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# TOWARDS SUSTAINABLE SECURITY: COMPLEX DYNAMIC SYSTEMS AND LEADERSHIP

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**Abstract.** There is neither one obvious power acting on the world, nor obvious balance of power and long-term peace and stability. The paradigm of complex dynamic systems would allow understanding more clearly the real order of the world that cannot explain the dominating old mechanical paradigm. Complex dynamic systems have characteristic features and act in many fields where leadership becomes inefficient when following mechanical paradigm.

**Keywords**: sustainable security, complex dynamic systems, leadership, chaos, order, management, organization, members

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## I. Introduction

Security, sustainability facets, security and sustainability interrelations are widely discussed in scientific literature (Matyasik 2014; Norkevičius 2014; Mačiulis, Tvaronavičienė 2013; Vosylius *et al.* 2013). Complex systems and leadership are seen as factors directly affecting sustainable security proxied by military.

The terms "warfare" and "leadership" became inherent. Both a serviceman and a leader act in response to arising challenges and problems and solve them in the most efficient way. The General Jonas Žemaitis Military Academy of Lithuania trains future commanders-leaders. "The graduates of the Military Academy of Lithuania are expected to be competent and responsible leaders. How are they prepared for that? How will they hold values, use their skills and overcome challenges?" (Kanauka 2013).

A leader's actions are influenced by a present situation. The future commanders-leaders of the armed forces are trained to act in unfavourable conditions and crisis situations by overcoming the impact of stress. In such circumstances future commanders have to be able to make rational decisions, mobilize their troops and command them in order to perform a mission anytime and anywhere. As difficult and stressful circumstances cannot be accurately forecasted and it is difficult to get prepared for them, it is aimed to train commanders-leaders who are capable of adapting to potential circumstances and undertaking efficiently their tasks.

The world is changing; therefore, this change is continuous and unpredictable. Reviewing earlier forecasts of analysts and experts of different fields after some changes, inaccuracy of forecasts appears. Heads of states

emphasize permanent global change that is not always beneficial. In his speech to the graduates of the United States Military Academy in West Point, the President of the United States Barack H. Obama said: "Four and a half years later, as you graduate, the landscape has changed. But the world is changing with accelerating speed. This presents opportunity, but also new dangers" (Obama 2014). Rapidly changing world brings new threats and dangers. Twenty years ago, U.S. President George H. W. Bush gave a speech to the graduates of the United States Military Academy in West Point. He said: "A half century has passed since that day when Stimson spoke of the challenge of creating a new world. You will also be entering a new world, one far better than the one I came to know, a world with the potential to be far better yet. This is the challenge. This is the opportunity of your lifetimes" (Bush 1993). In his speech to the graduates of the United States Naval Academy ten years ago the U.S. President said: "And in the decades ahead, the changes will be even more dramatic. In the years ahead, you will see dramatic changes taking place all around you" (Bush 2005). The U.S. Secretary of Defence Caspar W. Weinberger talked about the challenges 30 years ago too: "[...] when we must remain ready to consider the means to meet such serious indirect challenges […] we face difficult challenges […] we can meet the challenge posed by the unfolding complexity of the 1980's" (Weinberger 1984).

Challenges and dramatic changes arise continuously in the development of the world. These changes are dangerous but providing new opportunities. The world is as it is. Leaders have to step into the world that reveals complexity and becomes a challenge to leaders. It cannot be ignored or avoided as it will be one of the most serious leadership problems in the U.S. One cannot turn a blind eye to reality. It is necessary to monitor carefully changes and understand, evaluate and react appropriately to them. Global leadership requires us to see the world as it is, with all present threats and uncertainty. Facing arising challenges have to be an important part of American leadership. "We can't ignore […] to meet the demands of today must be a critical part of American leadership" (Obama 2014). Uncertainty, as a new factor, furthers challenges and dramatic and dangerous changes. There is a lack of clarity and it is not long-term. Obscurity and uncertainty are inevitable as a situation cannot be clear for a longer period of time. "In this era of surprise, we cannot know for certain […]" (Bush 2005). Future leaders might confront new challenges. Although the times are changing, tendencies remain. Unprecedented challenges are expected. "We have faced trials that were not foreseen [...]" (Obama 2014). "[...] we face a threat with no precedent" (Bush 2002).

There will be lots of challenges and threats and their reasons or origin will be unknown. They are almost inevitable. Having avoided some challenges, a crisis will arise nevertheless. "Because we face a spectrum of threats […] yet, while the source and nature of today's challenges are uncertain [...]" (Weinberger 1984). Leaders confront challenges and crises that are unavoidable in dramatic situations. Addressing them might require fighting and taking risk that lead to losses. "The bicentennial class of West Point now enters this drama […] you will face times of calm and times of crisis" (Bush 2002).

