Information Ecology in The Context of General Ecology: A Review

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Abstract--- The environmental method studied in this paper is a new level of knowledge studies. This allows for a better understanding of information processes in society, as well as a more effective development of information processing systems. Information ecology offers a conceptual framework for the analysis of data, the production of knowledge and the flow of information within a multidimensional context. This paper describes and analyses ecological studies in a variety of fields, from biology to technology, to sociology, to knowledge and information. Subsequently, elements of the general ecology building methodological and philosophical foundation for information ecology were presented and a concise definition of information ecology was developed and information ecology further developed as a methodological basis for information studies, generally based on the concepts and principles of the general information theory [1]. Complexity, ambiguity, and non-linearity are part of information ecology and are addressed today by exploring multiple types of knowledge, developing vocabulary for the information system, and recognizing the need for intermediation.

Keywords*--- information; ecology; process; environment; interrelations; subject information; object information; model; structure; pattern*

I. INTRODUCTION

Knowledge is a very complex phenomenon. Data can be analysed at several rates. The first stage focuses on information as a fundamental phenomenon in nature, culture and technology, exploring the properties and connections of knowledge. Definitions of first-level theories are the general theory of information and the qualitative theory of knowledge. The essential and inherent nature of the information is of primary importance to scientific research. There have been many debates and recommendations on these topics. The most advanced and detailed answer can be found in the general theory of knowledge. Dynamics of information has a prevalent importance for contemporary society, since mankind has reached the information age. At the third level, researchers are investigating information systems and processes in these systems, focusing on the products and services of the information process and on the interrelationship between information and products / services in the information environment. The ecological approach to information is at this level. Information ecology research is based on a global view of the existing interrelationships between information, knowledge, data [2] and information processing systems. Ecological approach in information studies presupposes the integration of knowledge and cognition from the first two levels of development of the most detailed and wide-ranging image of information reality The purpose of this paper is to construct the foundations of information ecology based on

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the principles of general ecology developed by Burgin, because any science in general and information ecology in particular requires it. It is necessary to understand that there are many interesting and important issues related to the study of knowledge. However, because information is one of the basic phenomena of the world, everything has more or less to do with information. The scope of information ecology does not include all phenomena in the world. By the same token, celestial mechanics studies the dynamics of planets, but does not tell anything about people living on one of these planets. Plant ecology does not discuss atoms and molecules, although all plants are made up of atoms and molecules [3]. This is a scientific approach, given that each science has its own domain, and that information ecology has been built as a scientific discipline. That is why, for example, the diversity of definitions of information suggested by different researchers has not been discussed here, but our work is based on the axiomatic definition of the general theory of information as the most advanced and inclusive theoretical model of information.

II. FUNDAMENTALS OF GENERAL ECOLOGY

In the sense of natural ecology, the basic definition of the environment (ecological system) which is important to the various ecological disciplines has been suggested. This definition has been established in a much broader context, including the current variety of ecological disciplines. With this objective in mind, the effect of the economic structure of the world on the organization of the environment has been illustrated. There are different models of the world where people live. Some assume that only material (physical) reality exists. Others add to it individual mentality called Mind. Here it has been based our study on the most advanced large-scale structure of the world, which has the form of the Existential Triad. It is given in Figure 1 being scientifically elucidated in the book.

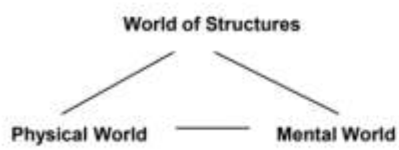

Fig.1: A graphical representation of the existential triad of the world.

The three realms that make up the Existential Triad are not separate realities: they communicate and touch. The mental world involves the mind of the human. It's based on the brain, which is a material thing, but it involves the mind. Mind-brain relations have been discussed by many philosophers in the context of the mind-body problem and there is no mutual agreement on this issue. However, not all the different approaches and opinions in this area have been discussed here, because this is not the aim of this paper. In addition, it must be understood that this problem belongs to the second level of information and cognitive studies, while information ecology [4] brings these studies to a higher, third level. At the same time, many physicists believe that mind has an impact on the physical world. This is only a working hypothesis, but it is certainly established that our knowledge of physical reality depends mainly on the interface between the mental and physical worlds. Note that there is no fundamental distinction between the material and the physical worlds in the context of the Existential Triad of the World. Nevertheless, not only humans, but also all types of information processing systems have a particular mind-set. For example, the content of the computer memory can logically be regarded as the inherent mentality of the computer. The operating system or word processor is therefore a basic part of the computer mentality.

