Architecture and Structure in Open and Intro-Open Systems*

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1. In a previous communication [1] some relations between information and structure were examined. This paper will present an overview of the architecture and structure of systems[1].

There are two major classes of systems to consider: *open systems and intro-open systems* [2]. This does not mean that we cannot imagine a closed physical system and treat real open or even intro-open systems as quasi-closed. But only under certain conditions, and with certain negligence, systems can theoretically be seen as closed systems.

If we do not need to insist on the notion of open system, being the object of systems science so developed today, instead we should show what *we mean by intro-open system.*

We believe that from a philosophical point of view, nature, existence, creates not only open systems but also intro-open systems. We could exemplify the system introduced by the case of the human brain whose psychological level has the potential to open to the establishment of structures that it can invent, so which are not given to it from its existing structures or received from outside.

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[1] The title of the paper includes the term intro-open system. We will notice an important difference between the intro-opening (introdeschidere in Romanian) and the half-opening (întredeschidere in Romanian). In Romanian, the words introduction and introspection are used. Intro-opening is a notion first used in another paper and is more related to introspection than to half-opening (întredeschidere). The meaning of the half-opening as a narrow space between two elements that do not close or do not fit together perfectly does not correspond to the meaning of the intro-opening.

Recognizing a special psychological level, although related to the concrete substrate, to the spatio-temporal substance, does not actually mean intro-opening. If we think about microelectronic intelligence, isn't an artificial intelligence program also a psychological level? A recent paper is entitled "Psychology of Artificial Vision" [3] and it is known that artificial vision is a subdomain of artificial intelligence. Can a device with artificial intelligence be an intro-open system?

In previous works [2] [4] we deny this possibility. Intro-opening implies an access of the psychological level and to the physical depths of the material world not only to the spatio-temporal universe of current physics. So we do not stop like Heidegger [5] in the middle of a road that proves to be bivalent philosophical, that is, with the possibility of materialist interpretation but also, in fact, especially idealistic. The fact that there is a path of intro-opening we find reflected for a long time in Romanian as Constantin Noica would find studying the meaning of the Romanian word "întru"[2] [6]. Even if Noica's analysis is of Heideggerian type, it eliminates the philosophical bivalence, demonstrating how in Romanian "our experience of being proves to be a rational one" [7]. The philosophical fairy tale "Youth without old age" called "the fairy tale of being" by Constantin Noica [8] shows how man penetrates the basic nature of things. This fairy tale reveals to us, through Noica's philosophical interpretation, how man can get there in depth and be their equal. The Romanian fairy tale, the first in Petre Ispirescu's collection, offers an ontological model foreshadowing not only the opening of a road *întru* but also a journey to the end that Heidegger avoided. Heidegger contemplates *întru* and, this rather poetic contemplation, it is after him the true thought.

Interesting in relation to what we call intro-opening is also the position of Edmund Hesserl [9, 10]. Husserl not only does not deny the spatio-temporal openness of any system, but unlike Heidegger he even pays all his attention to what it represents as reality and to the way in which science treats it. But he also seeks the phenomenology of the world through the psychology of man. Not through the spatio-temporal psycho-physical but through what could be placed apart from it, beyond it in the form of a pure phenomenological consciousness. Huserl's intro-opening, opening in the opposite direction to the spatio-temporal one, stops in a pure consciousness. At Husserl there is an intro-opening but

[2] The Romanian word "întru" is a pretty hard word to be translated in other languages. Let's try in English to translate it by "get into". It evokes a tendency toward deep realm, like in "my mind can *get into* some pretty deep stuff". (tr. note)

it stops in itself, although other nuances appear in his works that lead to considering him a philosophical polyvalent.

However, intro-oopening can have different *materialistic* nuances. The simplest first is that as a psychological level, in which the information itself can develop anyway, within certain limits, in relation to the physical substrate. The second interpretation is that of a psychological level that has not only a connection with a substratum known to current physics but also a material support of a new physical nature, deeper nature that really allows new, free, creative structures, the level itself psychological. The deep substance could be one of the ingredients necessary to become all the spatio-temporal realities, ensuring a ring of the material world.

Everything that is alive, by extrapolation, appears to us as intro-open, but the greatest interest is presented by the human brain as an open and intro-open system. When we say default intro-open system we will also understand open. The opening is dominant, the intro-opening is more hidden. Strictly open are only the lifeless systems, so also the technical systems created until today.

