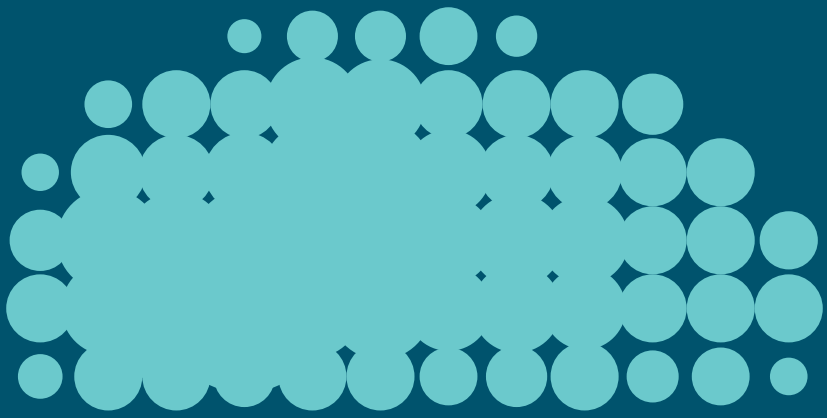

Information in the Context of Philosophy and Cognitive Sciences

Reginald Adrián Slavkovský

Edition Cognitive Studies

fftu

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Introduction

Increasing use of information technology raises theoretical issues associated with information more urgently. Then, theoretical examination of information leads to the fact that many things having not a lot in common with information at first sight show in a different light, from the point of view of information and information processes.

This textbook briefly surveys areas and contexts in which information plays an important role. It attempts to an approach looking for connections also among the fields of examination usually not linked together, such as information theory, information science and library science, information physics or information ethics. The emphasis is put on humanistic, philosophical and interdisciplinary approach, considering that this text is intended for students of Master's degree in *Cognitive Studies* Department. It offers ways of thinking, issues and connections, rather than a complete theory developed into the mathematical and technical details.

Writing of this text was an enriching experience for me. For example, by writing and lecturing about the effect of information period, I realized that it is a live theme which resonates with me and stimulates interesting discussions with others, too. I am grateful especially to the students and also colleagues for that. It was interesting to perceive issues of consciousness, thinking and rationality in terms of information and information processes. Is our thinking an information process, or even (digital) calculation? Or is our understanding of information (mainly if it is based on byte counting)

narrowed and it would be better to extend it in such a way being able to include also things like intuition or the whole view?

I hope this text will be useful for reader to make sense of broad issue of information and many of its contexts and connotations. Recommended literature can leads to further deepening of knowledge for those who will be interested in the topic. The text reaches its target if it leaves something more in the reader than just information data, sequence of words and sentences that one could find in a necessary situation (e.g. during an exam) in his memory. The text becomes real information and real knowledge to the reader if he contributes to better understanding of his own existence in the world.

In Trnava, July 31, 2012 *Adrián Slavkovský*

1. Different Attitudes Towards Information

Keywords: *information, message, contents, sign, information environment*

1.1 What Does Theory of Information Deal with? What is Information?

Most of our peers would probably agree with a statement that we live in a society flooded with information. If we start to ask them what information is, many of them will list a lot of examples. However, just few of them will be able to describe any characteristic or to give certain concept. In relation to information the more honest ones might admit what St. Augustine stated in relation to a time: if nobody asks me, I know it, but if somebody asks me, I can't express it.

Information is not only contained in informative brochures or books, but increasingly they are a flow of elements and characteristic of electromagnetic fields of cable and wireless communication and they are all around us. Telephone calls, television and radio broadcasting, signals of remote control, wireless internet, all of these may go through the surrounding environment and even through our bodies. They include weather forecasts, price decline on the stock exchange, results of sports events, political decisions or talk about anything when we want to hear the voice of a close person. In order to communicate via mobile phones it is necessary to encode human voice, information — preferably not changed — often transmitted to another distant place where it is decoded

again. The two most common meanings of the word „information“ can be evident from these examples.

> The first one is common, informal meaning defining information as a message of some kind, such as those given by information office or tourist guide. In this case a correct understanding of message is a necessary aspect of information. In case of telephone call it is what the other one want to tell us.
> The second meaning is technical, denoting symbols or things used for message transmission (letters, numbers, sounds, signs...). An important aspect in this case is the storage, transmission, display and processing of these symbols regardless of the fact what they represent. (Baeyer, pp. 18–34)

Within the frame of technical meaning it is necessary to recognize two types of signs. Physical signs are objects occupying some place in space or happening in time. Ideal signs are abstract representatives of physical signs, e.g. letter „A“ as a ideal sign is an invariant sign of all physical forms of this letter. (Cmorej, p. 14–18) In phone call the same ideal signs — words divided into letters — can be in different state of transmission expressed by different physical signs: sounds, electrically charged particles or magnetized surfaces.

In other words, the theory of information studies the nature of information. It is interested in historical way of its encoding and storage from the easiest forms as were cuts in animal bones and simple pictures of prehistoric man painted or carved into rocks, to futuristic which is today still in infancy, such as quantum computers. It focuses on how symbols may include contents, how the communication noise is created and whether it is possible to report everything what we want, to give complete message to the receiver, thus full meaning and value of what we feel and that is inside us.

The theory raises questions of analogy among human information processes and artificial processes happening in different ways of information technology. Is it necessary to classify and differentiate information? Why? Information can represent the power, they can make us stronger, and however they can also take control over us and thus weaken us. Information is in the centre of today's society, bringing new ethical issues. These issues are about accessibility of information, privacy, copyright, sharing of information on the Internet, etc. All of them are the object of theory of information.

1.2 Why to Be Concerned with Information and Theory of Information?

A matter of survival for an ancient man was (and where he lives still is) good knowledge of environment where he lived, familiarity with its potential pitfalls, as well as its beauty and opportunities of improving the quality of life. He had to become familiar with steep slopes, poisonous plants, dangerous predators, symptoms of serious illnesses and many other dangers that were watching for him (to those made–up in his mind). A detailed perception of landscape, including what happen around us and with us, and circle of life in nature helped him find beautiful places or places offering him enough food, to discover useful animals, plants and things. It also gradually helped him to guess principles in the background events; thanks to those he visualized the image about the world as a place where he was at home.

The role of such an important environment was later replaced by social environment, when people started to live in bigger groups. It had and still has its own threats and its own opportunities for better life, too.

The bigger part of today's world population lives in a society surrounded with information society. We can navigate ourselves by maps and navigation systems; we are insured against any unpleasant events in a country. Advertisements promising us a better

and more beautiful world if we pay for their products are anywhere around us.

Information technology gradually contributed to the fact that information has become more substantial environment of its kind than before, having its own threats (is it coincidence that for computer threats we use the word „virus"?). It offers incredible possibilities for better life, too.

It might not be a question of survival, but for valuable life in the present day of information technology it is more important to understand what information is, how it influences our lives, what its value is for us, how and why it can threaten us, how we can live in coexistence with it. All these issues lead us to asking for information nature, as our ancestors were asking for the nature of physical existence.