It is a modern world and people have been talking a lot about it. The presidents of the superpowers talk to the graduates of military academies or servicemen. New challenges, dramatic crises. It is a chaotic world. Threats arise where they are not expected and the origin of danger is not always obvious. The limits between open conflicts or hidden unfriendly actions are eliminated and it is impossible to forecast an initiator or time and place it might appear. Complex relations or interaction balance at the edge of an open conflict but may not necessarily lead to it. Leaders have to be able to deal with threats, counter them and get prepared for a crisis if it hits unexpectedly. It needs preparation. Future leaders have to be trained to be ready to fight in any circumstances, with any means, in any way and for any reason. "Yet, so blurred have the lines become between open conflict and half-hidden hostile acts that we cannot confidently predict where, or when, or how, or from what direction aggression may arrive" (Weinberger 1984). "In the complex new world we are entering […] we must engage ourselves if a new world order" (Bush 1993). "In this time of unprecedented dangers […] in our time, terrible dangers can arise on a short moment anywhere in the world, and we must be prepared to oppose these dangers everywhere in the world" (Bush 2005). "You graduate from this academy in a time of war […] this war will take turns we cannot predict. […] From this day forward it is your challenge as well. And we will meet this challenge together" (Bush 2002). "Our war on terror is only begun" (Bush 2002). "And already, we see disturbing signs of what this new world could become if we are passive and aloof. […] Two hundred

years ago, another departing President warned of the dangers [...]" (Bush 1993). "Difficult and dangerous work remains […] in this new era of warfare [...]" (Bush 2005) "...and continuing challenges here at home [...]" (Obama 2014).

It is necessary to understand what needs to be changed and how. We have to restructure, reorganize and reconstruct as well as to keep in step with the changing world, change mechanism or structure, ascertain and determine what we need, aim for, want and lack to achieve or have. Reorganizations and changes await us. "This success has brought our nation, once more, to a moment of transition. […] Even as our forces prevail in today's missions, we have the opportunity – and the responsibility – to look ahead to the force that we are going to need in the future. […] to clarify our strategic interests in a fast-changing world" (Obama 2012). "Now, just as the world has changed, this architecture must change as well" (Obama 2014).

There were mistakes that we have learnt from, we cannot repeat them, but will it help to avoid other mistakes in the future? We will have to overcome the resistance of people and colleagues from close environment who will be against the reorganization necessary for the future or will support different changes. "We can't afford to repeat the mistakes [...] when our military was left ill prepared for the future" (Obama 2012). "The opponents of change are many, and its champions are few, but the champions of change are the ones who make history" (Bush 2005). Future leaders will not be able to ignore the reality – fast-changing world, challenges, crises, unexpected threats with no clear limits. It's a chaotic world where leaders will perform endless transformations and mistakes will threaten their actions. Their comrades and people from close environment will resist changes. The length of such a chaos is not clear. We don't know whether or not we will ever achieve stability and peace and leaders will be able to relax and people could enjoy peace and clear future. Such a chaotic world is not explored and has no laws or powers that influence it and cause chaos.

An "ordered and reliable" system of organizations interacts with the real chaotic world. "Here is the real world as described in the new sciences of living systems and complexity theory. It is a world of interconnected networks, where slight disturbances in one part of the system create major impacts far from where they originate" (Wheatley 2007). "Reliable, ordered and predictable management systems and mechanisms created by people can exist efficiently in laboratory conditions, but in the real world that is characterized by chaos, these mechanisms and systems become not as efficient and meet many difficulties and disorder. Chaos is not a disorder, it is a complex order. The behaviour of living systems is shaped not by order, but by disorder – a complex order" (Skurvydas 2008). By trying to comprehend the behaviour of the complex dynamic systems (CDS), the focus is on the system adaptation process and conditions/circumstances that have an impact on the creation of the new order. The focus is also turned to the prolonged adaptation process of a system that is on the edge of a chaos. If a new order spontaneously emerges from a chaos status, it is called self-organization (Kaufmann 1993, 1995; Coveney, Highfield 1995; MacIntosh, MacLean 1999; Stirling 2013). If a CDS is a subject to impulse or input, the system's response is not clear or forecasted as the output may be evident in all possible ways. Such a great number of possible system responses and variants relate to high-level uncertainty and instability (MacIntosh, MacLean 1999).

Order and laws incomprehensible to a man are called chaos and an order created by people is applied. This order does not work well for people as they act in accordance with a chaotic order of the world instead of coherent system designed by people. Organizations established by people are overwhelmed with a chaotic order instead of efficient coherent system developed by people; therefore, it is necessary to improve an organization according to a desired order. The interaction of such organizations increases the level of chaos and thus even bigger disorder of the world – laws of the world – prevail. People keep developing, management tools become more and more powerful; however, chaos still rules. When do we notice the reality of organizations? Organizations typically become evident to us when a problem or crisis occurs. Organization's ability to survive is revealed when a crisis hits.