2. The notion of *architecture* of systems, at least of the systems that process information, and we will refer in the first part of the paper only to open systems, seems to be of particular importance. It is no coincidence that it appeared in the field of electronic computers. Although it seems to be an extension of the notion of architecture in the field of construction, the architecture of electronic computers has a much more subtle meaning that we can extend to all systems that include information systems. It is true that even specialists and manufacturers of electronic computers are not always consistent. They talk about the abstract architecture of a computer but also about the hardware architecture of the computer as well as the architecture of the software. Today, the combination of hardware, firmware and software, through firmware understanding what is microprogrammed in the computer, is so intertwined that *the notion of architecture can only refer to the whole computer viewed from the user's point of view. So the architecture appears at the user-computer interface.*

It is true that a computer can be viewed by a user at different levels, to take a theme from psychology and philosophy, for example at the level of microprogramming or Fortran language or a specialized language for certain requirements and functions. Each of these levels can be realized in different ways, for example a program in FORTRAN can be executed by means of a compiler (so by software routines) or it can be translated by firmware (microprograms), in microinstructions. It is important for the user to know the FORTRAN language, together with other logical aspects regarding the operational structure of the computer, including time constraints and other necessary aspects. What lies behind them, such as hardware, firmware and software, is less important, but can only be achieved with the help of certain structures of this type. The hardware and software structure was not available for a while. Today, through microprogramming, the computing technique knows important transformations *new structures* of computers allow the realization of *new architectures. But we make a difference between structure and architecture.* The first depends on the constructive technology of computers, memories and technical interfaces, the technology of programming and microprogramming, the second should depend on what we want from the computer and then on how we logically design information systems. So far, architectures have resulted from hardware-software structural organizations. The still huge technological possibilities of microelectronics, the emergence of artificial intelligence, make us think that we should do the opposite. *Let's imagine architectures and hence establish requirements for structures.* And the imagination of architects also includes requirements in relation to the human information universe, and let's not forget that the human brain has various levels, also in relation to society as a whole or its socio-technical and technical systems, tasks that I consider the field of functional electronics.

To imagine an architecture means to assume in the abstract a possible structure to realize it. The notion of "abstract machine" or "abstract electronic computer" is gaining ground lately. Kevin C. Kahn of Intel Corporation (Santa Clara, California) defines [11] with J. N. Fasel *et all.* the abstract computer as a collection of hardware and software that provides a well-defined set of functions. An abstract computer or automaton can only be made of hardware. An abstract automaton made by software has always been a good candidate for hardware integration [11]. In this case, firmware, as solid memory, is understood to be part of the hardware. Then, remarks Kevin Kahn, he can build an automaton dedicated to an application in the form of a single microelectronic device, i.e., a very large-scale integrated circuit (VLSI). At the other end, we could build " microprogrammable computers' of the highest generality but ... with ... a very low level of functional integration [11].

I have cited these considerations because in specifying an architecture, it can be developed for a specific function, a range of functions or an architecture can be designed for general use. For example, what would be the architecture of a general artificial intelligence, as general as human intelligence? Can we go in this direction? In principle, yes, but it seems that we do not yet have the necessary structures to achieve such a requirement. *The functional approach, by functions and with the integration of these functions, I consider to be the most convenient in the current stage, for the architecture of information systems of any class they would be.* Of course, these functions must be seen in relation to the requirements of man and society, so the functions we are interested in are no longer the traditional ones, amplification, recovery, logical calculation, arithmetic calculation, etc. but more general, otherwise oriented, but encompassing them. resort to the former. The combination of these functions, locally or distributed is another problem, in line with the contemporary trend towards distributed computing.

That is why the notion of *architecture*, in my opinion, cannot avoid not only the problems *in time* of information but also *space*, let's call it, *geographical*.

The user, to whom we relate the architecture, man or society, works in time, moves in space or is in a geographical space.

Let's see to what extent the current definitions of architecture satisfy such criteria, with the function or functions, time, space.

In the case of considering the intro-opening, insofar as we could do it artificially, new criteria and the requirement in relation to the architecture may appear. However, we currently exclude such a possibility from our considerations.