1.3 Who and how Studies Information?

Considering two distinct meanings of the word „information", there are two main fields of study dealing with information. Both of them have their own prehistory, but they were established in the 20th century.

Information science is the first of these fields, regarding information as messages from gathering, division, storage, comparison, classification, evaluation, communication to philosophical aspects of information.
Information theory is the second one, dealing with theoretical and technical aspect of information technology. It is associated with measurement, encoding, transfer, storage, processing information as symbols and its physical vehicle, as well as the design adaptations of information technology to the needs of a man.

Cooperation of both approaches is necessary in order to solve many problems; therefore, their boundaries are not strictly separated. There are also approaches focusing on the ontological nature of information to hypothesis about the information as another physical entity. I will try to briefly summarize all these approaches and put them into interrelation, in this textbook. I use the term „**theory of information**" for scientific and philosophical fields studying information referring to all approaches.

1.4 The Role of Philosophy and Cognitive Science in Study of Information

Development of computers, information theory and artificial intelligence stimulated a new intensive research of all aspects of cognition whereby it caused integration of current knowledge from various disciplines and the birth of cognitive science. The cognition is a term of wide comprehension, meaning the act or ability of knowledge acquisition, its process of acquisition, as well as a result of this process. It includes a processing of information, attention, memory, language formation and its understanding, learning, thinking, solving a problem and decision–making. Examination of human cognition links approaches of philosophy (particularly cognitive theories and the philosophy of mind), logic, and linguistics, theory of information, psychology, sociology, anthropology, artificial intelligence and neuroscience.

As Paul Thagard states, the core of cognitive science as an examination of cognition is a concept of finding analogy between

human thinking and its computing–representative model. (Thagard, p. 36) It is a research and mutual comparison of processes of thinking, as we can see it by self–examination, but also with modern display methods, e.g. magnetic resonance with processes that take place in artificially created devices intended for processing of information. Cognitive science could explain relatively lots of phenomena associated with cognition and contribute to creation of many our cognitive skills. Contemporary high–definition programs can define faces in more detail than people and we are on the way to devices capable of registering spoken speech, identify it, translate into another language and then write it as a text or transform it into a voice again. On the other hand, studies also show limits of computing–representative model of human thinking. All these change our understanding of information.

Philosophy is also connected with the examination of information. Though it does not make any empirical researches, it asks about the nature of phenomena related to information and provokes researchers to ask the basic questions all the time. It evaluates and put together all our experience with information and based on these facts it provides deeper and deeper comprehension of what information is.

Many authors dealing with the nature of information indicate that it is theory of information which can give a brand new reality description and our attitude towards future. H. Ch. von Baeyer states in introduction of his book (Baeyer, s. Ixxiv) , that the way of thinking and asking questions of the well–known American physicist John Archibald Wheeler (1911–2008) was a necessary source of his inspiration, especially his five „really great questions". These questions inspire physicists with new experiments and at the same time lead them to think behind the boundaries of the universe. The fifth question in English is as follows: „It from bit?" In English it is also a pun with an appeal saying: Does not everything what exist (means anything corresponding with the English „it") have its origin in information (whose measure is expressed by bit)?

J. A. Wheeler describes it in this way: *„every "**it**" — every particle, every field of force, even the space–time continuum itself — derives its function, its meaning, its very existence entirely — even if in some contexts indirectly — from the apparatus–elicited answers to yes–or–no questions, binary choices, **bits**. "It from bit" symbolizes the idea that every item of the physical world has at its bottom — a very deep bottom, in most instances — an immaterial source and explanation; what we call reality arises in the last analysis from the posing of yes — no questions and the registering of equipment–evoked responses.*" (Wheeler 1994, p. 296, quoted from Gleick, p. 10)

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2. Explanation of Terms and Methodological Problems of Research

Keywords: *form, matter, bit, entropy, definition*

2.1 Etymological and Philosophical Approach to Information

We will try to gradually deepen the previous understanding of information, resulting from intuition and reflection of different experience with information. Firstly, it will be etymology (the origin and history) of the word that has Latin root and consists of 2 parts: „in" and „form". „In" is a prefix denoting inner direction, „form" expresses a form, shape. Thus, to inform means giving a certain shape to anything shapeless and anything formless a definite form. However, what is a form itself?

In Western philosophy, the form is related to dichotomy of matter (hýlé) and form (morfé, eidos), that were used by Plato and Aristotle for explanation of changing reality, though they used it in different ways. Matter is a possibility, while the form is the execution of possibility. For Plato, ideas represent the form of things as the only true objects exist in an individual world of ideas, while things perceived by us are just their shadows, imitations of shining reality. Aristotle applied ideas of Plato to thinking. We know the tree as a tree not because we remember the idea of a tree from the perfect world of ideas, but because the form of a tree being part of a real tree may be contained in our brain. According to Aristotle, the form is made of all important attributes of thing. There was a tendency to find more abstract and more appropriate forms which became mathematical objects such as numbers, shapes, matrices, equations, functions, etc. Thanks to this view of forms we try to understand the world of atoms or quarks we imagine via various parallels from our world. However, the only characteristic corresponding with experiments is the expression of this world by mathematic formulas. These formulas are unclear and often in contrast with our common experience. The form expressed in this mathematical way is connected to technical approach of information.

At the same time, it should be mentioned that the most precise mathematical expressions by equations and formulas are more about their reciprocal relationship, rather than about things. For example, famous Einstein's formula $E = mc^2$ expresses permanent relationship among energy, weight and speed of light.

The meaning of the word „form" as though alternates between its philosophical reflection and usage in everyday language from the ancient time. Thanks to this fact we can say that the form got also these connotations: modification, order, discipline, organization, model, appearance, structure, relationship. Information refers to an activity and passage of time.

> Paying more attention to the technical aspect of information process, based on the previous philosophical ideas we can say that information is a transmission of form from one medium to another. This is also true when information is „just" stored for a long time also understood as a „thing" having certain meaning and used in some context. From the human aspect of information exchange it is better to describe it as communication relations.

2.2 Technical Approach to Information

This approach comes out from empirical observation, quantification, and measurement. Claude Shannon (1916–2011) is considered to be the father of Information Theory notably for his article "A Mathematical Theory of Information". Shannon used a method that proved itself in science numerous times. Without exactly defining what information is, he designed a concept of its measuring. Good example that shows how this approach can help comprehend certain phenomenon is the history of thermal research. A method of thermal measurement by thermometer was schemed out around the year 1600, even though it was not clear what temperature is. Data accumulated over time thanks to measurements and experiments. In the 19th century, on the basis of those data, it was possible to comprehend physical nature of heat as a total kinetic energy of random particle movement. The route from a simple thermal measurement to intricate physical theory took approximately 250 years. In our effort to comprehend information we are only in the beginning of the route, but numerous thinkers predicted that philosophical and technical approach to information would finally end in a theory that would include and connect both approaches.

C. Shannon suggested to measure information by bits. According to him, information is everything that can be formulated by a string of signs, while every sign represents one of two possibilities. Hence every sign represents 1 bit (abbreviation of "binary digit").

> Size of information, which is contained in a message, is the amount of signs (bits) needed for its encoding.