## II. Complex Dynamic Systems (CDS)

### *2.1. What are CDS? When were they first researched and by whom? CDS Scientific Paradigm*

Complex systems are a contrast to the classic conception of the linear mechanical order of the world. Researchers who thoroughly researched and described CDS are as follows: Thomas C. Shelling, U.S. economist and Nobel Prize winner who was one of the first researchers to describe complex dynamic systems that are able to change themselves, and Ilya Prigogine, Nobel Prize Winner who researched substance and energy flow through complex systems and described them as a dissipative structure – an open system that maintains itself in a state far from equilibrium. Dissipative structures produce new forms of order that arise spontaneously in a complex system when it is far from equilibrium, at "the edge of the chaos." When the flow of energy increases, the increased activity produces instability and "bifurcation" results. At this point, reorganizing occurs – self-organizing that results in the emergence of a new structure for coherence and efficiency. Without dissipative structures and exchange with the environment, entropy would result.

Complexity theories are increasingly being seen by academics and practitioners as a way of understanding and changing organizations. The popularity of the CDS theory increases and researchers consider it as a way to understand and change organizations (Schelling 1978; Prigogine 1997; Burnes 2005; Fouda, Koepf 2014). The theory is put to the test in practice. Complex systems are called chaotic systems, systems of systems, complex adaptive systems and non-linear systems. In this article they are called complex dynamic systems (CDS) (Skurvydas, Mamkus 2000; Skurvydas 2008, 2010, 2011; Wilson 2013).

The new CDS paradigm encourages facing the reality. The behaviour of the CDS is dynamic, spontaneous, chaotic, unpredictable and non-linear, while the order of the CDS is a chaotic order as today the chaos is perceived not as a disorder but rather as an order that is recondite and difficult to manage. Following the laws of the CDS, an original, unique, unpredictable and fragile order is formed. There is no sole world-creating power, there are many of them and they are constantly changing (Gell-Mann 1994; Bak 1996; Bar-Yam 1997; Prigogine 1997; Holland 1998; Kauffman 2000; Hilborn 2000; Skytner 2001; Laszlo 2002; Burggren *et al.* 2005, Skurvydas 2008, 2010, 2011; Taleb 2010; Anzo, Barajas-Ramirez 2015).

Researchers have doubts about determinism and the order created by people with the help of which the world should be efficiently ruled. Efforts are undertaken to establish and comprehend the laws of the CDS. It is considered that better results and more efficient activities will be achieved by applying the laws in practice than following presently dominating mechanical deterministic conception.

### *2.2. Features and Characteristics of the CDS*

The laws of the CDS are used to explain some obscure and unexplained chaotic phenomena of the present and past. The researchers define the following CDS features:

**1. Dynamics.** The law of dynamics is undoubtedly one of the key CDS laws as it describes the most common CDS behaviour patterns: behaviour of self-adjusting systems is formed over time, i.e. every time a new feature is formed according to the same rules. If the same feature is formed, most probably it happened in accordance with other rules. We may assume that a precise meaning of the CDS feature always manifests only with some probability (Bak 1996; Skurvydas 2008, 2010, 2011).

**2. Multistability.** Dynamic system aims to be stable. As there is no absolutely stable status and there are lots of statuses, dynamic system moves from one status to another by looking for a more stable one; however, unsuccessfully as a live system does not stay long in one place. In order to understand the concept of equilibration, one must think of it as a dynamic process in an organism functioning at far from equilibrium states, not as a static equilibrium. It is not a sequential process of assimilation, then conflict, then accommodation; it is not linear. Equilibration is instead a non-linear, dynamic "dance" of progressive equilibria, adaptation and organization,

growth and change. It results from "coupling" with our surround. The self-organization effect is observed *globally* when the system transits from a chaotic disordered state to a stable one (Fosnot 2005; Serugendo *et al.* 2011; Skurvydas 2008, 2010, 2011; Stirling 2013).

Non-linear systems have in general several stable states, and this number tends to increase (bifurcate) as an increasing input of energy pushes the system farther from its thermodynamic equilibrium. To adapt to a changing environment, the system needs a variety of stable states that is large enough to react to all perturbations but not so large as to make its evolution uncontrollably chaotic. In some cases, a relative equilibrium settles for a certain period of time. It satisfies all the parts of the CDS; however, it cannot be violated. "The failure of communism has shown that the market is much more effective at organizing the economy than a centrally controlled system. What Adam Smith, the father of economics, called "the invisible hand" can nowadays simply be called self-organization" (Heylighen 2001).

**3. Irreversibility (characteristic of behavior).** The CDS is always in a different status. Its behaviour direction is "complex" as it moves to the so-called "complex attractor". Thus, it "conquers" new spaces. It is a CDS globalization process – new links and interaction with environment. The CDS "live" at "the edge of chaos" or is in the process of constant search, instability, possible mistakes and doubts (Skurvydas 2008, 2010, 2011). An "attractor" is a form of a system behaviour that regulates (attracts) the behaviour of the whole system that looks chaotic at first sight.