Part of the definitions of the existing architecture in the literature refers to what is visible to the programmer, so to the specialized user. But let's not forget that a computer seen at different levels of programming, represents as many abstract machines and from this point of view as many architectures.

Don Senzig (Hewlett Packard Corp., Palo Alto, California) says: "By architecture we mean those parts of a computing system that are visible to the programmer, that is, the instruction set, input/output commands, interrupt characteristics" [12]. Others reduce the architecture to the instruction set, or to the logical vision of the machine through the instruction set [13].

A. K. Agrawala and T. G. Rauscher, in a book on microprogramming, define the computer architecture "as the attributes of a computer seen by the programmer, i.e., the conceptual structure (i.e., registers, arithmetic and logic units and their logical connections) and functional behavior (represented by the set of machine language instructions)"[14]. There is a clear tendency in this formulation to define the electronic computer at the level of the machine language, which *was* indeed the deepest layer of abstract computer possible. The authors, like we emphasize that "the architecture of a computer must be different from its implementation, which includes the full range of hardware units, the physical connections between them and how to perform machine language instructions" [14]. Agreeing only with this last point of view, we will notice that the last layer no longer corresponds to the machine language, because today we can program at the level of microprogramming. In fact, Agrawala and Rauscher acknowledge that "now it is necessary to consider architecture at the level of microprogramming ... microprogramming has evolved from an implementation technique to a subject that now deserves in itself architectural design considerations" [14]. Then do we attach the computer architecture to this last layer of firmware? I think that the set of abstract computers that a computing system presents represents as many architectures and I have the impression that *along with the functions it can perform in space and time.*

In fact, the very notion of *virtual machine* that is realized on a basic machine, host, strengthens the point of view that we support. The last layer of the engine is the host computer and in general we find it today at the level of microprogramming.

It is possible that on an identical hardware structure, through microprogramming, we can achieve different control units and therefore different architectures *even* at the level of microprogramming. Some architectures can then be made by the specialized user for functions desired by the user.

We did not intend to go into the details of computer architecture, nor to give in this introductory paper a rigorous definition of the architecture of a computer or an information processing system, but only to highlight some general elements, criteria for such definition. This results from the current trends in the development of computing technology and distributed computing, but also from the point of view we approach in relation to them. *Temporal architecture* for example is beginning to be considered, meeting this term in Daniel McGlynn [15] in connection with the microprocessor time cycle diagram.

We will probably have to define *architecture* in such a way that a general definition can be adapted from general systems to the particular case of the electronic computer or microprocessor comprising layers of abstract machines each with its own architecture. *The notion of architecture is important because it will represent, from now on, the user's point of view, its requirements limited by the constraints of the technological possibilities of equipment and programming* (proposed name for software). Concrete architecture is the result of a compromise, but the notion appears fruitful, promising for deciphering new paths of progress.

We must also note that in fact the constraints of the equipment are becoming weaker due to strong and general microelectronic circuits. All the more so then the architecture begins to depend more and more on the logic of our thinking and less on the hardware which becomes more and more flexible and malleable.

A final question we ask ourselves is whether the multiplicity of possible architectures of a single fixed system cannot ultimately constitute a more comprehensive architectural structure. Respectively, all the architectures of a system to fit into a more general architecture. A tendency to look at things in this direction could be encouraged by the definition of *the architecture of a computer network*. A recent definition is worded as follows: "The architecture of a network is a formal specification for a data communication system. It includes the definition of a set of interfaces and, for the most complex interfaces, a set of protocols (detailed rules of interaction through interface)" [17]. But the programs from different computers, which can be found at different levels in the respective computers, in different languages and for different functions. The general architecture can therefore include through its interfaces, the connections with the other particular architectures. Therefore we can speak of a *general architecture* if it connects particular architectures through interfaces.

A general architecture obviously can have not only internal interfaces but also, I would say especially, interfaces with the social user, enterprise, institution or society.

From the above consideration it follows that we can consider *the keywords of architecture, interfaces, functions, language, instruction set, temporal, spatial aspects, logical structure of documents, constraints of equipment and software, etc.*. In the light of such considerations we can judge the evolution of the architecture of electronic computers for our country [18] [19].