Opposite of the term "information" is the term "entropy". It is the measure of uncertainty of some situation or it is also the lack of information that should be included in a message. It is also measured in bits. For example when a patient wakes up from a medically induced coma, he does not know what day of the week it is. Entropy of this situation is $\log_2 7 = 2.80735$ bits. When he finds out, he will have information that represents the same value. If we imagine a sort of an artificial situation when he could only get "yes" or "no" answers, then this value suggests the "effort" needed for acquiring this information. If he repeatedly asked questions such as "Is it Monday?" he could randomly get the sought information after the first question, but in the worst case he would get it after the sixth question. By using suitable strategy he would always need only three questions. The reader easily detects this strategy.

Under this approach, the meaning of information or content of message it represents is neglected. Mobile phones work the same (and we are charged the same) whether we use them to send birthday wishes or we use them to transfer the noise of the city. Ignoring the sense is the price of technical possibilities this approach provides. Warren Weaver (1894 — 1978) collaborated with C. Shannon; he was interested in philosophical questions connected with technical processing of information. He asked: How precisely the symbols utter the meaning of the message? He also asked: How effective does the received meaning affects the conduct in the desired direction? W. Weaver, next to the questions connected with information, pointed out the importance of semantic and pragmatic questions. He is also the author of memorandum about mechanical translation dated in 1949, in which he proposed basic principles of computer translated texts from one language to another. His proposals included: the problem of multiple meanings can be tackled by examination of immediate context; and that it is important to compare and translate not words but logical, universal traits of language.

2.3 Search for Definition of Information

Creation of terminological databases accessible on the internet is the result of demand for unified perception of important terms. It is the logical conclusion of process when experts from various fields discuss (personally or by means of texts) the most appropriate characteristics of important terms. It is the open process in which people try to combine observations and insights into one definition. These observations and insights proved themselves and were usually created on the basis of very different methodological approaches. Jiří Stodola in his book about information quotes fine example of this procedure. (Stodola, pp. 42–44) After nice various definitions of information, he quotes definition from the Czech Terminological Database of Library and Information Science:

> *"In the broadest sense, information is seen as data about real environment, about its condition and its processes in progress. Information lowers or eliminates uncertainty (e.g. recipient of information); amount of information is given by the difference between degree of system uncertainty (entropy), which system had before receiving the information, and by the degree of uncertainty that was eliminated by reception of information. In this sense, information may be considered to be an attribute of organized substance that describes its in–depth structure (variety). It might as well be considered to be the product of knowledge fixed in signed form in information media. In Information Science and librarianship, the term information is above all understood as a message, communicable knowledge that has sense for recipient, or it is understood as a data that makes the choice between alternative possibilities easier. Perception of information as a psycho–physiological phenomenon and process, thus as a part of human consciousness, is important for Information Science (e.g. N. Wiener defines information as "content of what is exchanged with the outside world when we adapt to it and when we affect it by our adaptation"). In exact science, for example, information is considered to be a message that complies with strict criteria of logic or relevant science. In economic field the term information is understood as message which results into profit or benefit. In the information technology field, information is considered to be a quantitative expression of content of a message. In information technology a decision between two alternatives (0, 1)is considered to be a unit of information and it is expressed by a unit called bit"* (Jonák).

Looking for a definition is important for means of communication, it also contributes to deeper understanding of the event we want to name. However, it is necessary to take into consideration that defining will generally remain an open process. Even the effort to exactly comprehend what definition and defining is, indirectly refers to that open process. In an effort like this, there has to be something we want to understand (what the definition is), and what is already present (as an attempt of defining process). For the analytic mind that grasps concepts and conclusions in their mutual discreetness and logical conditionality, auto–reference character of defining seems as a paradox, as something that goes beyond rationality. In the abstract systems it creates and which include Set Theory or Quantum Physics this defect is solved by defining the basic terms of the system, but concept of definition alone stays undefined. On the other hand, intuition exceeds the abstract grip of mind with its forms of time and space, detachedness and causality. Hence it opens a kind of a "channel" to the timelessness out of space, to the eternal existence. That is where auto–reference is

"in its element" like a fish in the water. However, every try to make a report about such an experience in a form of language has to use the environment of mind again. From the strict logical point of view it seems to be paradoxical. Every try to gain insight into what information is, has roots in intuition and particular definitions are sort of a report about peeking.

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3. Information Science

Keywords: *library, information system, document, electronic information resources*

3.1 Subject and Development

Information Science deals with all forms of handling the information, especially it scrutinizes their extensions — institutions focused on processing of information, development and functioning of information systems. In its relationship with information, it puts greater emphasis on the aspect of the message. It observes material or technical aspect of information as much as these aspects affect the character of the information. It represents principal field of research, it utilizes various sciences: Archival Science, Library Science, Communication Science, Cognitive Science, Museology, Management, Law, Mathematics, Philosophy, Public Administration, and Social Science.

Main historical stream, which contemporary Information Science derives from, was formed mainly through theories, methods and practices of libraries since their beginnings. The first known libraries included the collection of sacred texts from Thebes, from the times of Egyptian Pharaoh Ramses II (13th century B.C.) with the inscription "house

of recovery for soul" above the main portal, and organized collection of clay cuneiform tablets, which was founded by the Assyrian king Ashurbanipal in the 7th century B.C. (it includes, for example, Epic of Gilgamesh)

With the increased amount of books and records it was necessary to find ways of their management so the user can simply and quickly find what he or she needs. Ever since the medieval times, the main purpose of a library has been to collect, to process, and to store recorded knowledge, experience, stories by means of sign systems and certain methods. With the growing size of libraries, variety of documents they contained, and with complexity of services they offered, a need for special discipline in this field emerged. This need eventuated into Library Science that has been forming since the second half of the 19th century. With the development of science and technology, especially in the 20th century, the assortment of media, onto which it was possible to record not only written form of the text but also sounds and video, quickly expanded. Instead of books, people started talking about documents, notably since the mid–20th century about information and information resources. Today, various information resources interconnect and standardize with each other by means of the Internet. Records they contain are now called Electronic Information Resources, and their advantage over the past is that they are accessible not only locally but practically from every place on the Earth.

3.2 Document as a Source of Information Science

The sources of today's Information Science are considered to be documentation, processing of calculations, and communication. In a simpler way they conform to the three streams which the Information Science draws from: humanitarian, mathematical–technical, and social.

A document is a physical object, a medium, which bears record of our ideas, utterances, about our knowledge. Thanks to documents, our utterances can travel from place to place and also persist in time. Documents significantly increase our communication possibilities and they also extend capacity of our memory.

Books, contracts, emails, but also inscriptions on clay tablets found at excavation sites, or a note with a message for a friend can serve as an example of a document. Today people strive to digitalize important documents more and more Digital version of documents is portable quickly and easily, it takes less and less space, it is easily copy–able, and it is not a problem to edit or update it.