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The World of Structures offers a theoretical manifestation of Plato's World of Ideas / Shapes since ideas or shapes are properly connected to structures. As shown by the presence of structures, hypotheses and tests are confirmed in a manner similar to that applied to material things, such as desks, chairs or houses. As a consequence, the structures are the structural level and the part of the universe. As a rule, when it is necessary to do so, knowledge of the mechanisms is essential for learning or for the development of systems and processes. Structures, which also include various interrelationships and geometric shapes, form material things in their life and understanding. Ecological approach makes it possible to explain homological processes in the physical and mental worlds. In the physical world, the development of organization and complexity is going through the following stages:

- Physical ecosystems comprise physical systems, arrangements and processes as its elements, parts and components.
- Mental ecosystems encompass mental schemas, arrangements and processes as its elements, parts and components.
- Structure ecosystems consist of structures of physical systems, arrangements and processes as its elements, parts and components.

For example, a mathematical model of a material ecosystem is a structural ecosystem, while a mental model of a material ecosystem is a mental ecosystem. Other examples of structural ecosystems include mathematical models [5] of scientific theories when the processes underway in these systems are included in the model. Combining all three components of world stratification into one structure, a complete ecosystem has been formed. Total habitats have three basic components:

- The physical constituent of the ecological system and its environment comprises physical systems, arrangements and processes.
- The structural constituent of the ecological system and its environment consists of structures of physical systems, arrangements and processes.
- The mental constituent of the ecological system and its environment encompasses mental schemas, arrangements and processes.

A general ecosystem is determined by three characteristics:

A section in physical (mental or structural) space (or a region in a scientific sphere), i.e. it is assumed that all the elements and components of an ecological system belong to a specific section in space (or a specific region in a scientific sphere). Key categories of its elements, parts and components, i.e. what elements, parts and components of the specified ecological system are considered to be the most imperative from the point of view of environmental studies. The main types of interactions and interrelationships between its elements, parts and components, including processes as dynamic links, i.e. the determination of the relations, associations and processes within the defined ecological system, are most essential from the point of view of the ecological studies.

III. METHODOLOGICAL ISSUES OF INFORMATION STUDIES

It is well known that information is a category of critically important resources for human beings as well as for all

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kinds of living beings. As a result, humans have information processing and utilization organs that are capable of handling information: (1) the sensing organs receive information from the environment; (2) the nervous system, including brain processes, and the transmission of information from one point to another within the human body that produces knowledge and intelligent problem-solving strategies; and (3) the action organs that provide information. In addition, people have created an array of technical information devices and resources to improve the roles of human knowledge bodies in the handling of information. Examples of such systems include different types of sensors, communication systems and networks for the transmission and distribution of information, information processing computer systems, knowledge and decision-making artificial intelligence systems, strategy execution control systems, and so on. There is, however, a distinction between the functioning of human information organs and the activity of technical information systems. On the one hand, assuming a satisfactory state of the entire body, human knowledge organs have always worked effectively and smoothly, with well-balanced inter-relationships between them, constantly promoting human development. On the other hand, various types of technical information systems designed to enhance human information organs have not been able to achieve sufficient harmony between technical systems, human beings and the environment. The problem lies in the establishment of the relevant links between the technical information systems. Many such systems, e.g. computers, were initially designed without interconnections between them. Later on, with the advancement of local and global computer networks such as the Internet and local networks, technical information systems have become increasingly interlinked, but they have not yet achieved the harmony and efficiency of human information processing systems.

IV. ECOLOGICAL APPROACH AS A NEW METHODOLOGY FOR INFORMATION STUDIES

Let us recognize knowledge ecology as a methodology for the study of information. It will allow us to understand what progress could be made on the basis of this methodology and what opportunities can be derived from applications.

IV.I. The Concept of Information Ecology:

As usual, the definition of a new terminology is necessarily needed first, so that the understanding and application of the terminology can be both accurate and reliable in the future [2]. The definition of information ecology shall, of course, preserve the spirit of the definition of general ecology. The effectiveness of this concept is shown by the implementation of ecological concepts in other fields, such as plant ecology, animal ecology and other environmental considerations. Of example, the significance of the relationship between the system and its environment is well illustrated in the book and it is not necessary to reiterate those points here. The definition of information ecology did not define information or information processing because the definition of information and information processing belongs to the level 1 of the information studies and the information ecology of the studies. That is why this paper does not address different approaches to the definition of information, but takes as its basis the concept of information from the general theory of information, the most detailed description of which is given in the book. From the point of view of scientific research, there are two basic approaches to the theory of reductionism and holism examined. The major feature of reductionism is dividing a complex system into elements and reducing the theory of the system to the theory of its elements. Ecological theory in general and information ecology in particular base their studies on holistic approach because relations, connections and processes uniting separate elements in an integrated system produce synergy making the whole system irreducible to its elements. Ignoring these regularities of system science [6] can cause various misconceptions and result

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in waste of time and energy in human society.