3. Can we raise the issue of the architecture of a National Information System (NIS)? The way in which we approached the notion of architecture in the previous paragraph results in such a possibility. *The structure* of the national information system is today conceived broadly from the point of view of equipment in the form of a network of electronic computers, geographically distributed databases, data transmission buses, etc. [20]. The model structure, the corresponding programs as well as the data structure are less well defined and this is not surprising because we have not developed an architectural conception of NIS. That is why the complete structure (equipment and programming) develops somewhat on its own, just as rural and urban settlements have developed in the past, without systematization plans and will eventually come out, something that will have a certain architecture, but how do we know that this is the architecture that will be useful and efficient in our society? We have a series of works on NIS carried out at the Central Institute for Management and Informatics, the Central Directorate of Statistics and the State Planning Committee, obviously each vision being by the position in state of the respective body. There are also known points of view expressed by individual authors [21] [22].

From the way we approached the notion of architecture, it results that it must correspond to the user and his functions. The user consists of society and individual. The NIS architecture must therefore satisfy social users and individual users. This double orientation is not at all contradictory and I believe that a communist society in which information will count to the greatest extent will satisfy both requirements. In socialism, however, we are not wrong, and especially in the conditions of our country, if in a first stage we insist on the systems in the economic units, as we have the task by the Plenary Decision of the Central Committee of the P.C.R. since April 1972, and whether we will design NIS with priority for the scale of society as a whole.

The NIS architecture is the one that stands in front of the society as a system, the architecture must correspond to the type of society we choose, even within the socialist system. That is why the problem of architecture is so difficult. We have possible structures but the architecture is not defined.

The society being, in a certain sense a system, comprising information, it also has an architecture.

Can we extend the notion of architecture to society? What can be the architecture of a society? The answer is given by Marxism, for which production relations and social relations in general are essential in society. *The architecture of society* must therefore refer to the norms, laws and customs that govern social relations. In society, the laws that society imposes have a great contribution to determining its architecture.

The structure of society is determined by the bodies of society, state bodies, economic units, associations of different natures, groups, by the relations between them, so also by the social relations in general [23].

It is obvious that between NIS architecture and society as organization, structure, architecture, there must be a high compatibility because they are interconditioned. In the Nora/Minc report on the computerization of French society [24] after observing the general rule that "Any technological revolution has caused in the past an intense reorganization of the economy and society" and emphasizes "the real serious changes of civilization that the computer revolution can bring them" the following conclusions are drawn:

- "computer science has today become an instrument of almost total plasticity, its organization can be molded without obstacles on all power configurations"
- So piloting informatics means choosing a model of society but the installation of teleinformatics can "fix the structures for decades"
- "... only need to be centralized, ..., to process the essentials on the spot, not to send above and for interaction only the exception" [24]

The above emphasizes, in our opinion, the importance of the NIS architecture compared to the NIS structure. I do not want to draw practical, concrete conclusions in this communication, but only to emphasize that the notion of NIS architecture is at the interface between society and the equipment-program structure of NIS, *is therefore exactly the term of conceptual interaction between leaders society and structure technicians.*

The political implications are obvious, nothing is more political in computer science than the NIS architecture.

4. To what extent can we use and prove fruitful the notion of *architecture* in relation to the human brain?

We must keep in mind that the transition from computer to human brain, for the purpose mentioned in this paper, must be done through an intermediate category: the computer with artificial intelligence.

The computer we have been working with to this day still has no goals of its own, and as one computer specialist points out, "the main function of the computer is to control external equipment" [25]. Obviously, such a computer although it carries out a laborious internal activity is oriented outwards, it is an open system. What about the computer with artificial intelligence? But the possible computer with artificial affectivity as C. Bălăceanu and Edmond Nicolau observed [26]? Are they still only open systems? Will the intelligent and affective information that will act on itself on any medium, even one of silicon, ever have intentionality in the sense of Husserl or will in a psychological sense? Although such systems can be considered with a reduced intro-opening as we suggested in the first paragraph, they cannot be considered as having a true intro-opening.

True intro-opening involves access to a primordial substance that we have called infor-matter, and if such a substance also exists in it are inscribed the informational elements of the laws of nature, then the architecture of the universe is determined by the underlying laws, it turns out that what is inscribed in the structured informatics that contributes to the generation of the universe but also to its maintenance, is in fact the deepest architecture.