Libraries had a important role regarding documents in the course of history. Thanks to libraries, documents (primarily books) that were considered valuable were accessible to the public. This accessibility was not something natural. In order for a library to work and to fulfil its legacy, there have to be a great deal of processes under way in the background. In the first place library is required to obtain new books, magazines, and other documents, in order to fulfil the needs of those who seek certain information in it. No library can gather entire amount of documents that humanity produces. It is on the library employers to choose relevant documents. Acquired documents have to be catalogued. It means to choose the most important book data and to assemble them in a manner so it is possible to search these records in a most effective way. Otherwise, library visitor would have to read all texts one by one. Creation of catalogues is a sort of filtering — only that information about information that helps easily identify the sought document gets into catalogues. Furthermore, libraries need to secure the system of borrowing of documents, so they are returned in time. They also have to ensure that people can easily navigate in

the library structures and all its services. Planning and securing human and material resources also belongs to the library operations.

Increasing complexity and difficulty of librarian labour led to the need of syndication and education of librarians in the 19th century. The first librarian organization was *the American Library Association* that was founded in 1876. Educational institutions in the library science field also originated in America, in the end of the 19th century.

3.3 Computational Processing as a Source of Information Science

Computational processing of information has roots in simple calculations. To state the amount was one of the first forms of transmitting information.

Expansion of the first great civilizations would not have been possible without counting and development of mathematics. Measurement of parcels, tax calculations, needs of trade — this all created new tasks for mathematics. Important breakpoint in the 20th century was the introduction of computers. In the beginning they only allowed increased speed and capacity of conducting mathematical operations, but later on, they entered into every aspect of our lives because it was proven that numerous activities can be improved if some of their aspects are transformed into calculations. For example initially, writing of a message meant difficult work of engraving to stone or clay, later it meant to write by various types of pens. When the message was supposed to be copied, it had to be rewritten again and again. Letterpress and typewriters managed to improve the duplication of documents, but only because of computers it was possible to bring the aspect of calculation into this process. Thanks to computer it is possible to intervene into writing by a lot of new ways: it is possible to delete the text, copy, move, search in the text, and even with the help of macros create own more complicated functions. Simple operation such as moving of a text in a computer is realized by certain operation with data stored in the memory, which on the lowest level of execution means a process according to certain algorithm, it is carried out by a calculation in the binary scale. Today with the help of computers scientists work on a brand–new way of writing: dictation. A computer receives the voice and by means of complicated algorithms it is transferred into written text. Programs like this still make a lot of errors, but it is probable that in future a number of texts will be created this way.

Computer Science is only part of the mathematical–technical stream of knowledge development, from which Information Science draws. Cybernetics is its another important source, and we will talk about it later.

3.4 Communication as a Source of Information Science

Communication is related to social flow of Information Science sources. The basic prerequisite of communication is that sent information is transmitted to the recipient, received and understood. If this condition is not fulfilled, we talk about communication failure. Communication is a kind of a dynamic domain, which is formed by direct and mediated sharing of thoughts and experience of people. We can perceive communication as an information exchange, too. Apart from verbal communication we exchange information about ourselves by trading of gestures, the way we communicate, the context we create (clothing, place...), and how we behave, especially in situations which participants consider to be extremely important. This analysis shows that there is nothing that can be entirely excluded from communication. Even when we hide our sadness or lie, it somehow marks the exchange of information. Therefore, we can say that while we communicate, we share

all our existence. Every communication channel (words, gestures, deeds) has its physical form. Language, perhaps for millennia, had been developing as more and more complex information exchange of sounds. With the discovery of writing it became possible to transform content, which passed through sound channel before (air waves processed by acoustic apparatus), in such a manner so they would find a brand new way — new physical media and also different sensory apparatus that perceives these media. Same as in the 19th century Braille writing system for blind people was developed using physical information channel, recognizable by touch, it is possible to create such a language coding system that would enable its perception by smell or taste.

Thanks to patience and willingness of people and thanks to advance of cognitive science it is now possible to apply this idea of channel variability in such situations that seem to be hopeless. Movie *The Diving Bell and the Butterfly* shows us the story of a man who was paralyzed, the only move he was able to do was to wink his left eyelid. It was based on a true story and book by Jean–Dominique Bauby. They wrote the book by Bauby thinking out the text in advance, then every time he heard appropriate letter in the string of letters he blinked. Even more striking is the project of entrepreneur Mick Ebeling, who at first wanted to help only one similarly paralyzed man as J. D. Bauby was. Along with his team, he created a device with open–source software that reads eye movement. It makes possible for people like Bauby not only to communicate but also to create art. (Ebeling)

On the most general level it is possible to see communication exchange (not only with other people) as a manner by which a human decreases his unsafety regarding relationship between the ever–changing outer circumstances and his own internal condition. Entropy, lack of needed information, also means higher rate of uncertainty. Uncertainty is not eliminated by any information, but only by relevant one that helps human to understand the situation in which he occurs, it helps him to adequately react and also to better synchronize his experience and beliefs into coherent, harmonic unit. Data that a human receives become real information only if they lower the rate of his nescience, uncertainty, and instability.

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4. Information and Communication

Keywords: *contextual and relational level of communication, analogue and digital methods of communication, meta–communication*

4.1 Complexity of Communication

Human communication has a great deal of aspects. From the existential aspect it is possible to characterize it as following: *"Human communication is an art oriented on not forgetting the brutal absurdity of life sentenced to death."*(Flusser, V., page 9) More commonly, communication is understood as a transfer of information by means of language, gestures, or by other sign systems that carry some meaning.

> From the aspect of Information Theory we can imagine communication even more universally as a transfer of information from the source through the transfer channel to the recipient, while between the source and the transfer channel there is a process of encoding and at the channel output there is a process of decoding of information.

Communication same as information has two aspects. First is the contextual aspect: we communicate by messages that bear their own meanings (not only by the medium of language). When we focus on material or technical aspect of communication, we emphasise physical (material) features of communication, information media, transfer techniques, handing over and processing of information. Everything can serve as a communication instrument: gestures, stones, smoke, language, letters, newspapers, telegraph, film, mobile phone, and internet. At the same time context is essential, so in certain situations even silence, not communicating can be carrier of important information. That can be happening at full consciousness. Apart from that we can also provide information to others unknowingly by means of communication channels (e.g. gestures, tone of speech), which we do not have entirely under control.

Important part of communication (not only by the means of modern communication instruments) is the possibility of displaying information adequately to our senses: lines on a road, photography, book, screen, loudspeaker, dashboard in a plane, headphones.

4.2 Contextual and Relational Level of Communication

Communication, perceived as a transfer of information, became significant contribution to the understanding of human relations. In order to understand various types of pathologies in communication, followed by the detection of suitable therapeutic approaches, and also for finding the ways of improving the communication skills, it is essential to distinct two levels of communication, especially on the grounds of distinguished work from this research area — *Pragmatics of Human Communication.* (Watzlawick, P. — Bavelasová, J. — Jackson, D. D.) Similar ideas, but more theoretically oriented can be found in the theory of speech acts by John L. Austin and his followers. (Austin, Searle) Variety of authors reached the already mentioned two levels of communication by different approaches, often as a result of analogy with another sphere of life, therefore, they have different denotation. Usually they realize that these two levels of communication cannot be strictly set apart,

that they overlap, they are in mutual tension, or they contravene each other in some way. As a start, I exemplify a scheme that has only informative character and it hints which terms are more interrelated. I will further elaborate upon each approach later on.

contextual level of communication	↤↦	**relational level of communication**
message	↤↦	command
data	↤↦	instruction
communication	↤↦	meta–communication
digital method of communication	↤↦	analogue method of communication
locutionary speech acts	↤↦	illocutionary and perlocutionary speech acts

Evident constituent of human communication is its contextual level. At the shallow sight, it may seem that transfer of information completely captures the communication events. People noticed long time ago that it is not true.