IV.II. Information Ecology as a Research Model:

The key issue of any research in general and knowledge studies, in particular, is the correct selection of an acceptable basic structure for the representation, modelling and exploration of the research field. An important breakthrough in knowledge ecology is the implementation of the "subject-object-interaction" triad framework as a basic information research system. The structure is described in Figure 2.

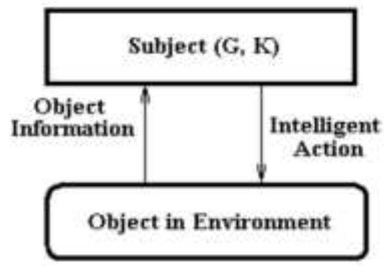

Fig.2: The triadic informational structure

"Subject-object-interaction" as a fundamental triad or set of names allows the use of the mathematical theory of named sets developed for the modelling and exploration of cognitive processes. This shows the fundamentality of "subject-object-interaction" because it has been shown that fundamental triads are the most critical structure in nature, mathematics, society and cognition to support insight. In addition, it has been shown that fundamental triads are indispensable for a variety of fields, including information theory, mathematics, chemistry, physics, networking and networking, logic, AI, database theory [7] and practice, mathematical linguistics, biology, epistemology, philosophy and science methodology, to name but a few. In the graphic representation (see Figure 3), a basic fundamental triad or a particular set called has the following appearance:

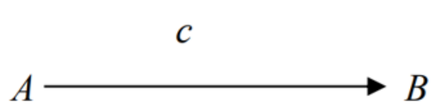

Fig.3: A basic fundamental triad or a basic named set.

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In symbolic representation, the basic fundamental triad has the form X= (A, c, B) where A and B are two objects and c is a connection or association (e.g. a binary relationship) between A and B. In the fundamental triad X, object A is called support X, object B is called name part (reflector) or name set X, and c is called naming correspondence (or reflection) of triad X. It must be understood that in the fundamental triad X, c is not always a function or a mapping. In the typical example of the simple named set (fundamental triad), the object A is made up of people, the object B is made up of their names, and c is the relation between people and their names. Another example is the simple name collection (fundamental triad) the object A consists of books, the object B includes their names, and c is the relation between books and their titles. A bi-directional fundamental triad or a bi-directional called set has the following appearance in the graphic representation (Figure 4):

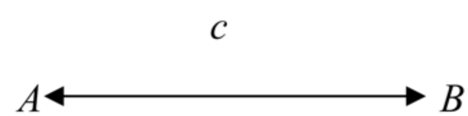

Fig.4: A basic fundamentals tried or basic named set

In a symbolic representation, a bi-directional fundamental triad has the form X= (A, c, B) where A and B are two objects and c is a two-way connection or association (e.g. binary relationship) between A and B. An essential example of a bi-directional set of names (a bi-directional fundamental triad) is provided by two people who communicate, i.e. by exchanging messages, e.g. e-mails, texting or talking to each other. In this bi-directional fundamental triad, A and B are human beings, while C consists of messages from one person to another.

In situations where mathematicians, physicists or computer scientists use connections or ties without a specific direction, such as edges in general graphs, in essence, these ties have both directions as in the bi-directional fundamental triad. As a result, it can be seen that the "subject-object interaction" structure (Figure 2) actually comprises a model in the world of information that provides efficient means for information studies in general and information ecology as their methodology. The "subject-object interaction" triad explains the situation where the object contains information for the subject and it is natural to call it "object information." In the course of interaction, the subject, having received knowledge about the object, frequently acts on the object physically, structurally or / and mentally. The action taken by the subject should be sufficiently intelligent to prevent such risks. Intelligent action must meet two conditions:

- It must be aimed at achieving the objective of the subject.
- The relationship between the machine and the world should be harmonious.

