoticed or silent until recently is that the science system also experiences a complementary revolution in reflexivity. This silent revolution in reflexivity is as profound as the complexity revolution and can be characterized by three major developments.

First, the science system is undergoing a differentiation into three levels and types where first order science continues to perform as the science of exploring the world, zero-order science becomes a new trans-disciplinary field of research infrastructures which enables new investigations of first-order science and, finally, second-order science which reflects on the explorations of first-order science and acts as a quality control and as an innovation pump for the overall science system.

Second, scientific investigations are more and more conducted in a new epistemic mode which was originally proposed by Heinz von Foerster and which can be characterized as the mode from within or as the endo-mode, compared to a traditional mode from without or exo-mode.

Third, a large number of academic disciplines like the social and economic sciences, the cognitive sciences or the life sciences recognize the importance of reflexivity as a crucial element for theory and model formation.

The lecture will be focused primarily on the first two dimensions of this silent revolution in reflexivity.

REFLEXIVITY AS A CHANGE OF MENTAL MODELS

Carlos Cordoba

César García-Díaz

Nobel Prize winner Murray Gell-Mann once said "Imagine how difficult physics would be if electrons could think". This highlights the challenges social scientists have to face when studying systems composed of human beings, as opposed to natural phenomena. Despite the great advances in understanding these systems during the last 20 years, it remains true that it is still very difficult to deal with this "thinking" capacity in a way amenable to scientific research. Humans have developed important abilities by using this capacity, e.g. making tools to change their environment and communicate with each other through verbal language. Thinking also allows humans to ponder their actions and to change their behavior in endogenous ways. We have decided to term this last ability reflexivity. In this work we propose an agents-based model to study reflexivity as understood as this type of process.

SECOND ORDER SCIENCE AND AUTOREFLEXION: CYBER-SYSTEMIC PERSPECTIVES

Denis Zhurenkov

Since the second half of the XX century there has been an exponential growth of technological advances, along with the differentiation of Sciences. Today we can say that the fundamental science is ahead of technology, and the resulting backlog is now being implemented in new technologies. However, the lack of mass "request" from the technology to fundamental science is not conducive to intensive development. An interdisciplinary approach is becoming a major scientific approach, and it must operate for a variety of sciences common results and laws. Crisis management in the problems of social systems is impossible without a search common to all areas of knowledge of the conceptual foundations of management, create a communicative space for representatives from different areas of knowledge related to management issues and organization of the moderation of their joint activities. These objectives are reflected in the different interpretations of an interdisciplinary approach. Unlike Wiener's cybernetics, secondorder cybernetics is conceptual and philosophical. Moreover, today the role of reflexive activity increases and communicative reflexive activity (V. Lefebvre, S. Umpleby, K. Müller) is becoming a major problem. Going from the management of the "subject - object" paradigm to a "subject - subject" paradigm led to the formation of new types of management: reflexive control, information management, active control systems.

Becoming paradigm "subject - self-developing poly subject environment" is inextricably linked with the development of a subject-oriented approach. This approach is a natural development of the subject-activity approach, with increasing attention to the subjects and their environment, and with a decrease in attention to activity-related component due to a sharp reduction in the impact of the regulatory component of the actions of the subjects in the conditions of modern reality. In the context of scientific rationality is clearly visible and the evolution of species from the classic management control to the "soft" forms of management through social media. Fundamental changes are occurring in management models, particularly striking changes are in the macro social systems - from the dominance of human-dimension models with extensive use of mathematical models.

The focus of post-non-classical scientific rationality is the ethics of strategic subjects selfdeveloping media, focusing particularly on the problem of preserving the integrity of the subjects and their assembly. In the context of post-non-classical scientific rationality [missing a noun?] takes place to ensure the integration of control mechanisms specific to the integrity of all types of scientific rationality. Accordingly, there are three mechanisms to ensure the integrity of the target: classical, non-classical, and post-non-classical. If in the context of classical and non-classical scientific rationality second-order cybernetics, providing the control problems were classic and cybernetics were providing the control problems, then in the context of post-nonclassical science, the centers of governance issues move into philosophy, synergy, political and economic sciences.

Actual problems of the institutionalization of areas of knowledge management to ensure responsive, perhaps it will be replaced by a third-order cybernetics (cybernetics of selfdeveloping environments). For second-order cybernetics, the key terms are: recursive, self, reflexion. A promising area of cybernetics development is the development of the theory based on the ideas of autoreflexion. Third order cybernetics could be formed on the basis of the thesis "of observing systems to the self-developing systems." At the same time managing to gradually transform into a wide range of processes to ensure selfdevelopment systems of social control, encouragement, support, moderation, organization, "assembly and disassembly" of subjects (V.E. Lepskiy). This approach is one of the ways the evolution of cybernetics and claims the new mainstream of classical cybernetics. Relevant are the following management tasks classes: network-centric systems (including military applications), information management and cyber security, lifecycle management of complex organizational-technical systems, systems engineering activity. Promising areas of application are: living systems, social systems, transport, and energy

PROBLEMS AND PARADIGMS IN HUMAN INTELLECTUAL ENDEAVOUR

Janos Korn

In order to understand parts of the world in the course of their navigating in it, human beings construct mental or physical 'images' of these parts. These images have been evolving throughout the 'human intellectual endeavour' as their shortcomings or 'problems' had been realised and corrective intellectual action taken usually through 'paradigm changes'. One of these hugely significant images affecting lives and society is 'conventional science of physics'. However, when confronted with 'issues of problem solving' presented by scenarios with more than a single object in relations especially with living, in particular human, components, methods of conventional science have limited applications. On the other hand, the methodology of conventional science is a powerful means for constructing images. These issues are regarded as problematic so the intention of current work is to introduce a paradigm change to a 'new science of systems' which makes use of the methodology of conventional science but with 'systemic' content. This science is offered for debate of acceptability [Korn, 2009, 2012, 2013, 2016]. In particular, the objective of this paper is to discuss a number of concepts arising in this 'new science' and to place it in the historical context of human intellectual endeavour.

