



HAL
open science

Unreduced Dynamic Complexity, Causally Complete Ecology, and Realistic Transition to the Superior Level of Life

Andrei Kirilyuk

► **To cite this version:**

Andrei Kirilyuk. Unreduced Dynamic Complexity, Causally Complete Ecology, and Realistic Transition to the Superior Level of Life. 2005. hal-00004214

HAL Id: hal-00004214

<https://hal.science/hal-00004214>

Preprint submitted on 10 Feb 2005

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

Unreduced Dynamic Complexity, Causally Complete Ecology, and Realistic Transition to the Superior Level of Life[†]

A.P. Kirilyuk*

Institute of Metal Physics, Kiev-142, Ukraine

Abstract. The unreduced, universally nonperturbative analysis of a generic system of arbitrary interacting entities leads to the absolutely universal and reality-based concept of dynamic complexity expressing the qualitatively new phenomenon of dynamic multivaluedness of the emerging incompatible (redundant) versions of interaction results called system realisations. The obtained universal science of complexity transforms ecology, always dealing with irreducibly complex systems, to an “exact”, causally complete science of civilisation development, essentially exceeding the dominating level of ill-founded empirical guesses or application of various existing imitations of “complexity”, “chaoticity”, “nonlinearity”, etc., obtained within the basically unchanged, dynamically single-valued, perturbative reduction of the canonical, linear science. The rigorously substantiated, universal law of unreduced complexity conservation and development, or symmetry of complexity, being applied at the global scale of civilisation development, leads to the objectively justified conclusion about the necessity and reality of transition from today's “protective” ecology maintaining a “sustainable”, but inevitable, destruction to the qualitatively new, creative ecology science and action based on the objective and universal criterion of progress (optimal growth of unreduced complexity-entropy), actively producing the man-made “SuperNature”, and accompanied by the general, also objectively substantiated, ascent of civilisation to the next, superior level of complexity. The latter involves a qualitatively new type of human settlement, activity, and social structure, superior level of individual consciousness and complex-dynamic, self-developing, unrestricted creativity in all aspects of life, which is equivalent to the causally specified Noosphere and genuine sustainability.

Keywords: dynamic redundance, entanglement, dynamic complexity, chaos, self-organisation, self-organised criticality, fractal, sustainable development, Teilhard de Chardin, Vernadsky

[†] Report presented at the conference “Nature, Society and History” (Vienna, 30 Sep - 2 Oct 1999), <http://www.iff.ac.at/socec/affil/conference99/pdf/rpKirilyuk.pdf>.

*Address for correspondence: Post Box 115, Kiev-30, Ukraine 01030. E-mail address: kiril@metfiz.freenet.kiev.ua.

Extended Abstract

The unreduced, universally nonperturbative analysis of a generic interaction process within arbitrary dynamical system shows that the accompanying natural entanglement of interacting entities has a redundant number of equally probable and incompatible versions, called system realisations. Therefore the emerging system realisations permanently replace each other in a causally random sequence, and this process constitutes the dynamically multivalued, or complex, internal dynamics of any really existing entity. The universally defined value of unreduced dynamic complexity is naturally obtained within the same analysis as any growing function of the total number of system realisations or rate of their change, equal to zero for the unrealistic case of only one system realisation. Any observed behaviour of a real system can be completely understood and rigorously described as a particular distribution of dynamically derived realisation probabilities, including such characteristic, and now causally extended, regimes of complexity as uniform dynamical chaos and multivalued self-organisation, or self-organised criticality. Application of the universal science of complexity to analysis of ecological systems always involving high, explicit dynamic complexity transforms ecology into “exact”, fundamentally based and causally complete science, contrary to various mechanistic imitations of the conventional “science of complexity” recently produced within the invariably perturbative, dynamically single-valued (unitary) approach of the canonical science. The real, unreduced interaction processes, giving rise to the universally defined complexity, form the natural, self-developing hierarchy of emerging realisations observed as “objects” or “patterns of behaviour” of the world. This multilevel hierarchy of the unreduced complexity provides also the causally complete, reality-based extension of the notion of fractality, now including any type of observed structures and their dynamic behaviour. The dynamically probabilistic character of the fundamental dynamical fractal of a system (including a planet or the whole existing world) provides the unique mechanism of its internal, autonomous structure development that can be described as the universal law of complexity conservation and development by its transformation between two universal forms, the latent form of dynamic information (or generalised “potential energy”) and the explicitly observed, unfolded form of dynamic entropy (or generalised “kinetic/heat energy”), both of them considerably extending their abstract, mechanistically distorted imitations in the canonical science. This “generalised law of entropy growth” substantiates the objective necessity and feasibility of the fundamental transition from the purely “constraining” (“protective”) ecology of today that can only “sustain”, but not stop, the modern planet's life degradation, irrespective of the technical details and estimates used, to the intrinsically creative, positive transformation of life and environment, which is based on the new, objective and universal criterion of progress (optimal growth of the unreduced complexity-entropy). This superior level of intrinsically constructive interaction with the environment extends and specifies practically the concept of noosphere and can be attained by the general, objectively inevitable and now well specified, ascent of civilisation to the corresponding superior level of complexity-consciousness-knowledge, including qualitatively new type of human settlement, social structure, and permanent, unrestricted creativity in all aspects of life.

1. Introduction

The diverse group of branches of modern knowledge approximately designated as “ecology” passes today through a critical stage of its development. The initial enthusiasm partially related to political and media aspects of ecological problems has now exhausted its (basically low) potential, and further development can only be based on qualitatively new, causally complete and universal criteria capable to transform ecology in a “normal”, theoretically founded and intrinsically unified science, as opposed to its modern state of huge eclectic agglomerate of “classified observations” and intuitive “general” ideas. The fundamental difficulty on this way is that ecology deals with a multi-level hierarchy of interacting processes of much higher complexity than the canonical “exact” sciences (remaining themselves basically incomplete and contradictory).

In this report we describe an attempt of such qualitatively new, unifying approach to ecological system description, based on the recently proposed *universal concept of (unreduced) dynamic complexity* [1]. We argue that (optimal) growth of this universally defined complexity (represented by its explicit form of dynamic entropy) can be used as the objective, unique *criterion of progress* in general and for specifying “ecologically optimal” solutions of various particular problems. It is not difficult to see that the absence of such criterion and its substitution for an “evident” estimation of what is “good for the environment” can easily lead to confusion and serious errors in realisation of programmes dealing with the unreduced, dynamically changing structure of multiple interaction processes in society, nature, and between them. Moreover, it is quite evident already today that the purely “protective” logic of practically all the really developed approaches in “ecological thinking” leads to a dangerously deepening impasse of a “rich”, but actually the more and more limited, “mechanistic” society of “strict (simple) rules”, fundamentally deprived from any true progress and inevitably degrading towards ever lower quality of life.