Another point worth mentioning is that the subject in the "subject-object interaction" triad is not necessarily a single individual. Instead, it may be a group of people, an organization, or even a society as a whole, as long as it has a common goal and knowledge. While the model of information studies based on the "subject-object interaction" triad is fundamental, it is extremely abstract. In order to be closer to scientific research in the field of information and even more closely to information processing techniques, it is necessary to specify in more detail the broader picture and the efficient structure of information processing systems and their complexities in an appropriate environment. Living beings, such as humans, animals and plants, consume energy, such as energy from the sun, and material things, such as water or air, with

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the aim of producing energy and substance to sustain themselves and produce other material things. In the same way, information processing systems consume information and structural objects, such as data [8] and knowledge for the production of new information and knowledge and for the achievement of intelligence. These processes provide for the construction of the next level of the information study model presented in Figure 5.

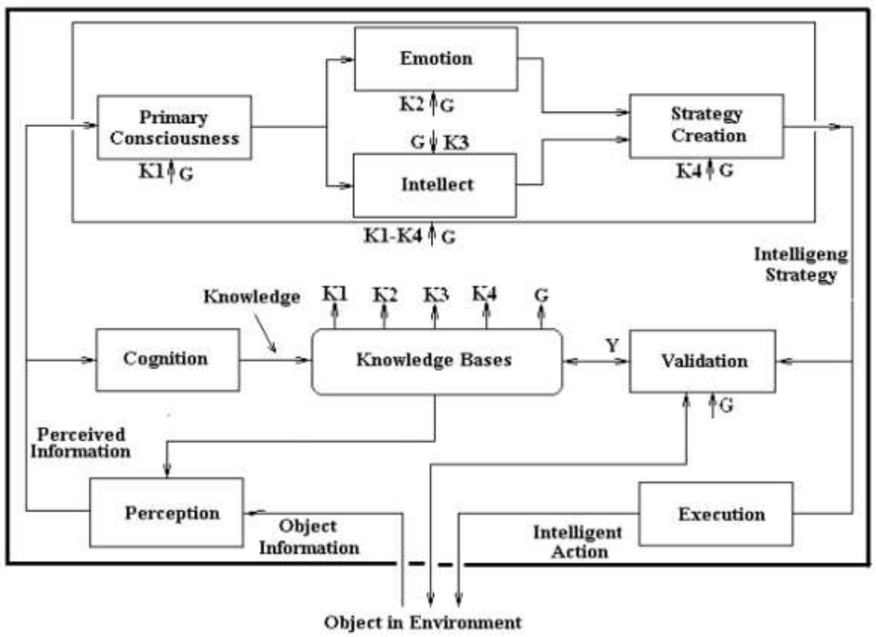

Fig.5: A detailed model for processes in information studies.

This process has been called the perception-processing-action cycle because it is repeated in people's intellectual activities. If the result of the intelligent action differs from the objective, the subject receives information about the error and repeats the perception-processing-action cycle. This cycle is also repeated in order to gain more knowledge, optimize the strategy and achieve a better result with less error and/or reduced resource consumption. The model for information studies presented in Figure 3 shows that the information discipline is a large, extremely complex system involving a variety of human information activities. It should be noted that there are three levels of perception. The first level is the receipt of information transmitted from the sender to the receiver. At this level, only the transmission of information without the processing of information takes place. The second level is the perception of information that comes to the recipient from a container / source of information. The transmission of information is followed by the processing of information at this level. The third level is cognition when the cognizer extracts / receives information from the information container. At this level, the extraction of information involves the processing of essential information and the production of new information.

IV.III. Ecological Approach in Information Studies:

A study technical framework based on this model has been developed following the development of a general model for third-level information studies discussed in the Introduction. A number of different approaches have been implemented in the knowledge study: systemic approach, functional approach and behavioural approach, to name a few. Each of them has made some progress while also facing challenges. Which one would be most fitting for the knowledge

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study? As noted above, the focus of information ecology as a methodology is the study of the interrelation between information processing systems within the organization. From the model of information discipline in Figures 2 and 5, it can be seen that the nature of information processes is the flow of information, which transforms object information into perceived information, continues to understanding, and creates an intelligent plan for action and, eventually, results in intelligent action. This structure forms the basic loop of the flow, which is the lifeline of the information processing system. The key issue for the information processing system is how to construct a mechanism through which the information flow can be successfully realized, controlled and operated. In addition, the role that the structure and operation of the information processing system should play is to serve and sustain the mechanism of the system so that the flow of information can be understood while the action of the system is the result of the application of the mechanism. The spirit of flight is the theory of air physics, not the particular structure of the airplane. Similarly, the soul of information processing systems is the mechanism by which the information flow of the system can be produced, rather than the structure, functions or behaviour of the system itself. It is clear from the analysis [9] carried out that the approach, which consists of a series of information conversions, is the most appropriate approach to information studies. This is the essence of information ecology as an information discipline methodology.