**4. Self-regulation.** As the CDS has a self-regulating power, it "dislikes" being controlled from outside (Adami 2002; Higgins 2002; Strogatz 2003; Skurvydas 2008, 2010, 2011). We can say that the CDS "self-regulates from inside". Self-regulation often takes place spontaneously under a different scenario; however, it does not mean that the CDS does not react to environmental changes. Several strategies of the interaction between the CDS and environment are possible: a) CDS adapt to environment; b) CDS create environment; c) CDS look for the most suitable environment (Skurvydas 2008, 2010, 2011).

This spontaneous emergence of order at critical points of instability is one of the most important concepts of the new understanding of life. It is technically known as self-organization and is often referred to simply as "emergence." It has been recognized as the dynamic origin of development, learning and evolution. The CDS ability to learn and creativity is a base for adaptivity as well as the ability to adapt to present environment and act efficiently. In other words, creativity – the generation of new forms – is a key property of all living systems. And since emergence is an integral part of dynamics of open systems, we reach an important conclusion that open systems develop and evolve. Life constantly reaches out into novelty (Capra 2002, p. 14). Intuitively, self-organization refers to the fact that a system's structure or organization appears without any explicit control or constraints imposed from *outside* the system. In other words, the organization is intrinsic to the self-organizing system, and it results from *internal* constraints and mechanisms, which are based on *local interactions* between its components. These interactions are often *indirect* and are carried out through the environment. Self-organization and emergence are not perfect; units in a self-organizing system are prone to opposing actions, their behaviour may induce needless redundancies, and decentralized control limits the ability of the system to find a globally optimal solution. However, for systems that are complex and operate in a dynamic environment, the use of self-organization offers significant advantages, such as increased scalability, robustness, reduced communication and unit processing costs. Social behaviour of humans is typically self-organizing, and it normally gives rise to emergent complex global behaviour. In many cases, individual human behaviour is based on small-range local information, and communication is carried out on local direct or indirect interactions, which produce complex societal behaviour. As complex systems, organizations exist far from equilibrium where the ongoing interaction of system components leads to emergent and self-organizing behaviour. A central principal of complexity theory is *emergent self-organization*, whereby systems achieve order because multiple local agents interact and those interactions produce unintended outcomes without the intervention of a central controller (Plowman *et al.* 2007; Chiles, Meyer & Hench 2004; Skurvydas 2008, 2010, 2011; Serugendo *et al.* 2011).

**5. Transformation.** It is a capacity to create a fundamentally new system when ecological, economic, or social (including political) conditions make the existing system untenable. It may prove necessity to configure an entirely new stability landscape – one defined by new state variables or the old state variables supplemented by new ones. The changes cascade through and may transform the whole panarchy with all its constituent adaptive cycles. Transformation explains the relations between the parts, how one part becomes another. It describes the process involved in the changing nature of the parts. Each structure is also self-regulating, meaning that structures inherently seek self-maintenance, organization and closure (Walker *et al.* 2004).

**6. Open to changes.** Life is the opposite of stasis. Isolation and stasis over time would result in a system running down – entropy and death. Natural selection increases the diversity while at the same time deselecting some of the possibilities. It also thriftily conserves the activity and self-organization accomplished at each stage so that it does not have to be done over again. Organizations are complex evolving systems. Just about all the things going on in organizations are complex interactions of people, changing technology and environment. Changes happen all the time (Dennett 1995; Fosnot 2005; Knowles 2014).

**7. A system cannot be accurately defined or forecasted.** It is impossible to forecast accurately the bahviour of the CDS and the beginning and end of catastrophes. Coincidence and chaos play a significant role in explaining the behaviour of the CDS. Every behavioural "mistake" (that is impossible to avoid and that can be internal or external) of the CDS may spontaneously and unexpectedly change the direction and tempo of the CDS that is a deterministic system and operates only in certain stages and usually in artificial conditions. The CDS behaviour can be forecasted only in short periods and by knowing that any detail can destroy any forecast. Often "a detail" is not a detail because it can multiply and cause unpredictable behavioural changes of the whole system. As a result, in the original disordered state of the system, distant parts of the system are basically independent; they do not influence each other. Knowing the configuration of the components in one region would give no information about the configuration in another, non-contiguous region.
If a faculty believes that an institution exists to support them, they are not actually living in the 20th century. God knows what will happen in the 21st century. They will find themselves in the non-sustainable isolation. It is not clear what will happen in the future because institution's forecasts cannot be blindly trusted and if they are, it is a feature of the past and not present behaviour. Reliance on forecasts can lead an institution to unfavourable situation (Bak 1996; Bar-Yam 1997; Prigogine 1997; Wheatley 1997; Heylighen 2001; Higgins 2002; Laughlin 2005; Skurvydas 2008, 2010, 2011).