The rigorously substantiated analysis within the new concept of complexity provides the causally complete, objective picture of the involved “global” interactions of “everything with everything” within a system, taking the form of a hierarchy of naturally emerging objects “automatically” provided with the *intrinsically probabilistic* behaviour. The latter means that the complex system structure is derived as a redundant, excessive number of “possible configurations”, or “realisations”, for each obtained object (result of interaction), which are all equally real, but cannot appear in the same place and moment of time. Therefore they should permanently replace one another, forming a self-developing, always changing hierarchy of objects and events of object emergence (which are none other than the causally complete extension of the notions of space and time respectively [1]) that behaves like a “living organism”, in a sense that is rigorously specified now. Thus emerging *paradigm of dynamic multivaluedness (redundance)* is indeed qualitatively larger than anything known in the canonical, dynamically single-valued science, and what is most important for ecological studies, the extended paradigm is directly, inseparably related to the *unreduced reality*, providing thus the truly adequate form of knowledge, which is actually unique due to its intrinsic universality. This major property determines the unique usefulness of the dynamic redundance paradigm for both particular ecological system analysis (which becomes truly complete now), and understanding of the necessary general direction of progressive civilisation development and means of its realisation inseparably related to the purpose, and the very meaning, of ecology, including all particular investigations (we shall specify this conclusion below, in section 3).

The universal concept of complexity provides considerable extension of the existing notions about its separate manifestations known as “self-organisation” (structure emergence), “self-organised criticality”, “chaos”, “fractality”, “adaptability”, etc., simultaneously *unifying* them within the unique process of “complexity development”. This means, in particular, that the truly unified knowledge of the new, *unreduced* science of complexity has very little in common with existing basically reductive, separated imitations of the canonical, dynamically single-valued (or *unitary*) science around

“complexity”, “chaos”, “self-organisation”, “criticality”, etc. All the canonical concepts of “self-organisation” (or “synergetics”), “chaos”, “self-organised criticality”, “fractality”, “adaptability”, etc. always deal with *only one*, “averaged” system realisation describing but the semi-empirically fixed “external form” of objects and phenomena and completely neglecting all other, equally possible realisations (and the connection between them) that constitute the unreduced, permanently changing “internal life” of the system represented by *unceasing* transitions between the *incompatible* realisations. In terms of rigorous (mathematical) description, such fundamental limitations of the canonical science, including the imitative “science of complexity”, result from one or another version of approximation known as “perturbation theory”, always applied in the unitary science and equivalent to an effectively one-dimensional, or even zero-dimensional (point-like), analysis describing a completely “separable”, exactly “integrable” system, whereas any really existing system, correctly described within the dynamic multivaluedness paradigm (unreduced concept of dynamic complexity) [1], necessarily implies an essentially multi-dimensional behaviour and inseparable dynamic entanglement of the entities participating in the driving interaction process(es). The gross, qualitative deficiency of the single-valued science can yet be somehow “settled” in the case of lower-complexity, “physical” systems with the help of formally imposed “postulates” and empirical “classification” of a relatively small number of “typical” behaviour patterns (even though this inevitably results in the well-known incompleteness and “mysteries” even for these systems [1,2]), but for higher-level systems, demonstrating explicit, strong and diverse manifestations of the unreduced complexity and studied in such “interdisciplinary sciences” as ecology, the mechanistic imitations of the canonical unitarity can not be successful even approximately (for example, the number of the necessary “postulates” increases beyond any reasonable value).

We proceed by presenting, in section 2, the main results of the unreduced science of complexity and then describe its application to truly constructive, “sustainable” solution of particular and global ecological problems (section 3), transforming ecology into an integral part of the intrinsically unified and totally realistic knowledge of the universal science of complexity.

2. Dynamic redundance paradigm, the universal concept of complexity, and its difference from mechanistic imitations of complexity

2.1. Fundamental dynamic multivaluedness, causal randomness, and natural entanglement of interacting entities

In order to illustrate the approach of the universal science of complexity and some key results of its application to particular and general ecological problems, let us consider how the dynamically complex, multivalued and entangled, behaviour emerges in the process of arbitrary, *unreduced* interaction between two or more real entities (objects, phenomena, beings, communities, etc.) [1,2]. If an entity, Q , characterised by the degrees of freedom (generalised “coordinates”), q , and containing N_Q independent structural “elements”, or “modes” $\{q_n\}$ ($n=1,2,\dots,N_Q$), enters in interaction with another entity, Ξ , characterised by the degrees of freedom ξ and containing N_Ξ independent elements, $\{\xi_n\}$ ($n=1,2,\dots,N_\Xi$), relevant to the interaction process in question (usually $N_Q = N_\Xi$), then the completely developed, unreduced interaction implies that “each element of Q interacts, or enters in combination, with each element of Ξ ”, which leads to emergence of at least $N_Q N_\Xi$ elements of the “compound” entity, $(Q, \Xi) = \Psi(q, \xi)$, constituting the product of the unreduced interaction between Q and Ξ (the analysis and its results can be directly generalised to arbitrary number of interacting entities). However, this increased number of elements, $N_Q N_\Xi$, of the interaction product exists in the *same* reality as each of the interaction participants before the interaction, and since the “number of places” in reality cannot change without entering in direct contradiction with the basic conservation laws, the unreduced interaction results should necessarily be *redundant* with respect to the number of elements, N_Q (or $N_\Xi = N_Q$), of the “free”, non-interacting entities. This means that the generic, unreduced interaction leads to formation of many, $N_\Xi (= N_Q)$, “versions” of the resulting “compound” (mixed) system Ψ , and since each of the versions is locally “complete” (i. e. it totally occupies the relevant “normal position”, or dynamical

“volume” in reality), they appear to be *incompatible* with each other and, being *equally* “pulled” towards reality by the driving interaction, are forced to permanently replace each other in a *causally random* sequence. Because of their local completeness we call each of the “versions” *realisation* of the system (of interacting entities), and as we have seen, the total number, $N_{\mathfrak{R}}$, of system realisations is equal to the number of interacting elements in its initial state, $N_{\mathfrak{R}} = N_{\Xi}$ (i. e. the degree of *dynamic redundance* is determined by the effective “content” of interacting entities, as it could be expected).¹