IV.IV. Basic Relations and Processes in Information Ecological Systems:

On the basis of the information ecology guidelines defined as a framework and model for the study of the information discipline, it is possible to explain many important categories of interrelations in the information ecological model. This was the study of the interrelationships between object information and perceived information, which constitute the first category of basic interrelationships according to information ecology. Our analysis is based on the axiomatic definition of information developed in the general theory of information. For a long time, the majority of researchers thought that human sensing organs and technical sensors were responsible for converting object information into perceived information. This is not true, however. For example, the concept of information as defined in Shannon's Information Theory does not provide a comprehensive representation of perceived information, but only reflects one of its components. It is therefore necessary to clarify what object information is and what information is perceived to be before other things are done.

IV.V. The semantic information production:

According to the author, the semantic knowledge about the object is the subject's interpretation of the nature of the object. The process of abstracting the system {syntactic (n), pragmatic (n)}, which is defined in steps (1) and (2), into semantic space can therefore produce semantic object details.

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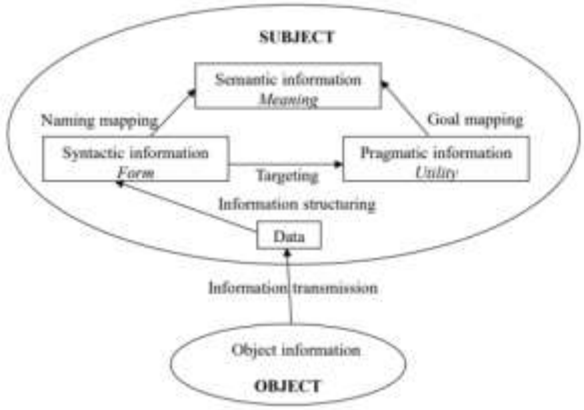

Fig.6: Conversion of object information into perceived information in intelligent systems

All perceived syntactic information, pragmatic information and semantic information have been produced and made available. This shows that the interrelations between the object have been produced and are available. This shows that the interrelations between object information and perceived information are properly described in the three steps described above. Note also that if the syntactic information is denoted by the symbol X, the pragmatic information by the symbol Z, and the semantic information by the symbol Y, then according to Figure 6, the essence Y can be derived from X and Z, which can be represented by the following expressions:

$$Y = \lambda(X, Z)$$

The 5-007 symbol in Expression (1) stands for an operator of abstraction and naming, which is a basic operation in the theory of named sets. In fact, Expression (1) can be regarded as a strict definition of semantic information that improves understanding that existed before.

V. CONCLUSIONS

The benefits of information ecology as a framework for information studies in the sense of general ecology have been explored. The context, the definition, the progress made and the importance of the new methodology have been identified. At the same time, it is difficult for one paper to cover everything from the field of information ecology. Other issues are being discussed elsewhere. Note that, having understood a model that expresses the interrelation between object information and perceived information in humans, it is essential to investigate whether the interrelation between object information and perceived information can be technically implemented.

REFERENCES

[1] J. Harte and E. A. Newman, “Maximum information entropy: A foundation for ecological theory,” Trends in Ecology and Evolution. 2014.
[2] S. E. Hampton et al., “Big data and the future of ecology,” Frontiers in Ecology and the Environment. 2013.
[3] S. C. Watkinson, “Molecular Ecology,” in The Fungi: Third Edition, 2016.
[4] C. E. Grueber, S. Nakagawa, R. J. Laws, and I. G. Jamieson, “Multimodel inference in ecology and evolution: Challenges and solutions,” Journal of Evolutionary Biology. 2011.
[5] B. M. Bolker, Ecological models and data in R. 2008.

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[6] A. S. Hahn, K. M. Konwar, S. Louca, N. W. Hanson, and S. J. Hallam, “The information science of microbial ecology,” Current Opinion in Microbiology. 2016.
[7] W. K. Michener and M. B. Jones, “Ecoinformatics: Supporting ecology as a data-intensive science,” Trends in Ecology and Evolution. 2012.
[8] C. M. Beale, J. J. Lennon, J. M. Yearsley, M. J. Brewer, and D. A. Elston, “Regression analysis of spatial data,” Ecology Letters. 2010.
[9] L. Z. Garamszegi, “Information-theoretic approaches to statistical analysis in behavioural ecology: An introduction,” Behavioral Ecology and Sociobiology. 2011.

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