EDITORIAL

HOW CAN ARTIFICIAL SYSTEMS RISE IN A TOOL FOR MIND?

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1. Introduction

Artificial systems play an extremely important role in human life. Each day, almost all people on the Earth have to interact with various complex systems, which are of a very different nature and target application. These all system structures and their whole sets can be of various degrees of complexity and can be discriminated into many categories. These three can be considered as their main kinds:

- artificial systems,
- living systems,
- natural systems.

All of them could have very various behaviours but some aspects – as well as their theoretical backgrounds – are universal. Artificial systems are those created by the human, so mostly by human will and decisions.

Almost anybody from modern human population must be dealing with some of these artificially created tools. Exceptions are formed by people living isolated from the main trend of human population activities, but these become just the very rare. The application of these systems can be seen in almost any human activity, from transportation to communication, from energy and food production to medical care, from education to defence.

By the run of time, the main interval which involves a period from the era of the using of very primitive tools before several hundred thousand years, over the era of invention the artificial fire, up to the present time there is almost nobody fully isolated from the use of artificial systems.

This concerns not only the populations in developed countries, but also many people living in developing, or in low developed countries, which still can be often more or less at least almost isolated from other world for present times. All these

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people use advanced artificial devices, either as individual tools, often also as whole systems.

There can exist differences in the nature and types of these systems, in the needs of respective humans, their education and in the role which in interactions among systems elements is performed by human subject. Of course, there can exist large differences in the nature and conditions of such interactions. There exist also large differences concerning the kinds, number and complexity of the artificial systems themselves. Moreover, these differences significantly increase with time and these artificial systems complexity.

Now there exists a very large spectrum of artificial system kinds, complexities and number of their activities, which the humans can interact with. Very often, the mentioned main categories of these artificial systems as well need to interact mutually.

Actually, there are no artificial systems existing just per se, in any case they have been created by humans (at least indirectly), who are using them (and from time to time incorrectly), curiously also serving them in the necessary operation care (e.g. maintenance, restoration, repairs, modifications, also construction and, production of new artificial systems and now also still more in social care and interactions).

2. Robots

At this point one must keep in mind that the artificial systems mainly have the name of "robots". Robotics is known for many years as very important discipline in system science.

However, the name robot was, as many people now had already forgotten, introduced into the world dictionary more than 100 years ago by the Czech famous writer, Karel Čapek, who being stimulated by his brother Josef Čapek had used it in his fantastic play R.U.R. for artificial systems able to reproduce themselves. They in this story subsequently appeared to be able to replace the whole human population.

The name robot was by Čapek from the very old Czech term "robota" meaning the forced slave labour. Fortunately, robots in the Čapek sense did not succeed in their attempt to replace humans – in the mentioned Čapek book. Similar it is till now about 100 year later in present reality.

Though our present artificial systems, simulating now some important human activities and serving to us in many respects, developed very fast in last 2 or 3 decades, they seem still to be far from the danger predicted by Karel Čapek.

However, the behaviour of many members of human population is highly influenced by advanced artificial systems. The sight of humans on word could subsequently shrink to very narrow fields. If this is a dander leading slowly to human degeneration, at present one does not know.

In all cases however, one has to be very interested, if the particular artificial systems under consideration operated well and if one can expect its proper operation also in future or under changed operation conditions, i.e. if such systems and the interactions with them are reliable.

Through all of his history, the human mankind fights with the problem of a correct interaction with various systems and specifically with the reliability and safety of these interactions. Of course, there also exists a question, if humans interact with artificial systems well.

3. System properties

Let us here consider as system of any arbitrary or living set of real or information components. Any system operation ability is described and classified by various expressions.

As the most important system characteristics, one understands in this respect certain ordering of real or abstract objects (system elements or functional blocks, sometimes also subsystems) arranged in such a manner, that as a whole they can perform some required external system functions (activities). (D1)

This system characteristic definition can be a basis for systems classified according very different aspects:

As living systems, one understands living organisms, their groups and communities, including human population. As natural systems one understands the non-living systems operating on Earth and in the Universe, e.g. global weather system and its subsystems - wind, river flows, see waves, sea streams, or Sun which acts via energy flow, Solar wind, etc. To natural systems one must of course add all the up to now known parts of Universe, because till now no extra-terrestrial living parts in Universe are known.