Non–verbal communication is frequently mentioned in Psychology. Even philosophically oriented theory of speech acts acknowledges that along with sentence and word content, a lot of other elements come into play, they can also bear certain message. In relation to the verbal content, this non–verbal message can form an addition, background, but it can also be in the tension with this verbal content, or directly oppose to it. Non–verbal elements of communication are circumstances (time, place, social peculiarity of situation...) gestures, intensity and pitch of voice, attitude in the relation to someone else (eye contact, social roles of both...), and others.

Regardless of factual origin of one of the listed elements, authors of *Pragmatics of Human Communication* warn that communication always has contextual level though only in the implicit form. "*Any evaluation of the relations is related to the one or more of the following statements: "this is the way how I see myself... this is the way how I see you... this is how I see, you can see me..." etc. in the theoretically infinite regress. For example, the announcement: "It is important to let out the clutch gradually and continuously", and "Just let it go, it will die immediately" they have similar content of information (aspect of the message), but they evidently define very different relations.*" (Watzlawick, P. — Bavelasová, J. B. — Jackson, D. D., p. 54)

4.3 Data and Instructions

With the design of new computers, constructers realized that the communication between human and computer consists of two layers: data and instructions. Initially, computers solved simple mathematical operations, later on they spread into almost every domain of life. For example, my laptop contains a program for reading texts. If I enter the text in the electronic form (data) and give command to read that text (instruction), as a result I will be able to hear the text from the speakers of my laptop. This whole process would be realized as a linear sequence of the binary states in the computer, it is impossible to distinct which state belongs to data and which to instructions on the grounds of this elemental level. If we move on to a higher level, to the realm of programming, we will be able to clearly distinguish between data and instructions.

Data can be perceived as information, and instructions as information about information (how to deal with them).

In a comparison with interpersonal communication, this analogy is quite broad, but it captures the fact that sensory–perceivable physical facts of communication can be divided into two basic levels, while the second level refers to and completes the first one, that is why this meta–level can be also understood as information about information.

4.4 Analogue and Digital Methods of Communication

The difference between analogue and digital access are best known from the development of music recording or more generally sound recording. Analogue media, such as gramophone record, are based on the principle of similarity and continuousness. Sound is mechanically recorded in a form of spiral groove on the disc. Groove profile "copies" the shape of sound waves. Digital media such as compact discs (CD) store sound in the digital form, thus as a sequence of nulls and ones physically encoded into longer and shorter "lines". They are based on a principle of discreetness (discontinuity) and encoding (without the necessity of similarity). Digital record succeeded, while analogue is on the decline.

> Human speech represents the digital way of communication with characteristic principles of discreetness and encoding, while non–verbal aspects represent the analogue way of communication with principles of similarity and continuity.

The word "laughter" either spoken or written has nothing to do with the expressions of laughter and can be encoded differently in every language. On the other hand, physical expressions of face and the whole body, which are called laughter, can continually change, therefore, it can have an immense number of "shades". Anyhow, it is not that human either laughs or does not laugh and there is nothing in between. Apart from that, laughter can be "broadcasted" and "received" as positive and negative (heart–whole laughter, mockery, malevolence...) element of communication, while this expression does not have to be clear and understood the same way by all participants of communication. Thanks to the digital communication we have all conveniences of modern civilization, but when the relation is a priority, analogue communication gets into the spotlight

and digital falls into the background. Even meta–communication, which is an important prerequisite of psychotherapy, stands and falls on a possibility if trust develops in a therapeutic relation, and that is again connected with analogue communication (for example, if the client feels accepted, understood, and so on).

4.5 Communication and Meta–communication

> Bertrand Russell's theory of logical types, which originated from the effort of solving the paradoxes of a set theory, became an inspiration for the tries to tackle the language paradoxes such as liar's paradox. By distinguishing between language as a language in which we talk about certain area of reality, and meta–language as a language about this language, brought light into some complicated situations. They also analogically introduced the term meta–communication as communication about communication.

However, this approach is useful for understanding some complicated communication situations, it is not a tool that would solve every problem of this kind, not even with the good will of both sides. Let's presume that two people encounter each other in a conflict on the contextual level of communication. After some time they start to repeat the arguments and do not move on, they can try to communicate about the way they communicate, for example about their mutual relation and what affects it. This level, which was until now only implicitly present in their combination, is becoming explicit. They pushed the original topic away and now they talk about how they talk about that topic and what affects them. They moved on one level higher, they are now in the meta–level of communication. Even this level has, along with its explicit contextual part, hidden, relational one that can be called meta–level of

communication. All aspects of communication in the communication are never fully uncovered to the participants, there is always something implicit. Under normal circumstances it is not a problem "...the more spontaneous and "healthier" relationship is, the more the relative aspect of communication is lost in background. On the other hand "unhealthy" relationships are characterized by never–ending fight for the character of relationship, and by that the contextual aspect of communication is repressed." (Watzlawick, P. — Bavelasová, J. B. — Jackson, D. D., p. 55)

4.6 Multilevel Communication

Even the very same information can include different levels, and what is absurd on one level can have deep sense on other level.

Let's have a look at this short dialogue from the books by A. A. Milne about Winnie–the–Pooh:

"What day is it?" asked Winnie–the–Pooh.
"It is today," squeaked the Piglet.
"My favourite day," said the Pooh.

If someone asks what day it is, it can be perhaps because he is in the hospital and does not know if it is Thursday of Saturday. Or he can ask about other characteristics, according to which days differentiate from each other (sunny, rainy, windy...). From this point of view is Piglet's answer absurd, because it gives no information. Everyone knows that the day in progress right now is today. We usually consider something as favourite if it has greater value for us, it brings us more pleasure compared to other matters of the same kind, and it can be repeated. But every day is, when it is in progress, today. Hence Pooh does not bring us information, from the aspect of day distinction, either. However, he tells us something: he says that he has favourite days and that every day is his favourite. This information does not relate to days distinction, but to his attitude towards life. His answer shows positive thinking and a reference to the conscious awareness, life concentrated on present. That is entirely another kind of information than a message that can be encoded by nulls and ones.

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5. Methods of Using Information throughout History, Information Revolutions

Keywords: *language, letterpress, information and communication technology*

5.1 Hindsight of Information Processes

Origins of special study of information and information processes date back to the 19th century, but they became a standalone object of study in the mid–20th century.

> On the ground of these studies and more complex comprehension of information it is possible to show retroactively the development of information technologies that mankind used to improve the knowledge and communication. They are: sounds (words), gestures (letters), books, libraries, catalogues, computers, communication means, databases, networks, search engines.