The architecture seen by the laws that generate the universe is the architecture seen at the spatio-temporal level, it appears to us as systemic, mathematical, although if we take into account everything that defies mathematics in mental and economic-social life, we should be more careful. Part of the architecture of the universe is systemic, mathematical, but it stops being so at the psychological level of man. For man, society and the universe, therefore, the problem of architecture arises differently because these are intro-open systems.

At the neuronal level of the brain can the notion of architecture be applied similarly to the computer? Yes, if we look at the brain in a behaviorist conception, as a system with inputs and outputs, with stimuli and responses. No, if we look at the brain through its intro-opening as having access to a substance that may have no structure. Any architecture is a *constraint*, no matter how wide it is. The brain has an intro-opening to what has no architecture, precisely because it has the possibility to lose architectures, sometimes artistic imagination, sometimes as possible things and we cannot know if such devices could ever create real things.

We can look at the architecture of the brain neuronal and even molecularly with the above reservations, we can look at the architecture of the brain psychologically, much of our psychological level has an architecture still insufficiently well known, but we will talk about psychological architecture with even more careful reservations; we can also look at the architecture of the brain in relation to intro-opening, where it is intro-open in without architecture but where it could create architecture.

How exactly? By mathematics, geometric shapes or phenomenological intentionality, not exactly of the Husserlian type, but understood in the direction of the introduction, as a source of meanings that can no longer result from anything formal. It may be that in this direction, of intro-opening, a mix of mathematics and intentional phenomenology specific to the intro-openness may be needed, and this mixture may generate an architecture that must be understood at a level different from that of our open systems which we usually treat as mathematical objects. The world in depth is potential, potentially infinite for architectures, so we can't say to the extent that it still has its own architecture. The architecture of our universe seen at the level of depths is the informational and phenomenologically intentional structure, as a whole, both inscribed in what we believe to be computer science. The information of the laws of the universe is based on more complex information, partly mathematically descriptive, partly not.

Economists and sociologists are slowly coming to such conclusions regarding the description of the economy and society. Among these can be cited first of all N. Georgescu-Roegen [28] for whom the capacity to comprehend mathematics is limited in relation to economic and social processes, especially in terms of their dynamics.

The architecture of society is therefore only in the first approximation, but very, very important, which I said in the previous paragraph, but by introducing the component elements, society transcends its architecture, by its ability to decide its spatio-temporal architectural constraints with enough freedom by its management structures but also by the potential to find ways to the fundamental material resources of existence. It is this second agreement that could also influence the architecture of society in the future in the sense of the previous paragraph.

The open and intro-open system has an architecture and can be an architecture creator, the open system has only architecture.

5. In this session, Prof. Cartianu, Edmond Nicolau, Solomon Marcus and

Mariana Beliș refer to psychological and psychological informational processes.

Between the nervous and the psychic, a discipline like psychophysiology [33] seeks to establish a connection. Functional models of the nervous system and the brain are proposed by C. Bălăceanu, Edmond Nicolau, Gh. Cartianu [29] *et all.* and functional models of the psychological level are also tried, recalling in this direction the older contribution of Ștefan Odobleja [34] and the newer contributions of Mihai Golu [35] [36].

I think that the whole argument in this introductory paper on the architecture of intro-open systems and devices reaches a climax with the consideration of *psychological architecture*, obviously of the man of the greatest interest. It is a topic that we intend to develop later considering its philosophical importance in a concept of a material ring of the material world as well as the practical importance for functional electronics because one of its directions is that of coupling with the human brain.

We will observe that the interface aspect of the architecture of the psychic level is put from three points of view:

- in relation to the external space-time world, which also includes the organism that supports the psychological level
- in relation to himself or to a part of himself, from which one can follow the rest of the psychological architecture
- in relation to computer science, a primordial substance in which the living organism that supports the psychological level is introduced.

Elements of psychological architecture will be largely conscious consciousness, automatic consciousness, subconscious, cognitive, affective, control and monitoring modules, then what determines consciousness, etc. Psychological architecture, unexplained to this day satisfactorily neuro-cybernetic or psychophysiological, can operate with everything that constitutes psychological reality and in these conditions new physical assumptions may prove necessary. But first we need models of psychological architecture going down to a certain detail that takes into account genetic, social and creative factors. In this way we will better understand the interaction between society and man, maybe we will understand the philosophical foundations of civilization.

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