Natural systems influence both artificial and living systems, often very significantly. All these three above mentioned kinds of systems inter them interact, very often in complicated manner. They interact of course also with human beings, either as individuals or as groups or communities, or even the whole human population. Another aspect concerning all these three mentioned kinds of systems is, that they can be also classified with respect to their level of determination.

For simplicity, one shall call here such structures only as systems, without respect if they represent the systems, their sets, alliances or complexes of alliances. One can distinguish the systems and also the system alliances, as concerns the level of their uncertainty in their parameters, system functions, requirements on their properties and also in their structures. All these significant system characteristics can scarcely be of determinate values, more often they are more or less uncertain. The last situation is very often typical if the considered systems interact with biological components.

In all cases, whether one faces either natural or artificial systems, one is very interested in a non-problematic interaction, as far as possible, i.e. on that one can predict the behaviour of systems under consideration with high enough degree of reliability, and that systems, that one created would operate as one had intended.

4. Requirements on system properties

As concerns the artificial and by human created systems, one aims to have minimal number of systems faults as well as the pragmatic feature that the deviation of systems functions F from expected values is as small as possible. Note, that there can be more than one system function. Very often, one has to deal with many of them.

One is further interested in maximal duration of these acceptable states or, more specifically spoken, on the maximum range of independent variables P in which this condition is valid. In other words, one is interested in maximum functional reliability and in the longest life-time (life-range) of such systems.

Functional reliability has therefore to be considered as one of the most important factors specifying the practical applicability of any real system. Arbitrary system – though having excellent properties and power – would be of very low practical use if it were functioning well only exceptionally, under not precisely defined conditions and with many faults recorded during operation. The expenses, which one has to spend on keeping such system in operation (if they are not proportional to the system value and power) can significantly diminish its real applicability.

Of course, some specific cases occasionally exist. It is when the requirements on high reliability can be neglected with the respect to some other aspects, e.g. the low production price. However, such situations appear only exceptionally.

In general, the high operation reliability and long life-time belong to much more requested properties of almost all real systems. Moreover, one usually requires, that the system not only operates well, but also that it is safe. It means, that its operation has any negative influences neither on function of other systems operating in its neighbourhood, nor on any human subject or human community with which system interacts.

Such requirements are expressed in the concept of system safety. Nevertheless, among the aspects of system safety, often also the particular system resistance against disturbing influences, caused either by operation mistakes of staff or by human inability or bad will, is included.

The tendency to construct systems with high functional reliability and high safety has been known for a long time now. Originally, it was projected into the system creating philosophy, that the very reliable systems have to be constructed from very reliable parts, before all. Though this design philosophy is evidently not wrong, sometimes it can lead to un-realistically and expensive solutions. Therefore, also other design philosophies for highly reliable systems construction were developed.

In principle, there are four known fundamental principles; besides the previously mentioned utilization of very reliable components with long life-time, one can also use the philosophy of system (or some of its parts-sparing, resp. redundancy), or the philosophy of minimization of system function sensitivities on the values of system parameter changes. These three approaches are known, and have been used already for many years.

The last approach developed and used in various applications recently (the first works in this respect appeared in the beginning of 90's), can be based on the concept of the so-called *prediction diagnostics.*

This represents the till now most advanced methodology of system reliability and safety improvement. Of course, in praxis all these four basic approaches of system reliability are often combined and the art of reliability engineering consists in the skill applied for their combination. However, there is also another aspect, which has to be mentioned. Many systems and/or system alliances must be considered as uncertain, i.e. one is not able to specify exactly the system state, the actual values of their parameters, system functions or requirements to them, respectively.

Actually, any act of system parameters, functions or structures investigation causes the increase of the considered system uncertainty.

Uncertain system can be of the artificial, as well of the real nature, moreover, as concerns complex, for example living systems, or alliances an uncertainty becomes their typical feature. (D2)

Though a good part of existing system methodological tools were developed till now for systems with well-defined parameters and properties, development of new, specific approaches is necessary for successful dealing with uncertain systems.

5. The role of interfaces

In all the larger information systems, consisting from parts, either artificial or living, the information elements or system parts must communicate via interfaces, in living systems called as synapses.

These elements must ensure the correct, fast enough and reliable transition of information from one part of the respective information system into the corresponding part of the other one so that the transferred information were accepted, understood and not too much delayed and distorted. Such information transfer is called a regular.