The ways of adjusting information technologies to the needs of a man are much more intensely looked for nowadays. Just like children learn language for millennia, which then becomes essential part of their lives, modern children learn to use computer, mobile phone, and other technical gadgets, which same as language will also become natural parts of their lives.

Within the scope of the information study, processes of handling information were examined one by one. It concerns these processes: creation of information, their acquisition, preservation, processing, searching, comparing, sorting, filtering, rating, measuring, coding, transfer, distribution, usage, displaying, and removal.

Story about information and information processes is depicted in an interesting way by J. Gleick in his book *The Information: A History, a Theory, a Flood.* It takes place in an age in which, contrary to ours, every thought and utterance disappears as soon as it originates. It describes the discovery of letters and alphabet, shows how African drums served to transfer the information, and so he tells the story of information technologies that changed the nature of human mind. He provides portraits of key figures who contributed to the development of modern comprehension of information: Charles Babbage — inventor of the first big mechanical computer, Ada Byron — poet's daughter, who was the first real programmer, key figures such as Samuel Morse, Alan Turing, and Claude Shannon — creator of Mathematical Theory of Information.

Similar information technologies development overview is found in many authors' bibliographies. Some changes as a part of this development were so critical that they changed the character of society significantly. Therefore, some authors do not hesitate to talk about them as information revolutions. Even though I speak about some aspects of these revolutionary changes in other chapters, here, I report them chronologically according to their influence on the society. Consequences of the modern information age are dealt with in Chapter 11.

5.2 The First Information Revolution: Language

Thanks to the physical fields' theories such as gravitation of electro–magnetic field, we see reality as an interconnected web. Seeing that the most precise expression of our comprehension is represented by mathematical equations, according to J. A. Wheeler or H.

Ch. von Bayer we can imagine reality as an information web. Contemporary biology shows the sophisticated systems of information interconnection and exchange of information in living nature. This all is happening, pursuant to our knowledge, on unconscious level.

When our human ancestors started to communicate with each other some 350 — 150 thousand years ago using the language, the first and the simplest level of communication was born — a conscious exchange of information. It consisted of them learning to encode the means using the sounds. This information was also very fragile. If it was not preserved in the human mind, it perished with the subsidence of sounds. These archaic cultures preserved these important messages by individuals learning them.

Thanks to the language, our ancestors could form the first larger communities, their structure was not coded in the relatively stable instincts but it was based on a dynamic communication, therefore, it was much more flexible. Nevertheless, human was detaching from the world of nature only gradually and slowly. Knowledge, customs, and traditions concerning acquisition of food, morals and law, mythology were passed on verbally, that is why their reach was quite small, except of what was there and then. Society as a whole had as much knowledge as all its living members had altogether. Structural core of society consisted of family ties.

5.3 The Second Information Revolution: Letters

The next outstanding advancement to more intense and effective processing of information was the discovery of letters. Findings of proto–letters (signs that partially served as letters) are dated back to the 7th millennium B.C., and findings of letters date back to the 4th millennium B.C. "Fresh" verbally transmitted information that was significantly constricted by time and space, could now be "preserved" thus its effect was notably amplified. It caused that the civilizations that used letters gained cultural advantage and they were developing faster. Society structure became more complex. It is hard to say if this increase of complexity led to greater happiness, but we can observe in the history that it meant greater power. To this day, there are tribes in the isolated parts of the world that have not undergone this revolution. Some aspects of their approach to the reality can be inspirational even for us. Information Technologies are considered to be our tool, and as with any tool, whether it is harmful or beneficial tool depends by great degree on how we use that tool.

Two great changes that influenced thinking of the individual and society's level of knowledge are connected with the discovery of letters. At first–hand verbal communication there was no difference between the outer reality, its presentation in a language and factual verbal utterance. Moreover, it implied that the way people spoke about reality, was the way it was perceived, their myths — for example about the origin of the world — meant reality to them.

The first change means that with the discovery of letters and partially by its influence, people start to separate language and thinking from the outer reality, and they start to evaluate independently and critically. Mythical thinking under the influence of great figures is breached and philosophical thinking originates. Karl Jaspers considered this change so important that he called the epoch from the 7th to the 2nd century B.C. the axial epoch, some sort of axis of history.
Further letters allowed the great increase of society's knowledge. People did not have to remember all knowledge, and they could devote free mind capacity to the creative think-

ing. Space and time borders were significantly extended, inside of which the knowledge could be shared and elaborated on. (Eriksen, pp. 38–42)

5.4 The Third Information Revolution: Letterpress

Mechanical duplication of written text has been known since the 8th century in China, but true expanse of book copying happened in the mid–15th century in the Europe thanks to Johannes Gutenberg.

Since then, it was not only possible to store the information, but it also became possible for the information to be copied effectively — the same information could reach huge number of people in a relatively short time, which laid foundations for the modern industrial society.

A book has been changing its form, but until this day it remains a distinguished information medium. With the increased amount of books, new challenges emerged. People started to accumulate books in the libraries, and after certain number it was very important to think out a method of finding a desired item in such enormous number of books. Some could search according to the name of author, other looked for a book with specific name, and another one could seek information about some topic.

5.5 The Fourth Information Revolution: Information and Communication Technology

With the development of computers since the 2nd half of the 20th century our possibilities of handling the information considerably extended again. Their basic principle does not fundamentally change, intensive development, however, concerns some of their features: computers can process information faster and faster, they need less and less space for storing the information (and while it is not only memory that is being reduced in size, but also other components, computers are smaller and smaller) and their communication interface is more and more adjusted to the needs of user.

Internet, which became important phenomena in the 1990s brought and important change: it created virtual space that interconnects almost every type of information, and allows fast access to them. There are encyclopaedias, traffic orders, weather forecast, radio and TV stations, magazines on the internet. You can also do shopping, manage bank accounts, call, see the galleries, attend remote symposium, and much more.

When modern people enjoy all these conveniences, it has influence on the society. It is more and more dependent on the proper information systems functioning. For example, air transport without such system would not be possible. Around 100 thousand flights are despatched daily, they have to be interactively coordinated by various means. National economics and bank systems are interconnected by similar fashion. Administration and coordination of increasingly higher amount of life spheres demands greater international cooperation, which would be impossible without modern information systems.

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6. Information Structures and Compressed Information

Key Words: *gene, meme, materialization, compression*

6.1 Genetic Information

Since the beginning, human language has been developing by people not calling individual objects by different name, but they named the whole groups of objects. Individual names remain reserved for persons, important places, or for some other unusual realities. When in the ancient times Aristotle laid foundations of scientific approach to sort out the knowledge in certain field, but also to organize language he devised the hierarchical system of categories. Its main idea was quite simple. Higher level — family — represents mutual characteristics of all items that fall under this category. Lower level in the hierarchy — class — are delimited from the other classes of the same family by class difference, thus by the attributes, given group differentiate from the others within the same family. From the ontological point of view classes differentiated in form, from the point of view of knowledge it is by the characteristics we can describe. Nature of the form remains puzzling. In the 18th century, the Swedish physicist and physician Carl Linné (1707 — 1778) based modern taxonomy on this principle.