Plurality of realisations for any system with interaction ($N_{\mathfrak{R}} > 1$ and practically always $N_{\mathfrak{R}} \gg 1$) provides therefore the *purely dynamic*, consistently derived *origin of randomness* in the world, completely ignored by the canonical science that always deals with the dynamically single-valued, effectively zero-dimensional description within a version of “perturbation theory”, including the canonical “science of chaos” and all other internally separated branches of the unitary “science of complexity”. Naturally, the dynamic origin of randomness emerges together with the *causally derived probability* of realisation appearance: since by their very origin all realisations have “equal opportunities”, the probabilities of their appearance, $\{\alpha_r\}$, are also equal, $\alpha_r = 1/N_{\mathfrak{R}}$, so that

$$\sum_{r=1}^{N_{\mathfrak{R}}} \alpha_r = 1 .$$

In practice, and especially for more complex systems, realisations are often inhomogeneously grouped into dense agglomerates or “dynamic tendencies”, so that individual “elementary” realisations are not experimentally resolved within any of the groups, the latter playing the role of “compound”, actually observed realisations. In this general case the probabilities of actually observed realisations are not equal, but are still exactly determined within the same analysis: $\alpha_r = N_r/N_{\mathfrak{R}}$, where N_r is the number of “elementary” realisations within the r -th observed group-realisation, and

$$\sum_r N_r = N_{\mathfrak{R}} .$$

It is clear that the “expectation”, “average” value of a generalised system “density”, ρ_{exp} , measured in a long enough observation over the system is obtained as a sum of “partial” densities for individual (actually resolved) realisations, ρ_r , weighted with the causally determined probabilities, α_r :

$$\rho_{\text{exp}} = \sum_r \alpha_r \rho_r .$$

At the same time, any higher-resolution (short-time) observation over the system, capable to register a single realisation appearance, will give for the measured value (function) ρ any its possible single value (function) ρ_r with the corresponding, causally (analytically) determined, *a priori* probability α_r , which means that the measured quantity (ρ) is the *probabilistic sum* (now *causally specified*) of the component quantities (realisations) $\{\rho_r\}$:

$$\rho = \sum_{r=1}^{N_{\mathfrak{R}}} \oplus \rho_r .$$

If now one considers the internal structure of an arbitrary, r -th, realisation of the compound system, $\Psi_r(q, \xi)$, i. e. ρ_r dependence on q and ξ , then one discovers physically real, *dynamically emerging* entanglement of the interacting degrees of freedom, so that they enter into the expression [1,2] for the compound system density for that realisation, $\rho_r(q, \xi)$, in certain, realisation-specific, “nonseparable” combinations between $\{q_n\}$ and $\{\xi_n\}$, where those degrees of freedom of the “free” interacting entities occur in a sum of their nonlinear combinations, involving also “interaction

¹ Those “numbers of initial-state elements”, N_Q and N_{Ξ} , come eventually from a similar dynamical “splitting” into multiple realisations at a lower “level of complexity” (see below), which demonstrates the internal consistency of our analysis and also leads to the far going conclusion about the (rigorously proven) necessity of explicit creation of the very first (lowest) level of complexity of any system, including the World as a whole, from the outside of the system, contrary to the incorrectly “arranged” *ex nihilo* creationism of the canonical science (including e. g. unitary cosmology and “self-organisation”) [1,2].

potential” that specifies the interaction as such. This property of *dynamic entanglement* of interacting entities constitutes the second major manifestation of the unreduced complexity, inseparably related to its first manifestation, dynamic redundance (causal randomness): any real interaction result is redundant because the number of possible versions of dynamic entanglement between the interaction participants, just forming the compound system realisations, is much higher than one. At each particular level of interaction development one always has the well-defined number, $N_{\mathfrak{x}}$, of *dynamically discrete* entanglement versions, or realisations, with well-defined structures, while the irreducible causal randomness appears through the probabilistic character of the *sequence* of realisation emergence in the process of their permanent change. It is not difficult to understand that in the course of their permanent “turnover” all newly formed realisations should also transiently *disentangle* into the initial interaction components before they form the next, always probabilistically “chosen” version of entanglement (realisation).

The dynamic entanglement-disentanglement process, explicitly obtained within the universally nonperturbative analysis of the unreduced science of complexity, actually reveals the causally complete *meaning of the notion of interaction* as such, remaining rather “intuitive” in the canonical science. The causally probabilistic, dynamically discrete pulsation, or “quantum beat” of entanglement-disentanglement events within any unreduced interaction process naturally forms a self-developing hierarchy of levels, since the multiple interaction products of an already formed level (usually in the form of a number of well-defined “combined” realisations/objects) also cannot avoid interact (entangle) among them, giving another multiplicity of objects forming the next (higher) level, etc. Considered from certain its level in the “direction” of lower levels, this dynamically unified hierarchy of complexity forms what is called the *fractal* structure of complexity of entities from this level. This naturally, dynamically formed, *reality-based* fractality is the realistic, multivalued (and thus irreducibly *probabilistic*) extension of the canonical, purely mathematical, mechanistic “fractals” from the unitary “science of complexity”, which either produces them “numerically” from abstract, over-simplified “models”, or tries to semi-empirically define their external properties, without revealing their (universal) dynamic origin. It is clear that the whole hierarchical, naturally developing, intrinsically probabilistic structure of complexity of a closed system, including the whole World, also constitutes such extended fractal that can be called the fundamental dynamical fractal of the system. Contrary to canonical fractals, limited to some particular, “fuzzy” and “self-similar” objects, the dynamic fractality of the universal science of complexity naturally incorporates the hierarchy of all existing (and dynamically related) structures/objects, together with the detailed mechanism of their emergence and complex dynamics of existence, including both “apparently fractal” structures (like some crystallisation patterns or “coast lines”), and “apparently non-fractal” objects (like an egg or a pebble lying somewhere at the “coast line”). Mathematically this diversity of structures can be obtained within the universal formalism of dynamic multivaluedness due to its unreduced, nonperturbative character, where the “essentially nonintegrable” equation part is naturally separated from a quasi-integrable (but essentially nonlinear, multivalued) part, so that the latter gives dynamical splitting into redundant realisations of the current level, whereas the former determines the dynamic branching development to other levels of the fractal hierarchy of complexity [1,2].

Due to this *totally adequate* type of description that *directly* reproduces in the formal structures (equations) *all* the consecutively *emerging* details of the *really occurring processes* (including especially the autonomous multiplication-branching of unreduced interaction products), one obtains within the universal science of complexity the rigorous and completely specified, non-postulated understanding of the *purely dynamic* origin of such omnipresent, and dually “opposed”, properties of natural phenomena as *discreteness* and *continuity*, *randomness (unpredictability)* and *regularity (order)*, *localisation* (“concentration”, “rigidity of form”) and *non-locality* (“dispersion”), *globality* of dynamics and *individuality* of emerging behaviour patterns, irregular *symmetry* (“similarity”) of structure/behaviour patterns and *uniqueness* (“inimitability”) of each of them, etc., which can only be taken for granted in the dynamically single-valued, perturbative, effectively zero/one-dimensional paradigm of the whole canonical science. The ultimate involvement and diversity of the obtained fundamental dynamical fractal, reproducing indeed any existing object, structure element, or pattern of behaviour, is the natural reflection of the truly *unreduced* character

of the underlying description that provides thus the universal, really complete *general solution* to a problem, in the form of *causally probabilistic sum* of *explicitly derived* system realisations (which turns, for the expectation values, into an ordinary sum, where realisation contributions to the measured system density are weighted with the causally derived realisation probabilities).