Regular functioning of interfaces is a dominant feature of large information systems. This concerns also the operation of synapse systems in brains of living bodies. Here are known two main kinds of synaptic systems: the set of electrical synapses and the set of chemical synapses. In human brain both these sets operate.

This seems to be typical especially for the very large and complicated uncertain systems controlling the behaviour of advanced animals, namely of human brains. Some scientists estimate the complexity of the human brain to about 100 billion of neurons connected with about one trillion of others on the brain activity participating cells. The total communication complexity is estimated e.g. M. Bertolero and S. Basselt in the July 2019 issue of Scientific American to about 300 trillion, i.e. 300 times 1012 connection nodes. These nodes communicate together in very complicated repairable communication hierarchically structured system of interfaces (synapses) still able of refreshing and improving.

Though of the probable complexity of similar control and communication systems in other animals can be eventually much lower, their ability to control the animals' behaviour is more limited. It concerns also the interactions with artificial systems.

Nevertheless, the spectrum of behaviour activity of particular animal can be significantly different from that, which one considers as typical for humans. This can concern namely the smell, hear and sight. Though the quality of these senses at nonhuman bodies can be much higher, the total is lower, just because of the lower number of information processing elements (neurons). The structure of composition of such animal senses can differ surprisingly from humans, nevertheless high differences can also exist between them. However, all these spectra composition need to be more precisely investigated also with respect to eventual changes in time in present, past and in future.

The definitions *D1* and *D2* can be considered as basis for dealing with large uncertain systems, namely if they are more complicated, involve many living components and form eventually also the whole alliances or their sets.

The theory of such large, complicated and also partially uncertain systems and the methods for dealing with them is now in the focus of very large interest, not only in system science but also in many other areas. The improved knowledge of it will be probably one of the most important tools for understanding the life of all of us.

Suppose, that one can use the tools for detailed analysis of an actual extremely complicated brain network structure, based on complex of EEG, near infrared and functional magnetic resonance imaging (fMRI) technology, to reach the knowledge about the detail structure of the brain network.

A special interest must be given to load, operation reliability and energy supply at the majority from its about 300 trillion human brain nodes. Between this large set of nodes, some can be more important because their well operation ensures the good function of the critical parts of brain. These nodes have been saved in proper operation.

This concerns especially the brains of extraordinary, in some respect genial persons, like e.g. Albert Einstein was. He was without doubts a genial man. As far as it is known, his brain was after his death used for deep analysis and the large set of microscopic cuts was analysed and is now still exhibited in some Pennsylvania museum. However, no spurs of his geniality were found by the use of that time disposable methods, probably because his talent's for genial ideas corresponding nodes were considered. Of course, only a part of the tremendous large number of his brain communication nodes were investigated that time.

The selection of such extremely large set of brain nodes, responsible for high intelligent behaviour is evidently a very difficult task.

6. Concluding discussion

Almost all of the human brains are able of the extremely important function, i.e. the consciousness. As far, as is till now known, this is not to reach at any of artificial systems, even if they are very complicated. Of course, one cannot exclude that some very complex information artificial systems also could reach such ability in the distant future. At the future horizon, which one can see now, this is not probable.

Though at present such goal as mentioned above seems to be very far from reality, several results presented in this year seem to indicate that such goal can be in principal not fully impossible.

The properties of technical artificial systems can be analysed usually by the methodology of the so-called prediction diagnostic, which principals were founded already in 1981 (Novák M.: Probleme der Toleranzes und Zuferlessigkeit techischen Systemen) and 1982 (Novák M.: Statistical Approach to System Parameter Synthesis). Some of these works seem to be applicable considerably soon e.g. those for wireless control of artificial prostheses based on particular person intention analysis or for replacing the failing paths between some of important parts of brain network.

Similar tools can be also used for deeper analysis of other animal brain functions, especially those, the senses qualities of which are significantly over those of humans (e.g. as concerns the smell, sight, audition). Of course, such a goal will require investing very high effort to reach it. However, without it our knowledge can subsequently shrink to set of interesting but, for wider understanding of informatics role in real word, for their point focusing not enough useful and combinable components. Therefore, much more works and published papers similar to some mentioned here are necessary, without respect to the role of the uncertainty of the natural or artificial components, which also are changing in time.