**8. The whole is more than a total of the elements.** If we know the elements of the whole, it is still unknown. Biologically, the brain is a complex system composed of a set of neurons and interactions between them. Although conscience is a result of neuron operations done at a lower level, it is currently not possible to understand or explain human conscience by observing the brain neurons and their interactions. For example, an important reason that has historically triggered collective behaviour in natural societies is the ultimate goal of species survival. This goal is not explicitly expressed at the individual level, but it is reflected in the collective behaviour of society members towards the emergence of *social functions* and group dynamics allowing the maintenance of the system's organization (Serugendo *et al.* 2011; Lindberg, Schneider 2012).

**9. A process makes a structure.** Structures are human constructions – cognitive mental systems with transformational laws that apply to the system as a whole, not only to its elements. Those organizational designs that are based on the holographic principles of connectivity, redundancy and self-organization facilitate innovation and rapid change adaptation. An advantage that today's organizations have is that through information technologies they can very easily transform themselves into holographic entities and thus eliminate the bounded rationality that may characterize them.
Formally, the basic mechanism underlying self-organization is the (often noise-driven) variation, which explores different regions in the system's state space until it enters an attractor. This precludes further variation outside the attractor, and thus restricts the freedom of the system's components to behave independently. This is an equivalent to the increase of coherence or decrease of statistical entropy that defines self-organization. The idea is very simple: the more widely a system is made to move through its state space, the more quickly it will end up in an

attractor. If it would just stay in place, no attractor would be reached and no self-organization could take place. Even when a community's actions conform to an external mandate, it is a community – not a mandate – that produces the practice. In this sense, communities of practice are fundamentally self-organizing systems (Wenger 1998; Heylighen 2001; Walker *et al.* 2004; Kontoghiorghes *et al.* 2005).

**10. Synergy.** Dissipative structures that are characteristic of synergy. Generally, the emergent phenomena are an externally identifiable outcome, for example, particular pattern or structure, property, behaviour or system state, which, although not explicitly represented at a lower level, appears at a higher level. That complex collective behaviour usually occurs without *any central control*, and it is derived from the simple local individual behaviours and interactions, who analyzed lasers and similar collective phenomena, was struck by the apparent cooperation or synergy between the components (Heylighen 2001; Serugendo *et al.* 2011). Cooperation and synergy (interaction) are characteristic of the CDS elements.

**11. Spontaneity.** Spontaneous collective behaviour when a leader is not clear or he/she is not present. During spontaneous movement the CDS elements maintain minimal distance from each other (Skurvydas 2008, 2010, 2011). Having input and output (the input-throughput-output component and their interactions both within themselves and with the external environment).

**12. Adaptation.** It is an ability to adapt that is related to continuous learning from goal-directed experiments (learning from mistakes). A change adaptation is defined in terms of the extent to which an organization can adapt to changes rapidly. Relationship between learning organization characteristics and organizational outcomes of change adaptation, innovation and bottom-line performance demonstrates how democratic and open systems, which allow employees to think, challenge the operating norms of the organization be creative and take risks, ultimately transform themselves into innovative and rapidly adapting entities capable of coping with highly complex and rapidly changing environments; conceptual framework with regard to the association between learning organization practices and change adaptation, innovation as well as bottom-line organizational performance.
The CDS adapt when a crisis hits external factors or during reorganization of a system. Adaptability is the capacity of actors in a system to influence resilience. A characteristic feature of complex adaptive systems is self-organization without intent. There are two types of system modes: fast and slow adaptation modes. System modes are liable, i.e. they may change rapidly. Rapid changes of behaviour are observed during critical periods; therefore, we can say that a catastrophe strikes. Other features, such as continual adaptation to changing environment will only be exhibited by the more complex systems, distinguishing, for example, an ecosystem from a mere process of crystallization (Levin 1998; Heylighen 2001; Walker *et al.* 2004; Kontoghiorghes *et al.* 2005; Skurvydas 2009; Wilson 2013).

**13. Self-organizing crises or catastrophes that are characteristic of behaviour.** It is believed that it is **impossible to predict accurately the beginning or end of a catastrophe** because any CDS behaviour "mistake" (that is impossible to avoid and that can occur in the inside and outside) can spontaneously change not only the direction of the behaviour but tempo as well. Crises allow CDS cleaning excess and, if necessary, updating missing elements. Consequently, a CDS crisis is an inevitable feature of such systems behaviour. The more dynamic the system, the more self-organizing the crisis. It is encouraged to know better the interaction of the CDS elements instead of the elements alone as the behavioral feature of the CDS as the whole is more than the total of their elements. As a result, we cannot make a decision about an element by the whole of the DS as well as to understand the whole by the behaviour of an element. A common characteristic of physical self-organizing systems is the existence of some *critical threshold*, which causes an immediate change to system state when reached. That critical threshold can be a combination of values of certain system variables (Prigogine 1997; Rose 1998; Higgins 2002; Adami 2002; Strogatz 2003; Perkiomaki *et al.* 2005; Laughlin 2005; Skurvydas 2008, 2010, 2011; Serugendo *et al.* 2011).