An important summarising property of the unreduced general solution, obtained within the dynamic redundance paradigm, is its intrinsic, omnipresent *creativity*, a quality totally absent in any canonical, one-dimensional “solution” and looking even mysterious, “irrational” within the unitary thinking. Creativity of the universal science of complexity is clearly, mathematically and physically (conceptually) specified as the unceasing, irreducibly *probabilistic change* of *dynamically emerging* realisations within their naturally formed “groups” giving “objects” and their hierarchical levels (“levels of complexity”), equivalent to *autonomous*, fractally structured *growth* of the universal hierarchy of complexity, which also gives rise to the causally complete understanding of *time* [1,2]. The fact that this kind of creative change is omnipresent in nature, in sharp contrast to any construction of the canonical science, was first clearly emphasised by Bergson [3], but the evident impossibility of reproduction of creativity in the *known* form of scientific knowledge led him (and some other similarly oriented philosophers) to conclusion that *any* scientific knowledge cannot properly describe creativity of nature that can only be perceived by irrational ways of “intuition”, etc. (the conclusion that is only confirmed by the clumsy imitations of “change” and “creativity” within the canonical, basically unitary, but extremely speculative “science of complexity” à la Prigogine and Santa Fe). The universal science of complexity provides the ultimately consistent kind of knowledge that is both intrinsically creative and rigorous, complete and ever developing, which is especially important for the “strategic” applications in ecology described below (section 3).

2.2. The unreduced dynamic complexity/chaos, its measures and characteristic regimes

It is not difficult to deduce from the above results that the causally complete, mathematically rigorous and reality-based definition of the quantity (or “measure”) of arbitrary system complexity as such can be obtained, in principle, as any strictly growing function of the number, $N_{\mathfrak{R}}$, of causally obtained (and not merely empirically “counted”) system realisations, equal to zero for the (unrealistic) case of the unique system realisation (i. e. for $N_{\mathfrak{R}} = 1$). This shows, in particular, that *each* of the canonical science constructions (and the related unitary “way of thinking”) has *zero value of the unreduced complexity* and is thus *totally, qualitatively inadequate* with respect to reality it pretends to “explain”, since *any* real object has a non-zero, and actually high enough, dynamic complexity. Because the naturally branching arborescence of complexity produces the number of realisations growing exponentially with the “height” (hierarchical number) of level, it is often pertinent to use a logarithmic function in this definition of complexity, $C = C_0 \ln(N_{\mathfrak{R}})$, where C is the system complexity defined up to a constant. We see thus that expressions for quantities like “complexity”, “entropy”, or “information” with the help of logarithm of the “number of (empirically counted) states” (or “possibilities”) mechanistically *postulated* in many fields of the canonical science originates in reality from the underlying universal hierarchy of the unreduced complexity necessarily incorporating probabilistic realisation change. The causally substantiated version of this definition within the dynamic redundance paradigm permits one, in particular, to derive analytically complexity dependence on various system parameters through the same dependence of the number of realisations $N_{\mathfrak{R}}$, being now a *dynamically determined* quantity (contrary to its empirically fixed, ill-defined analogues in usual definitions). Note also that the above “logarithmic” or any other similar expression of complexity through a simple standard function represents, in general, only a (correct) *estimate* of the real dynamic complexity of a system that can be more exact for a particular dynamic regime of quasi-homogeneous, multi-level realisation probability distribution. Usually the “absolute”, integral measure of complexity by realisation number enters in the universal formalism of the unreduced science of complexity rather in the form of generalised *action*, \mathcal{A} , which is the complex-dynamic, universal extension of the ordinary mechanical action, proportional to the redundant realisation number [1,2].

Another type of practically important measure of unreduced complexity deals not with the absolute number of system realisations, but rather with the *rate* (temporal or spatial) of their *change* within the system dynamics (or the existing object as such), which directly reflects the above “creative” essence of the unreduced complexity concept. This differential measure of complexity is closely related, of course, with the above integral measure, and their dual combination represents the natural sequence of two types of stages in the hierarchical complexity development process, the quasi-“horizontal” development of an existing level of well-defined structures/objects/regimes (better characterised by the rate of realisation change) and approach towards emergence of a new “level of complexity” providing qualitatively new type(s) of “main” entities (better described by the total number of their possible realisations/states). In the universal formalism of complexity dealing with the generalised action for the integral dynamic complexity, the rate-of-change measure of complexity takes the form of generalised *energy*, E (temporal rate of realisation change, $E = -\partial\mathcal{A}/\partial t$), or generalised *momentum*, p (spatial rate of realisation change, $p_x = \partial\mathcal{A}/\partial x$) [1,2].²

This reality-based expressions for the unreduced complexity demonstrate another important result of the universal science of complexity, the causally complete extension of the notions of space and time: causal *space* is formed by the naturally emerging realisations themselves, while *time* characterises the facts of their sequential emergence (in the course of permanent replacement of one of them by another) described as *events*, which shows that space is a “tangible” entity, or “dimension”, perceived as a “material”, or “structure” (of a particular “texture” described by the “characteristic length”), while time is *not* a “material” entity and therefore *cannot* be consistently interpreted as a real dimension, in addition mysteriously “mixed” with the real, spatial dimensions into a formally described “manifold” of space-time (as it is stated in the canonical “relativity” implying some far going conclusions, see [1,2] for more details). It is clear also that the causally defined space and time, as well as the *causally extended*, consistently *derived* effects of their “relativity” [1,2], form the hierarchical structure of levels determined by those of the universal hierarchy of complexity (or the fundamental dynamical fractal). Similar to energy, the causally extended, universal *mass* is determined by the temporal rate of the (probabilistic) realisation change, but considered rather for the case of internal, “hidden” (and high-frequency) realisation change process of an object; the causally defined mass is dynamically related also to the corresponding level of causal space represented by the “characteristic length”, in profound accord with the forgotten idea of René Descartes about the fundamental relation between length and matter (see [1,2] for more details on the intrinsic relation between the “universal science of complexity” and the equally universal approach of Cartesian science, later falsified by the canonical, unitary mechanism).

Finally, as far as the definition of complexity is involved, it is important to emphasize that the notion of *dynamical chaos* can also be consistently specified only within the dynamic redundancy paradigm showing that in general it is a *synonym* of the unreduced dynamic complexity and means “partially (dynamically) ordered (causal) randomness” appearing in the form of generally nonuniform (inhomogeneous) distribution of realisation probabilities. This causally complete definition of chaos in the unreduced science of complexity clarifies much of confusion and evident contradictions inevitably appearing around this notion in the canonical, single-valued “science of complexity”, where “chaos” is often confused with its limiting case of “absolutely irregular”, uniform “randomness”, which is only externally postulated or intuitively “guessed” and provided with a number of basically wrong interpretations, such as “exponentially divergent trajectories” (see [1] for more details). The causally complete notion of chaos shows, in particular, that *every* really existing dynamical regime or object is internally *chaotic*, irrespective of “rigidity” of its externally observed “shape”, which means that *any* real entity can exist only due to the internal hierarchy of *causally random* change of multiple realisations, which fits to the observed external “shape” due to *inhomogeneity* of (causally determined) *distribution of probabilities* of those realisations. These details of unreduced, chaotic pattern formation are essential for ecological complexity levels.