In ancient times people already noticed that when living creatures reproduce, they transmit all basic attributes on the offspring. However, the first success in the research of heredity dates to the 19th century and are connected with the name of Gregor Johann Mendel (1822 — 1884), founder of Genetics and Augustinian monk working in Brno. On the basis of several experiments with pea crossbreeding, he formulated three rules that later became known as the Mendel's laws of inheritance. Mendel observed 7 characteristics in the several consecutive generations. Upon the mathematical evaluation, he concluded that they do not directly inherit characteristics but only their endowments. It made possible to suspect that behind outer characteristics (phenotype) there is some internal bearer of information about these characteristics. This bearer was later named a genome.

However, Mendel's discoveries were forgotten for some time, in the 20th century they provoked the development of molecular genetics. Its important milestone was firstly the proof that DNA has essential role at transfer of genetic information of almost every living creatures, and later in 1953 it was the discovery of double helical 3D structure of DNA that was connected with the names of James Watson and Francis Crick. According to their model, primary structure of DNA consists only of four types of nucleotides, which simply said means that human genetic information is like a book written by four types of letters. In 1990 *Human Genome Project* was commenced, with the aim to scan (determine the sequence, hence identify order of the nucleotides) complete human DNA. This project was successfully finished in the beginning of the 21st century.

> All these discoveries allowed new, completive view on life. According to it, DNA is the basis of the information system that is comprehensible to all life forms. Life itself can be understood as some concept of organizing mass and energy to the system, which is the result of storing an enormous amount of information in such system. (Stonier, p. 20)

6.2 Memetic Information

When the idea of natural evolution won recognition, analogy with the development of human culture proposed itself. Similarly to development of various types of mammals in the course of time, the same way human languages, music genres, types of mobile phones, or patterns and ornaments on the garbs of neighbour regions developed. Formulation of this approach is called memetics.

The word "meme" first appeared in the Richard Dawkins' book *"Selfish Gene"* published in 1976. He comes up with the idea of generalization of biological evolution applied on the culture, which leads to postulate the new type of replicator that would be analogy to the biological replicator — the gene. Dawkins called this new hypothetical replicator a meme. Scientific field dealing with memes is called memetics.

Susan Blackmore sees memetics as an attempt to explain spreading and development of ideas, fashion trends, world views, and as a matter of fact all expressions of human culture in the society, by means of theory of evolution. Evolution in any system happens when three pre–requisites are fulfilled: features variability of particular system constituents, choice and heritability, hence preserving the chosen. Variability results from the fact that reproduction is not entirely immaculate, therefore, variability can be interchanged with the requirement of certain volume of errors during reproduction. If given system fulfils those pre–requisites, relative number of those constituent attributes that help survive in the environment has to increase. According to the author, it is algorithmic, mindless mechanism that does not have designated goal. So if such replicator that fulfils these pre–requisites exists, evolution has to occur. But that means that evolution in the biologic sense is only a special case of evolution. (Blackmore, p. 33–42)

Even though memetics is based on the term "meme", it cannot be exactly defined yet. Pursuant to S. Blackmore, meme is any content of human mind or exhibition of a man that can be passed onto

the other people so this content or exhibition (opinion, behaviour, fashion trend, roundelay, story) is learned by imitation. Meme is the basic constituent of culture that spreads by non–genetic way — by imitation. Imitation, according to the author, is extremely developed in humans, it is developed so much that she rates it as an ability that distinguishes humans from other creatures.

> From the Theory of Information point of view, we can understand meme as a certain meaningful part of cultural information. Many memes (for example, this text) can be converted into digital form. If meme has physical form of computer file, it can be easily and fast copied, sent to another places, but it can also be modified. In this case compared to genetic information two symbols are enough (1 and 0), thanks to which meme is encoded.

6.3 "Selfishness" of Memes

R. Dawkins in his book *Selfish Gene* considers their "selfishness" as an important attribute. S. Blackmore also borrows this metaphor. "Selfishness" of genes means that they do not care about welfare of species or organisms they are a part of. They care only about copying of themselves. The fact that they are part of bigger genome complex' (chromosomes, organisms, societies) only means it grants them the advantage — better chance of copying themselves. Word collocations as "they care...", "they want" have to be understood as metaphors, in reality, it is a mindless process.

According to S. Blackmore, memes are also selfish in this sense. They do not care about the welfare of their bearer. They do not care about anything; they do not have any goal. If it is possible, they copy themselves — they wander from mind to mind and gain people. The result of selection is that they merge into bigger units

— memplexes, e.g. world views, cultures, architectonic styles..., which as units compared to particular units have much higher chance of success.

> Even though memetic perspective seems to be strange or even perverse at first sight, it brings interesting consequences. In a very simple way it explains facts such as commercials, behaviour of institutions, impressiveness of ideologies, alienation in the modern society, religious wars, expansion of sects, clever imitation of altruism, and much more others.

Briefly I would characterize that memetics just because it perceives human impersonally, it can surprisingly simply and concisely depict those aspects of human utterances that result from the fact that human is not a person in ideal sense. Under the pressure of culture it lets materialize parts of itself. If we focus on individual or deep personal meetings of two people, materialized aspects of a human somehow stay hidden. But if we look on big society, perhaps the whole humanity, they suddenly emerge with all their insistency. K. Lorenz concisely expresses it by writing that if some ideal beings without instincts could observe mankind as a whole, big movements, always present wars and destruction, and they could not see individuals, they would never imagine that humans are too gifted with intelligence and their behaviour is controlled by responsible morals.

6.4 Science as Information Compression

Since the oldest times, people have been searching for some ultimate origin of everything. In the Greek philosophy they spoke about Arche, in Indian about Brahmana, and in Chinese about Tao. Various thinkers came up with various concepts, but there was always a suspicion behind that the whole diverse reality is derivable, and has origin in one primeval principle. Using Information Theory vocabulary they suspected that enormous amount of sensory sensations can be somehow compressed into brief information, from which those data are derivable.

A similar idea is in the background of searching for the essence of science, searching for something that allows it and related search for "theory of everything" or some universal formula, universal force thanks to which all happenings in universe could be explained. One of the important contemporary views on science understands it as a Compression of Information. For example, primeval observations of heavenly objects led our ancestors to the creation of theories about their movement patterns. They were successful in such degree that more than 2000 years ago they were able to predict the eclipse of the sun. Today we can tell the same information by simple physical formulae, hence we can send rockets and satellites that are, for example, requirement for our navigation systems to work.

Compression means that from the big volume of data we pick the important ones, and we cleverly express what they have in common or what repeats in them. There is our belief behind, which we probably do not even realize, that data are able to be compressed hence the essence of the world are repeated structures. In contemporary physics, this view is represented by the so–called holographic principle. It borrowed its name from the hologram, two–dimensional picture that caries information about three–dimensional object. Even a part of the hologram is enough to see the whole picture. Holographic principle is part of the hypotheses concerning quantum gravity, which say that all information contained in the volume of space can be represented by theory working on the edge of this field.