**14. Resilience.** Resilience is the capacity of a system to absorb disturbance and reorganize while undergoing a change so as to still retain essentially the same function, structure, identity, and feedbacks – in other words, stay

in the same basin of attraction. Because of the possibility of multiple stable states, when considering the extent to which a system can be changed, return time does not measure all of the ways in which a system may fail – permanently or temporarily – to retain essential functions. Adaptability is the capacity of actors in a system to influence resilience (Walker *et al.* 2004).

**15. Attractor.** In all systems, an important issue is their capacity to deploy the effective global behaviour that permits the realization of their intentional or non-intentional goals. Non-linear systems have in general several attractors. When a system resides in between attractors, it will be in general a chance variation called "fluctuation" in thermodynamics that will push it either into some attractors. The CDS has several attractors and moves to them but its priorities can change (Heylighen 2001; Serugendo, Gleizes, Karageorgos 2011).

**16. The absence of centralized control.** Some of these features, such as the absence of centralized control, are shared by all self-organizing systems, and can therefore be viewed as part of what defines them.
Communities of practice exist in any organization. Because membership is based on participation rather than on official status, these communities are not bound by organizational affiliations; they can span institutional structures and hierarchies. This living process results in a much richer definition than a mere institutional charter. As a consequence, the boundaries of a community of practice are more flexible than those of an organizational unit. The membership involves whoever participates in and contributes to the practice. A community of practice's life cycle is determined by the value it provides to its members, not by an institutional schedule. It does not appear the minute a project is started and does not disappear with the end of a task. It takes a while to come into being and may live long after a project is completed or an official team has disbanded. To be effective, therefore, managers and others must work with communities of practice from the *inside* rather than merely attempt to design them or manipulate them from the *outside.*
We are making a transition from hierarchical forms of organization to this web-like creation. They self-organize like crazy into different groups. It changes them. It changes their work. Ultimately, they are ignoring the existing structures (Wheatley 1997; Wenger 1998; Heylighen 2001).

**17. Summary.** As the systems or their elements form (usually spontaneously) original features of a system or a system as the whole by interacting and it is impossible to comprehend all the interaction cases, a more possible way to know systems or their elements is not only the search of mechanisms but dynamic features as well. A dynamic phase space of system functions is suitable for that. It is necessary to recognize not only the dynamics of the system functions but also the dynamics of the interaction of the systems functions as the whole as it is more than a total of elements. If we know elements, it does not mean that we know the whole (Hilborn 2000; Skurvydas 2008).

### *2.3. The Fields of the CDS*

The CDS have a characteristic behaviour and peculiarities that are different from mechanical concept organizations. The features are usually very different when compared to mechanical deterministic theory.

**Issues.** Evolution has played a key role in the formation of complex systems or systems of systems (SoS) in the areas such as society, biology and the military. One of the interesting aspects in comparing these systems is in the trade between interdependence and the ability for the systems within the larger system to act independently. In the evolutionary process individuality was more dangerous than living in groups. People could easier defend themselves in groups and hunting was more successful (Bar-Yam *et al.* 2004).

**Cellular biology.** Plants and animals are extremely adaptable, living in the majority of environments presented on the Earth. The level of adaptability achieved by plants and animals has come at the cost of independence, at least in the case of Mitochondria, which was once a bacterium. The evolution of cellular biology has led to the high levels of interdependency, at the loss of component independence (Bar-Yam *et al.,* 2004).

**Society.** Humans are mammals, the majority of which are social. Some of our ascendancy in the animal world

comes from improvements to the individual, e.g. larger brains and opposable thumbs, but perhaps a larger portion came from our collaboration and cooperation in groups and the evolution of these group skills, e.g. hunter-gatherers. The individual was at greater risk of starvation or predation. More effective groups ate and bred better. The availability of rich sources of nutrition, meat and grain added energy to the human system and allowed the development of more complex behaviours. The cycle of human interaction and cooperation has led to increased efficiency in the fulfillment of basic human needs, as well as the production and usage of more energy, hence greater complexity, ad infinitum, at least to date. With respect to the question of tradeoffs between interdependence and independence, humans can operate at the independent level and some choose to do so. However, independence usually comes at the cost of efficiency of filling basic human needs, e.g. the hermit (Bar-Yam *et al.* 2004).

**The SoS characteristics.** The following characteristics were common across the three fields of biology, sociology and military: evolutionary development, emergent behaviour, self-organization, adaptation, complex systems, individual specialization, and synergy (Bar-Yam *et al.* 2004).

| Different elements | Biological | Social | Military |
|---|---|---|---|
| Operational independence | Maybe | Yes | Yes |
| Managerial independence | Maybe | Are not applied in some cases; maybe | Yes |
| Geographic distribution | Yes | Changing | Yes |
| Interdependence* | Yes | Sometimes | Qualified goal |
| Multiple taxonomies* | Yes | Maybe | Yes |
| Goal/need seeking* | Maybe | Need; goal seeking may evolve | Goal |

**Table 1.** The SoS (or CDS) characteristics are not common across the fields of biology, sociology and the military (Bar-Yam *et al.* 2004).