² The twisting, “vortex” patterns of realisation entanglement/disentanglement can also be characterised by the generalised angular momentum obtained as the “angular derivative” of generalised action, similar to usual relation between the ordinary mechanical action and angular momentum.

The unreduced understanding of dynamical chaos shows that one can have two characteristic regimes of dynamic complexity appearing at its various levels. One of them, called *uniform chaos*, is realised when the driving interaction is such that the resulting realisation probability distribution is quasi-homogeneous; the system in this regime performs a non-structured “random walk” smoothly covering the whole space of realisations, with a canonical example of internal dynamics of a free elementary particle that accounts for the property of its “rest mass” [1,2].

The dually opposed characteristic case of complex dynamics is the extended (multivalued) *self-organised criticality (SOC)*, or simply *self-organisation* that occurs when realisation probability distribution is highly inhomogeneous, so that they are dynamically “grouped” into one or several “agglomerates” of very similar (but still *different*) elementary realisations within each agglomerate and the system dynamics appears as a number of quasi-stable structures (objects) “enveloping” those realisation agglomerates, with only rare system “jumps” between them (when there is more than one agglomerate) and only small (often not resolved) chaotic variations of their external shapes. All the canonical cases of “self-organisation” provide examples of this regime of the unreduced complex dynamics. Note, however, the essential extension of such internally chaotic “self-organisation” with respect to the ideas of the canonical, single-valued “synergetics” and similar imitations of the unitary “science of complexity” [4], which are always based on perturbative approaches, “exact solutions”, etc. and incapable to obtain the adequate picture of internal, irreducibly probabilistic realisation change process just maintaining the “self-organised” shape of the observed structure, which is only superficially described by the “exact solutions”.

Simultaneously, our extended self-organisation generalises the canonical “self-organised criticality”, or SOC, concept, since we show that *any*, more or less distinct, pattern is obtained in reality as a result of permanently maintained “equilibrium” between the opposite system variations around the observed “shape”, which is taken as the (purely empirical) “paradigm” of the canonical SOC (it is specified rather in computer experiments, than by a universally applicable, analytical description). Contrary to the canonical “self-organisation” and SOC concepts that do not contain any intrinsic randomness, the extended SOC of the unreduced science of complexity incorporates the same causal source of randomness as uniform chaos regime, in the form of fundamentally unpredictable order of emergence of incompatible realisations (though closely resembling each other in this regime). From the point of view of extended SOC, the difference between the phenomena canonically classified as “self-organisation” and “self-organised criticality” is reduced basically to the effective number of complexity levels directly involved in each of them: “self-organisation” corresponds to the extended SOC with basically one (or few) actually resolved complexity levels, while “self-organised criticality” involves many actually resolved levels of complexity (perceived as a hierarchy of “avalanches” in canonical examples of “self-organised criticality”). This latter regime of multi-level SOC actually incorporates also such popular regime of complex dynamics as *turbulence* obtained in the limit of large number of closely spaced (and only partially resolved) levels [1].

2.3. The universal law of complexity conservation and development by transformation of dynamic information into entropy

The obtained holistic picture of complex dynamics of the world with many dynamically connected levels and various dynamical regimes at each level should have a more specific unified expression, in the form of universal law of development of this unified structure applicable also to any dynamical system making a part of it. This is the law of conservation of the unreduced dynamic complexity causally substantiated within the universal science of complexity and representing the unified extension of all the conventional “conservation laws” (of energy-mass, charge, etc.) and other “principles” postulated in the canonical science (“principle of least action”, other “variational principles”, “principle of relativity”, etc.) [1]. It is important that *conservation, or (dynamic) symmetry, of complexity* can be realised only due to its internal *transformation* from the latent (“hidden”, or “folded up”) form of *dynamic information*, or (generalised) “potential energy”, into the explicit (“structural”, or “unfolded”) form of *dynamic entropy*, or (generalised) “kinetic/heat energy”. Note that these causally substantiated concepts of information and entropy considerably

extend and clarify the conventional, intuitive, detached from reality, and largely erroneous ideas about them in the canonical science, while the unceasing transformation of information into entropy is the direct and absolutely universal generalisation of the “second law of thermodynamics”, in which it is naturally unified with the extended “first law” (i. e. energy conservation), within the above complexity conservation law. The universal, *reality-based*, causal *information* of the unreduced science of complexity describes the dynamic complexity of multiple realisations at the very beginning of the unreduced interaction process for a given system or level of complexity when the interacting objects (realisations) formed at lower levels are ready to start their fractal dynamic entanglement giving later the final results of the interaction process (i. e. again realisations, but formed at the current, higher level of complexity, in the form of “objects” or “behaviour patterns”). The universal dynamic *entropy* describes the dynamic complexity of multiple realisations just at those final stages of the interaction process, in the form of “fully developed” dynamical structures or regimes of a given system or level of complexity. It is therefore evident that the dynamic redundance paradigm, providing a causally complete description of the unreduced interaction process in the form of multiple, incompatible, and totally realistic realisations and their dynamic (autonomous) entanglement through hierarchically emerging fractal substructures, constitutes the indispensable basis for the consistent concepts of information and entropy unified within the single concept of dynamic complexity. In particular, our dynamic entropy includes the full, *context-bearing* knowledge about the system, as opposed to formal conventional measures of information (and complexity).

One of aspects of the obtained universal law of development is especially important for substantiation of strategic goals of causal ecology outlined below: it becomes clear now that both typical cases of “degradation” of structures, energy, etc. and “progressive” growth of structures result from the *same* universal process of complexity development, or *unfolding*, from the hidden form of information (potential energy) to the explicit form of entropy (spatial structure), but taken at its different stages of, respectively, the end of development of (a level of) the hierarchy of system complexity and the beginning of the (next) characteristic cycle of development. It becomes also evident now that *any* object or structure, including the *whole existing world*, cannot appear “from nothing” (*ex nihilo*), as it is implied by the unitary science (especially within the canonical cosmology and “synergetics”/“self-organisation”), but should first be “conceived”, or “inserted”, from the outside, in the form of (generalised) potential energy, or (dynamic) information, of interacting entities coming from the “outside” levels of complexity, which can then, indeed, autonomously “develop”, or “unfold” itself into the totally “replete”, tangible form of spatial structure, or (generalised) entropy.