Notion of change

The dictionary describes the concept of dynamic verb 'to change' which somewhat modified is : 'To make the form, nature, content of things, present or future course of events, minds, opinions and so on different from what it is or from what it would be if left alone [Anon. 1995]. This description implies the presence of : An initial state [IS] which is regarded as problematic in some ways otherwise there would not be a change or an alteration, A final state [FS] which gives direction to and hopefully resolution of the change, and A mechanism or a 'system' or an 'active structure' which is intended to accomplish the transformation from IS to FS. The initial and final states must be consistent otherwise a mechanism or process could not exist. Consistency is judged by the kinds of 'properties' carried by the 'empirical objects' involved in a change.

Nature of change

An 'empirical object' is described as one that can be detected by the senses of an observer through perceived 'properties' as opposed to a 'theoretical object' which is expressed by a 'structure of statements of the subject predicate' form [Korn, 2016]. Both kinds involve a degree of 'interpretation' which can cause misunderstandings. Any change of state involves an 'empirical object' physical or mental which carries the change. The senses carry the physical properties seen to be involved in a change to a brain/mind assembly of a living thing which transforms them into 'thoughts' for generating, or not, action.

When action is initiated by an observer to be performed by an aggregate of interacting objects, we speak of '1st order cybernetics', when the observer itself takes part in the action we have '2nd order cybernetics' [Umpleby, 2000]. The latter case can occur in 'purposive systems with feedback' [Nice, 2008, Korn, 2012, 2016].

Changes take place in parts of the 'Inanimate, natural world' due to action by mechanical [volcano, earthquake, tornado…], electrical [lightning…], chemical [burning by lava…] effects arising by chance, ‘Animate, natural world’ including ‘humans’ due to accidents by chance and intentionally according to purpose, ‘Social world of living things’ due to accidents by chance and intentionally according to purpose, ‘Artificial world’ due to accidents by chance and intentionally according to purpose by control and computer systems.

Purposive activity is as common in the living sphere as the phenomenon of gravity in the material sphere. It has been operating since times immemorial and structurally has not altered.

Images of parts of the world

In ancient times people looked around their surrounding including the heavens and attempted to express their thoughts which they communicated, or not, to their fellow human beings perhaps first by means of natural language. Natural language is the immediate symbolism for representation of aspects of parts of the world called the ‘primary model’ and has served as a means for navigating in the world. It can do this due to its structure or syntax of ‘subject – predicate’ which reflects the structure of parts of the world and is considered innate in humans with semantics learnt in the course of growing up [Chomsky, 1965].

Based on natural language a vast variety of other models have been invented : Systems of gods, mysticisms like astrology, superstitions like omens, all requiring an ‘intermediary’ for interpretation of aspects of parts of the world. They eventually were superseded by conventional science of physics which observed a part of the world directly and formulated relations between concepts of selected aspects in terms of mathematical models and formulated explanatory hypotheses sometimes of great generality [Pledge, 1966].

Great achievements of physical constructions like pyramids, aqua ducts, cathedrals, railways etc and a huge variety of artefacts together with intellectual accomplishments in the arts and sciences have been realised by humanity as ‘products’. Remains of these have survived and are in use by people but the ‘systems’ or ‘active structures’ which created them by and large have disappeared. It is astonishing that this huge accomplishment still going on, has taken place practically without a supporting ‘systemic or engineering theory’ [Lewin, 1981].

Although the term ‘system’ has been in use since ancient times like solar system and its use is popular today, there has been scare theoretical development in this field of experience. Attempts have remained at the speculative level resulting in fragmentation of this essentially ‘unique phenomenon’. A large and significant approach hit the intellectual field in the form of ‘control theory, before and during the 2nd WW followed by another initiated by von Bertalanffy and associates in the 1950 which has led to a vast effort of publications, conferences, sporadic teaching and models with ill defined concepts [Bertalanffy, 1950].

Models as stories or description of parts of the world real or imaginary as natural language are immediately comprehensible to those familiar with a language. Other models have been created like mathematical models which are capable of computation, diagrams of large variety which display structure, artistic works and designs and so on. All models require the selection of their own ‘invariants’ like quantifiable concepts of a mathematical model, labelling of a diagram, colours and shapes of a painting which can then be used for creating relations to form the selected ‘model’ of a ‘whole’.

There is a great deal of uncertainty and lack of understanding in selecting invariants called the ‘methodological problem’ which leads to a ‘model’ which is not possible or difficult to ‘read’ or to reproduce its original comprehensible natural language form. If this form is regarded as ‘faithful’ representation of a part of the world then another ‘model’ may be regarded as a distorted form. The ‘methodological problem’ can be solved by using natural language itself for the development of a ‘linguistic model’. ‘General principles’ and linguistic modelling in its operational form is the basis of development of a ‘new systems science’ which constitutes the current paradigm change.

This science if debated and turns out to be acceptable, is intended to be the ‘science of structure of related [in static state] and interacting objects [in dynamic state]’. It is friendly to problem solving and design or engineering [Lewin, 1981], based on accepted branches of knowledge, eminently teachable at all levels and can be used for modelling living and human activity scenarios i.e. it is not sensitive to boundaries of disciplines, can include particular methods of conventional science for working out specific problems associated with single objects, unlike conventional science it can cope with ‘irregular occurrences or behaviour’. Thus, ‘systems and conventional sciences’ together produce the ‘scientific enterprise’. Software development for simulation in time is still needed.