## Concluding Observations

Unpredictable phenomena and crises continuously occur all around the world. The speeches of the former and present leaders of the superpowers dedicated to the armed forces and society emphasize the necessity to prepare for the emerging new threats and challenges and address them. As the dominating mechanistic deterministic paradigm is not appropriate for the chaotic evolution of the world, researchers direct their attention to complex dynamic systems paradigm that corresponds to the real chaotic world. The laws of the CDS conflict with the laws of the mechanical paradigm. Social behaviour of humans is typically self-organizing, and it normally gives a rise to emergent complex global behaviours. The behaviour of separate people as well as organizations or public behaviour globally has the features of the CDS. People, building up a society, follow the laws of the CDS.

## III. The Real Situation. Present /Coming CDS Era vs the Old Mechanical Era

### *3.1. The Change of Leadership Concept under the Influence of the CDS. The Essence of Leadership according to the CDS*

While researchers discuss the significance of leadership, a question arises what leadership is when evaluating organizations as complex adaptive systems (Plowman *et al.* 2007). If an organization is treated as a CDS, the role of a leader and leadership becomes vague in an organization.

The articles about leadership present leaders having knowledge about future events and being able to eliminate ambiguities or problems in all organizations. Traditional attitude to leadership has been shaped of a long-lasting

understanding about organizations as systems aiming for balance with clear future, while leaders control behaviour and plan intervention (Stacey 1992; Wheatley 1999; Plowman *et al.* 2007). Leaders in mechanical linear system could follow the rules and principles with regard to a stage an organization was in at that time. An organization transformed to fit the next stage according to forecasted evolution, a leader took forecasted actions and activities. However, crises hit an organization at an unexpected time. Not everything happened following the rules and established procedure.

Russell Ackoff states that currently we are in the process of leaving mechanism-machine age that originated in the Renaissance and entrenched when the society was industrialized. Then mechanism-machine metaphor became an attitude about evaluation and talking about organizations (Reed 2006). Now humans look for other energy resources or efficient use of present ones. When significant changes will take place in the energy area, the prevailing economic-political situation will change in the world as well. Future changes deny some economic-political forecasts that reflect present economic-political world stability and encourages making new forecasts having very little to do with stability and clarity.

Some mathematical catastrophe theories played a leading role in the objective real world theory disciplines and still do and their role is becoming increasingly important. However, in mathematicians' circles and society, these theories assumed a wrong role of being capable of solving problems in social and natural sciences (Homburg 2014).

### *3.2. Differences between Mechanical and Complex Dynamic Systems Leadership*

Mechanical systems are rather simple and forecasted; however, complex dynamic systems are different. Leaders have the symptoms of this phenomenon and unreasonably require simplicity and certainty in complex systems that are in unclear and variable environment. System thinking is essential in an unstable and rapidly changing environment. According to Ackoff, cause and effect relationship was sufficient to explain all the phenomena. We still have the mechanism-machine age thinking. Current problems and questions that organizations have are more complex and challenging than earlier. Leaders act in complex, complicated and puzzling environment. Success in an unstable environment requires different thinking about problems and organizations (Bar-Yam *et al.* 2004; Reed 2006; Lynch, Dagostino 2013). Former separate economic, industrial and political areas are closely related. Changes in one field influence other fields. Processes differ in type and length. Results are unpredictable, inconclusive and continuous. Leadership in such circumstances becomes similar to surfing to the goal that is not invariable as well.

Leadership requires interaction of the opposites in complex organizations and unstable environment that would lead to transformational thinking, origin of a new paradigm with a new power of thoughts (Paparone 2004; Bradberry 2012).

Traditional attitude to organizations is based on the idea that the world is already known and explored as it is a mechanical system with a different operating force and rules of procedure (Capra 1996; Stacey 1995; Plowman *et al.* 2007). Therefore, organizations have rules of procedure, formalized control and hierarchical structure of government that simplify ongoing processes and allow a simple, clearly defined and predictable response to global changes. Traditionally, organizations look for order and leaders are expected to reach for stability by reducing complexity with the help of codification (Boisot & Child 1999; Plowman *et al.* 2007); therefore, leaders strive to control future by diminishing complexity and uncertainty directing to clearly defined future (Plowman *et al.* 2007).

An organization receives information that causes fluctuation but identity helps to maintain balance at the threshold of a chaos. If a system maintains order too strictly, it might alter as it will not be able to transform and consequently will fail. If it lives in a chaos, it will not have memory and will not be able to learn and adapt while transforming. When information is accessible to everyone in an organization, a response is fast and effective and it is easy to transform and it does not mean that anyone can make a decision. It means that everyone evaluates information himself/herself, thus leading to the most objective evaluation of information according to which decisions will be made (Wheatley, Kellner-Rogers 1996).