Note finally that the universal complexity development law has also its detailed mathematical expression, in the form of the universal evolutionary equation for the generalised action-complexity mentioned above. This is the extended Hamilton-Lagrange-Schrödinger formalism, in its two dually related versions, the Hamilton-Lagrange equation (generalising the Hamilton-Jacobi equation from the conventional mechanics) that describes the localised (“trajectorial”) behaviour of a system taking consecutive realisations and the generalised Schrödinger equation describing the related nonlocal “jumps” of the system between realisations [1]. It can be shown how this universal formalism is reduced to any correct equation describing a real system behaviour in the corresponding situation. This unlimited universality of quantitative description of the unreduced science of complexity is essential for the case of diverse and irreducibly complex systems considered in ecological studies.

3. Causally Complete Ecology as Integral Part of the Universal Science of Complexity and Its Main Practical Applications

Now we can briefly outline the main applications of the universal science of complexity to ecological problems. These applications can be divided into two large groups, one of them including various particular system behaviour, analysed within the causally complete description of the unreduced science of complexity, and the other one concerning the general perspectives of human society and nature development within the new, causally substantiated and really objective, concept of progress.

The first type of ecological application of the universal science of complexity consists in the unreduced, nonperturbative consideration of a process of interaction of a number of entities (of “human”, “social”, “natural”, or mixed origin) forming a well-defined dynamical system and leading to emergence of a new generation of dynamical structures/regimes, according to the unified analysis of the dynamic redundance paradigm described above. In terms of formal description, this causally complete picture of unreduced interaction process is provided by a case of the universal Hamilton-Lagrange-Schrödinger formalism [1]. The pertinent form of the universal equation, reduced to a particular configuration of the Hamiltonian, is not rigidly fixed and may depend, even for a particular system, on aspects of system behaviour that should be studied in more detail. However, a number of “typical”, frequently occurring cases of Hamiltonian configuration can be specified, such as the well-known cases of “motion in a potential field”, “relativistic dynamics”, etc. What is most important is that each of those particular equations, usually “nonintegrable”/“nonseparable” (i. e. “irresolvable” within any version of the canonical, single-valued analysis) is then analysed within the universally nonperturbative, intrinsically realistic approach of the unreduced science of complexity, which leads to their “complete solution”, but in the form of *causally probabilistic* sum of realisations forming, in a general case, the *fractal hierarchy* of sublevels of complexity. The obtained dynamically complete solution can be described as a case of generalised SOC regime introduced above (section 2.2) and incorporating a number of naturally emerging, related, complex-dynamical structures composed of the dynamically entangled interaction participants (of “human”, “social”, “natural” origin, or their combinations). Contrary to “exact” (“closed”) solutions of the canonical, single-valued “self-organisation” or “self-organised criticality”, complete solutions of extended SOC always emerge “naturally”, “autonomously”, without any empirical insertion of “expected” results, and contain both the “internal sense (content)”, in the form of causally probabilistic, fractal, self-developing hierarchy of *permanently changing* “elementary realisations”, and the intrinsic “direction of progress” pointing towards higher explicit complexity (generalised entropy) in the internal hierarchy and beyond, in accord with the universal law of complexity development (section 2.3). Those purely dynamical, naturally emerging “links” and “direction” within the complete solution of the unreduced science of complexity reflect the intrinsic wholeness and creativity of the new knowledge (see also section 2.1), where each particular system is always *naturally obtained* and continues to *autonomously evolve* as a part of the unified complexity development process, corresponding to the uniquely, objectively defined progress (optimal growth of the unreduced complexity-entropy).

This brings us to the second type of application of the universal science of complexity to ecological problems, which deals with that objective criterion of progress (growth of the unreduced complexity-entropy), but applied now at the level of the whole civilisation and its most important components. The result of this “global” application of the unreduced complexity concept can be specified already in general terms. Namely, the complex-dynamical analysis of various aspects of modern stage of civilisation development and universal sense of development proposed by the dynamic redundance paradigm shows that civilisation is now at the end of a big level of its complexity development and should pass to a superior, qualitatively higher level of the unreduced complexity-entropy, or else the natural degradation of the exhausted level of development will inevitably bring it to complete demolition [1]. This superior level of civilisation complexity is characterised by the *unreduced creativity* in the combined man-nature development providing a *real* possibility of *maximum* realisation of intrinsic, “hidden” complexity (generalised information) to *every* person, group, community, etc. In accord with the universal property of dynamical (causal) discreteness in the structure of universal arborescence of complexity, this new level is separated from the current level of development by a qualitatively, “conceptually” big “gap” that can be spanned by developing complexity only in the course of the corresponding revolutionary transition of civilisation represented at first by its most “advanced” structures.

In terms of ecological system evolution, the new level realises the transition from the current purely “limiting” (and actually inefficient) ecological action to the opposite, “creative” mode insisting on *more*, rather than less, *intense* interaction and *change* within the global ecosystem concentrated, however, on the *constructive*, complexity-growing development, as opposed to the current, inevitably destructive tendency. The feasibility and specific content of this important transition are nontrivially substantiated by the universal law of complexity development (“generalised law of entropy growth”) described above. This law shows that the total complexity conservation is realised

indeed by permanent “degradation” of dynamic information (or “potential energy”), initially present in the system, into dynamic entropy (or “spatial structure”) representing the result of system interaction development. However, this process of internal complexity development contains natural “stages” of various scales corresponding to levels of the emerging complexity-entropy (observed structure), and whereas the elements of visible destruction, explicit degradation of the older, finished stages and those of visible creation and progress of the next-stage structures are both equally necessary and coexist during the whole development of complexity, the end of each stage of development is characterised by domination of destructive tendencies (just *realising* the end of a stage), while the new stage beginning is perceived as prevalence of explicit creation and progress. This means that the latter “good” period of visible creation and progress of a system is *not* at variance with the *generalised*, complex-dynamical version of the law of entropy growth, contrary to the same case within the unrealistic, single-valued paradigm of the conventional science, and in order to pass from a stage of dominating degradation to the stage of creation the system (civilisation) should simply realise the natural transition to the next (qualitatively higher) level of complexity (in the case of civilisation, this certainly needs some nontrivial efforts of a “conceptual”, rather than “quantitative”, type related to the “new level of thinking”, etc.).