There is no defined state or model for the CDS. Their leaders take action due to a firm intention, not because of a clear action plan. Local plans are developed when necessary or in unexpected cases. Leaders have to trust in organization's intellect. The future is unknown but they believe that an organization is capable of handling all challenges (Wheatley, Kellner-Rogers 1996). Imposing strict order in an organization is useless and harmful. Loose order, ability to balance at "the edge of chaos" and fast response to changing circumstances determine activities. A leader resembles an acrobat balancing on high ropes at an appropriate pace (too fast or too slow pace may cause a fall) and having sensitive receptors that analyze environment and allow making most appropriate decision at the moment.

When we think of organizations as mechanisms, we do not evaluate the power of internal communication in the self-organizing organizations. The order of mechanical systems relies upon standard procedures foreseen for all the cases. However, when a chaos erupts, all the actions lose control (Wheatley 2007). In the CDS world, leaders focus not only on clear, planned actions, steps and stages, they address the potential of organization members, ability to involve them into processes, mechanical detachment to processes and ability to inspire. Plans cannot be trusted and followed blindly as determination and organization's daily routine is more important. Strict hierarchy and order of actions decrease organization members' efficiency.

The CDS laws contradict hierarchy and order created following the example of mechanical organizations. The majority of people disagree with the CDS theory, though everyday events prove the theory globally. According to it, the real world, not the mechanical one that we made up, requires us to learn to deal with the chaos and adapt strategy and change our behaviour so that it could lead us to order instead of increasing chaos. We got stuck between two paradigms/theories one of which is not effective and the other one is too odd to be accepted. A new real world chaos creates new order. The world that is able to create order without command, control and charisma. When individualities find common interest and desire that are uniting them, they self-organize and decide how to proceed. Self-organization evokes creativity and creation of adaptive system. Power and possibilities develop from new relations (Wheatley 2007; Lindberg, Schneider 2012). Common aim and desire arouse creativity leading to excellent results. It is important for organization members to communicate with each other and that free and non-hierarchical communication and common aim would reveal creative potential.

We want a system to be dynamic and able to adapt to changing environment. The limits of such system are inflexible and fragile, however, live and having creative potential able to work efficiently and reduce chaos. Stability, reliability, predictability and control are great for mechanisms, yet people and organizations are not mechanisms (Knowles 2001; Moen 2013).

During the last several decades, researchers collected data on dynamic systems. It was established that the CDS are able to self-organize for interrelated learning, adaptation and development. It is a contrast to our normal behaviour towards how we follow hierarchy and laws. The ability to communicate, have great vision, motivate people to work hard, achieve results and innovations and implement changes. Leaders are expected to create resistant and adaptive organizations able to deal with growing crises without losing track and progressing with leaders' luck. We must understand how to motivate people and develop an ability to self-organize and transform. We also have to be aware how we lose these abilities and thus cause even greater chaos and require hierarchy, role, purpose, command and controlled leadership (Wheatley 2007).

According to some researchers, the mechanical paradigm still dominating nowadays does not reflect the real world. The CDS paradigm is more realistic as it demonstrates the presence of order and disorder (chaos) and denies the idea that the world can be organized according to personal wishes and this order will be stable. The CDS paradigm contradicts the mechanical one by indicating that a long-time stability, balance and clear order in particular cannot be brought to the world. Thus, the world has to balance disorder (chaos) and order. The CDS is criticized for its universality – an ability to solve problems in different fields. However, the advantage of the CDS is presented as a possibility to classify and concentrate all possible and suitable analogues of a situation.

## Conclusions

1) Crises, chaos and challenges are characteristic of mankind. The world change is a continuous and unpredictable process. Uncertainty is inevitable.

2) There are many forces acting on the world with no clear balance, long-term peace and stability. Global processes are characterized by a chaotic state.

3) Humans and organizations are not mechanisms. A human, society and the world are complex dynamic systems.

4) The paradigm of complex dynamic systems according to which the world balances on the edge of chaos contradicts mechanical systems paradigm that proves that the world is known and explored.

5) The paradigm of complex dynamic systems allows understanding global chaotic phenomena.

6) A possible way to explore systems or their elements is to research dynamics of the systems as the whole function interaction.

7) The essence of leadership and the role of a leader in the conditions of complex dynamic systems are different than in the mechanical paradigm.

8) Traditional approach to leadership has developed from a long-lasting understanding about organizations and the world as mechanical systems, the future of which is already known, that has clear separate acting power, rules of procedure and leaders control behaviour and plan interventions.

9) Leaders unreasonably require simplicity and certainty in complex systems that are in unclear and unstable environment. The order of mechanical systems relies on standard action procedures provided in all cases, in creators' opinion.

10) Organizations that operate in accordance with the principles of complex dynamic systems adapt more successfully to a rapidly changing environment. When information is available to everyone in an organization, everyone evaluates it for himself/herself and thus allow most objective evaluation of information according to which decisions will be made leading to quick and efficient reorganization.

11) We got stuck between two paradigms one of which is not effective enough and the other one is too odd to be accepted.

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