Therefore it becomes clear that the current purely “constraining” (“protective”) mode of ecology belongs simply to the ending stage of civilisation development that can be called *Unitary System* (of thinking, social structure, production, man-nature interaction, etc.) and is determined by the basically “one-dimensional” (single-valued), “unitary” approach and practice in both scientific knowledge and various aspects of life, dominated by rigidly fixed, mechanistic hierarchies of subordination involving *both* men and “circumstances” (within *any* existing “political system”, including its most “democratic” and “liberal” versions).³ While modern societies remain within the Unitary System determined eventually by the dominating level of human *consciousness* (the latter being causally specified as high enough levels of the unreduced dynamic complexity [1]), the basically “constraining” ecology *cannot* make any essential progress in principle, *irrespective* of the *quantity* of applied efforts and “technical” refinement of the methods of “ecological situation estimation”, etc.⁴ However, the civilisation *can*, and *should*, pass to the next, *qualitatively* higher level of complexity that can be called *Harmonical System* and is characterised by the unreduced,

³ Note that the terms “unitary”, “unitarity” have a rigorously defined, universal meaning in the whole variety of applications, from the fundamental physics (“unitary evolution”, etc.) to civilisation dynamics considered here. “Unitary” means “qualitatively homogeneous”, that is “changing only gradually, quantitatively”, *not* containing any “emergence” of “something qualitatively different”, especially “irregular” and “transient” (including autonomous system “jumps” to a different state), and thus actually *opposed* to any nontrivial *development* (*intrinsic change*) of a system. Unitary evolution in physics can always be described by a single-valued, analytical, smoothly varying function of time; it is totally predictable, non-random and therefore time-reversible, contrary to any real system behaviour. Unitarity of a social structure means basically unchangeable, mechanistically fixed, pyramidal hierarchy of “positions” and “links” (which explains, in particular, why a transition from one version of the Unitary System to another, when it becomes inevitable, always happens through a highly destructive “social revolution”). It becomes clear, within the unreduced science of complexity, that the *inbred unitarity* of the *whole* canonical science and the related general “way of thinking” (including its mechanistic, formal imitations of “complexity”) is simply the *synonym* of its fundamental *single-valuedness* resulting from perturbative reduction of any interaction, whereas the dynamic multivaluedness phenomenon naturally emerges in the universal science of complexity due to the *unreduced* interaction analysis and provides realistic representation of the observed nonunitary evolution. It is not surprising, therefore, that the unitarity of the canonical knowledge, dominating way of thinking, and “governing” social system are inseparably related within the same, strongly restricted complexity level designated as Unitary System and always opposed to any manifestation of the unreduced, naturally developing (internally changing) dynamic complexity.

⁴ Indeed, that all the “protective” efforts of the canonical ecology can only slightly “optimise”, but not eliminate the inevitable degradation of environment and quality of life follows not only from the “generalised second law”, but even from its usual versions supported by numerous qualitative and quantitative observations and estimates. The same conclusion can be drawn for various existing (and often quite popular) versions of pseudo-ecological “primitivism” insisting on “returning back to Nature”. They correspond to *decreasing* complexity of living (instead of its growth objectively determining the unique direction of the true progress), and it is clear, in particular, that “primitive societies”, especially when they are dense enough, can produce much larger harm to the natural environment than “industrially developed” ones, as confirmed by currently progressing destructive processes in some “developing” countries (especially those with uncontrollably growing population that keeps basically “primitive” life style). These practically confirmed conclusions show that all the existing types of society belong, despite their visible diversity, to the Unitary System, for which there can be no any “really good”, decisive solution of “ecological” problems.

“dynamically multivalued” (not mechanistically “eclectic”!), non-unitary thinking, social structure, production, living, interaction with the “environment”, etc. In the system of knowledge this transition realises the ascent from the canonical, single-valued, unitary science to the ultimately complete and unified science of complexity, as it is described above. Correspondingly, at the level of Harmonical System “ecological” issues naturally pass from inevitable “sustainable destruction” at the ending Unitary System stage to “sustainable (practically unreduced) creation” characterised by production of a qualitative new type of structures of a “man-made nature” type, or “SuperNature”, which possesses *not lower* complexity than “natural nature”, as it inevitably happens with man-made structures within the Unitary System, but *higher* complexity than the “untouched”, “wild” environment. This shows unambiguously that the full acceptance and application of the new, unreduced concept of complexity is the indispensable basis for the real transition to the level of Harmonical System and creative ecology, contrary to various existing superficial *imitations* of “revolutionary” type pointing as if “in the same direction” of “progressive change”, but actually *lacking* the essential, profound, causally complete *understanding* of the origin, direction, and content of the necessary changes (the recent Western “youth revolution” in 60-70s with the pronounced “nature-oriented” tendencies and its further “green” ramifications provide a characteristic example of such poorly based “high hopes” inevitably ending just with a more profound degradation of the existing, unitary type of life, without any its really progressive change).⁵

It is also evident, already within the current stage of development, that there can be no more “pure ecology” and that in order to become the objectively substantiated, truly scientific knowledge, ecological approach should naturally incorporate all the dynamically related domains of complex reality, including the unreduced, entangled physico-chemical, biological, social, economic, political, psychological and other aspects. The natural, dynamic unification-entanglement of the new Harmonical thinking is qualitatively larger than any mechanistic “interdisciplinarity” readily acknowledged already within the existing unitary science, but always reduced to a mechanistic “superposition”, eclectic agglomeration of internally disrupted “pieces” of extremely simplified, effectively one-dimensional imitations of reality. The extended, causally complete and creative ecology of the new level of complexity can be considered rather as a particular (and actually quite natural) “entrance” to the Harmonical level of life in general, naturally unifying all its aspects, as it has been expected, especially since the beginning of this century, in a number of approaches centred around the concept of Noosphere (in particular, due to works of Pierre Teilhard de Chardin and Édouard Le Roy in France and Vladimir Vernadsky in Ukraine/Russia). However, being often intuitively correct, all the previous ideas in this direction could not be properly specified up to the objective, scientifically substantiated, and reality-based knowledge capable to induce real qualitative changes. Now we can realise such specification of Noosphere (and similar expectations) within the unreduced concept of complexity that comes, without any coincidence, just at the time when the Unitary System development has *fully* realised all the possibilities of its level of complexity (because *technically* it can give “everything to everybody”, but *cannot* realise the maximum personal satisfaction and really high *quality* of everybody's life practically, even at the existing level of complexity [1]), so that civilisation simply *cannot* remain any more at the current level without seriously risking to suffer many “global”, “demolishing” catastrophes.

Within this brief presentation we can only schematically outline some major properties of the unreduced, causally complete structure of the new level of complexity of civilisation development designated as Harmonical System, or (causally extended) Noosphere. The social structure at the Harmonical level is not dominated any more by rigid unitary hierarchies of “power” of any sort and scale; this is not a pyramidal, centralised, but rather *distributed*, “multi-peak”, fractal-network type

⁵ It should be quite clear that any external, “political” or “ideological”, variations of the Unitary System, of any “side” or “colour”, promoted by various “political forces” can produce only another version of the same unitarity (often yet more simplified, in accord with the intrinsic level of consciousness of self-proclaimed “forces of progress”), despite externally big changes during canonical “social revolutions”. The really essential, qualitative change from the Unitary to Harmonical System can be realised only through internally continuous, peaceful (but “conceptually” dramatic) “revolution of complexity/consciousness” based on the profound, qualitative change of the dominating “way of thinking” (dramatic *growth* of its explicit complexity) and practically occurring, most probably, by a gradual (though relatively rapid) growth of the “seeds” of new thinking within the exhausted Unitary System.

of structure, and what is most important, it is a *dynamically* “self-controlled”, and therefore permanently self-developing, progressing structure practically realised, in any field of activity, as a large number of *intensely* interacting, mutually and *directly useful, explicitly creative* “enterprise”-initiatives of basically “small”, often “individual”, material “size” (they can *dynamically* form larger unifications for attainment of various extended goals, etc.). The total *openness* and free, easy informational access, *personal*, well-specified *responsibility* and well designated, *causally complete results* (explicit, *complete solution* to a problem in the sense of unreduced complexity specified above) are natural, irreducible properties of the new social structure dynamics. It is not difficult to understand also that all “standardised”, “mass” types of phenomena (in any “production”, “popularity”, material and informational “distributions”, social “motions”, etc.) inevitable within the Unitary System with its “industrial” development of *everything*, will be replaced with *individually* structured dynamical hierarchies of the unreduced creation in all fields of human activity (where the “main directions” exist, but “emerge” naturally, as a result of the unreduced “self-organisation” of many really freely interacting individual tendencies and efforts). The practically unlimited, “sustainable” progress (growing complexity) of the Harmonical System is determined by unrestricted possibilities of creativity of the unreduced, interacting imagination and “spiritual” levels of human complexity dominating the (new) “material” levels within the new system, contrary to the pronounced domination of the lower, “material” levels and related “market-place thinking” within the Unitary System which are basically *limited from above* (that’s why the Unitary System cannot progress in principle after the current stage of “technical satisfaction” of everybody).

It should be clear that the described new type of social structure changes dramatically the possibilities of development of “ecological” aspects of life already “in general”, by the described new possibilities in every aspect of its functioning. However, based on the universal criterion of natural complexity growth, one can also suggest more specific changes of the “material” structure of civilisation directly involved with ecological problems. Thus, a new type of human settlement, realising the above principle of the unlimited “man-made natural environment” (SuperNature), will progressively appear and grow to the scale of the whole planet. This qualitatively new kind of man's habitation can be described as a City-Forest, or ForestVille, where human settlements with their whole “infra-structures” are *totally* submerged into, and *determined by*, a man-made (but also *naturally developing*) “forest” or another pertinent natural environment that is much more “natural”, and qualitatively more *inclusive/universal*, than modern “parks”, but is neither as “wild” as usual “natural” forests (and actually possesses *higher* total complexity than the latter). It is important that not only the original natural elements, such as plants, will be much more present in this new environment, but also all infra-structure elements will as if “follow the living forest tendency” by being organised into structures of at least the same, and then higher, dynamic complexity (one can compare this type of structure with the opposite case of ultimately simplified “dictatorship of stone” in the internal structure of even the best modern cities). One can say that, in a way, this kind of solution realises the fundamental “return to Nature” (as well as to related “artisan” modes of interaction with it and material production) intuitively desired or implied by many “ecological” tendencies, but now realised at a much higher level of complexity, where one can not only preserve the quality of a “civilised life”, but also crucially (and unrestrictedly) increase it. We deal here rather with the man-made return *of* Nature, which is “constructed” as a guided living structure complexity, with the indispensable explicit *understanding* of its *unreduced* dynamics (inaccessible to unitary science imitations, irrespective of the “computer power” applied). We emphasize therefore that the actual realisation of the new kind of environment can be based only on the causally complete understanding of the unreduced complexity of natural processes at all levels, which necessitates a decisive change of the whole system of knowledge and thinking, now properly specified by the universal science of complexity [1]. It should also be clear that there will be many (permanently changing) types of the new environment that may be originally closer to one or another type of the usual natural environment (such as “savannah”, or even “desert”) and then progressively exceed, by both their dynamic complexity and external “look”, anything ever produced by the known “natural nature” of the planet.

In any case, the “ecological” problems change qualitatively their status in the new type of settlement (and the related new social structure): in principle, this new “way of life” is not only “automatically clean” by its very essence, but it is also “self-cleaning” and *the more “ecologically prosperous” (sustainable), the more it develops*, which is the true essence of the *genuine, unreduced sustainability* concept (as opposed to the inevitably growing contradiction “between man and nature” within the current, Unitary level of life that can be only externally “accommodated” within the canonical, “protective” ecology approach). This means that within this new kind of living men do not try (vainly) to “protect nature” from himself, but rather to *create*, and re-create, *ever growing* “natural” (unreduced) complexity, without any visible limitations to the appearing new forms and related levels of consciousness of the progressively emerging SuperNature, which demonstrates once more the irreducibly creative character of the Harmonical System of life and its superior possibilities “intuitively” predicted within the Noosphere paradigm and similar concepts. In fact, at a developed enough Harmonical level of complexity/consciousness, there can be no essential remnants of the current ruptures between “artificial” and “natural”, “production/work” and “consumption/pleasure”, “science”, “ecology”, “art” and “practical life”, “protection” and “creation” (not to mention the canonical “rich” and “poor”!), since the *unreduced* interaction processes are described within the universal science of complexity as inseparable *entanglement* of interacting entities naturally forming the “compound”, qualitatively new entities of higher levels of complexity that continue the unrestricted development of the existing stock of “potential” complexity (dynamic information).

In summary, both specific and general applications of the qualitatively new, causally complete knowledge of the universal science of complexity to ecological problems outlined above lead to essential extension of ecology to an objective, truly scientific domain of knowledge inseparable from the necessary similar transition in other fields of knowledge and the accompanying practical, global transition from the currently dominating (but completely exhausted) Unitary System to the qualitatively superior Harmonical System of thinking (consciousness) and practical living.

References

- [1] A.P. Kirilyuk, *Universal Concept of Complexity by the Dynamic Redundance Paradigm: Causal Randomness, Complete Wave Mechanics, and the Ultimate Unification of Knowledge* (Naukova Dumka, Kiev, 1997), in English, 550 p. For a non-technical review see also: E-print physics/9806002 at <http://arXiv.org>.
- [2] A.P. Kirilyuk, “Double Solution with Chaos: Dynamic Redundance and Causal Wave-Particle Duality”, E-print quant-ph/9902015 at <http://arXiv.org>.
- A.P. Kirilyuk, “Double Solution with Chaos: Completion of de Broglie's Nonlinear Wave Mechanics and Its Intrinsic Unification with the Causally Extended Relativity”, E-print quant-ph/9902016.
- A.P. Kirilyuk, “Universal gravitation as a complex-dynamical process, renormalised Planckian units, and the spectrum of elementary particles”, E-print gr-qc/9906077 at <http://arXiv.org>.
- [3] H. Bergson. *L'Évolution Créatrice* (Félix Alcan, Paris, 1907).
English translation: *Creative Evolution* (Macmillan, London, 1911).
- [4] H. Haken, *Synergetics. An Introduction*, 3rd edition (Springer-Verlag, Berlin, 1983).
- H. Haken, *Advanced Synergetics* (Springer-Verlag, Berlin, 1983).
- H. Haken, *Information and Self-Organisation: A Macroscopic Approach to Complex Systems* (Springer-Verlag, Berlin, 1988).
- H. Haken, “Slaving principle revisited”, *Physica D* **97** (1996) 95.