Perception of science as a Compression of Information is a brave hypothesis and today also a strong belief, according to which various aspects of reality have suchlike character that their complex

state and development can be quite well summed up into the simple information and based on that simple information expand the description of reality in the course of time.

A good example is the description of basic characteristics of electromagnetic force using four Maxwell's equations. Throughout the majority of human history, people did not perceive this force, but today thanks to the 4 referred equations we use this force for proper functioning of computers, mobile phones, lighting... Physical aspect of transfer and process of information is today mainly covered by devices that use electric and magnetic attributes of matter. They may be different attributes in the future. The first steps to create quantum computers are underway, which we will speak about later.

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7. Ontological Approach to Information

Keywords: *structure, alignment, meaning, entropy, complexity*

7.1 Information as a Part of Structure of the Universe

Cybernetics is the example of an approach that leads from the usual understanding of information to increasing level of generalisation. Ultimately, it is possible to understand each system as a process of information exchange among its components and also with its environment. Tom Stonier's understanding of information is a similar approach, connecting information with natural sciences, especially physics, even more.

> He understands information, along with the matter and energy, as the third important physical entity creating the basis of the Universe. While matter and energy create the outer structure of the Universe, information creates the inner structure — the subtle one.

He himself emphasises that it is a hypothesis, internally coherent system of thoughts that is not proven yet by the criteria of contemporary natural science. In that sense, it is a part of metaphysical philosophical thinking attempting to look for connections and postulate assumptions that are not verifiable today, but offer

explanations in line with contemporary scientific knowledge and current state of culture. If Stonier's hypothesis was to be scientifically proven later on, it would not be for the first time in history. Established physical theories of power, heat and electromagnetism were created long after people started to examine and utilise these phenomena. These theories were also rooted in metaphysical concepts that were initially impossible to prove. Since very lately, people were not confronted with a need to explore information; there were no attempts to create a theory explaining the concept of information. Only with the development of communication technology (telegraph, telephone, radio, television) and computers were the information engineers encountered such challenges, as how to transmit information most effectively and cheaply from one place to another, while eliminating mistakes and noises. The question of the essence of information was increasingly important, along with practical improvement of transmission, selection, filtering, coding and other processes involving information. Technical approach to information helped to solve problems, but there were internal contradictions. C. Shannon — the founder of the Theory of Information — expressed the notion of abstraction from the meaning of the information most accurately: "*The basic problem of communication is to reproduce the message that was chosen in one place, more or less accurately in another place. Messages usually carry meaning, according to a certain system; they refer or relate to specific physical or conceptual entities. From technical point of view these semantic aspects of communication are irrelevant. The important aspect is that they are chosen from a set of possible messages.*" (Shannon — Weaver, p. 31–32) Although Shannon ignores meaning explicitly, it is still present implicitly. If he defines information using the probability of choice, he anticipates the presence of an observer at least in two aspects: probability includes expectations and context; and choice predicts someone, who can make it. Both require implicit semantics as the horizon of meaning. (Aguado, p. 347)

7.2 Information as Alignment

While the relation between information and alignment or inner organisation of a system is obvious, postulating information as another physical constant is a more challenging intellectual endeavour. For example, if we take matter organisation, a book is a material containing aligned areas, with each area carrying a certain set of colours and forms we recognise as specific characteristics by a human eye. Modern electronic e–book readers enable identical way of text reading, while using only one are allowing visualising the information saved in a much more economical way — in a form of tiny areas using electromagnetic qualities of the materials. Even better example is a house built from separate construction materials that is put together to form a building according to a certain plan (information about organisation). T. Stonier generalises these experiences and shows that in this way we can look at anything from an ice crystal, a crystal of any other chemical substance or complex molecules of organic substances to DNA. The DNA organisation structure is nowadays considered a carrier of genetic information, which also supports the idea of a close relation between information and organisation or structure.

When we observe a change of the inner structure of a substance by changing the temperature, we will discover certain break points, when a substance changes its inner organisation significantly. The best known example and closest to our experience is water. In temperature below 0˚C it creates ice crystals and becomes a solid matter (or in certain circumstances snow), from 0˚C to 100˚C it is liquid and over 100˚C changes into vapour and thus becomes gas. Measurements show that if we, for example, warm up the ice, its temperature rises, but at 0˚C the heat will not be manifested in the change of the temperature, but in a substantial change of its inner structure. Information about stable inner relations that manifest themselves as crystal lattice is lost. At the same time Entropy — the measure of uncertainty — is growing. "*Entropy of a system can be*

changed either by changing the heat content or the organisation of the system. Both approaches result in a change of the information content of the system."(Stonier, p. 39)

> If we add information in this way that is, along with matter and energy, a third part of the physical structure of the Universe, it will be characterised by these three aspects: 1. Information is manifested as organisation or alignment, 2. Information is a function of improbability and 3. Information content of a system is a function of the amount of useful work required to create this information content. (Stonier, p. 102)

7.3 Technological and Physical Information

The concept of information came from using the information by applications in some way. Due to a rapid development of telecommunication technology in the 20th century, it was necessary to prepare theoretical basics, based on which it would be possible to continually develop more effective ways of information transmission over telephone, radio, television and later on the Internet. Shannon's Theory of Information was very useful for fulfilling this purpose. However, Stonier questions whether this aspect of information is the most important and whether it offers the most general view of information.

> Information in the technical sense is a successful choice from a given list of symbols. It is the same as a statistical measure of uncertainty or "measure of surprise" in the occurrence of symbols in the string.

The difference between technical and physical concept of information can be easily shown in a simple example. Notice the following sentences:

(S1) AR ČHTONE ÁÁETFO JVOTT IANMEAB.

(S2) THISSENTENCEISRICH IN INFORMATION.

Based on a technological approach, it could be reasoned that the first string contains more information for a Slovak person. If a Slovak would have the letters hidden and should guess them, in case of the first sentence (S1), most Slovaks would need more attempts to finally guess the complete sequence of symbols than in case of sentence (S2).

On the other hand, the physical approach makes sentence (S2) appear to be richer in information, the reason being that more work and thus more energy were invested into its creation. (S2) contains sequence of letters related to a meaningful context, while (S1) is — related to the same context — only random series of symbols. However, situation would be different, if, for example, sentence (S1) would be encoding of sentence (S2) using a certain agreed code. The whole situation would be more complex, it would require more work and it would have higher degree of information richness. The reason is, it would not be enough to know Slovak, its vocabulary, rules and its use, but it would also be necessary to know the code to decode the message. People able to communicate create a more complex system than those, who are not able to communicate together. It is a similar difference as in the example of house and building material with a construction plan. Finally, people that are able to communicate together and keep their communication confidential by encoding it at the same time, create an even more complex system. However, meaningful context is important at all times. Physical approach to information does not mean abstracting from the meaning, not even in case of considering information richness in an ice crystal.

7.4 Consequences of Ontological Approach to Information

The fact that information is not a product of a human mind, but a quality of the Universe and a physical entity, seems to be a basic aspect of an ontological approach to information. At the same time, it emphasises, more than other approaches, that meaning is something that is not possible to ignore without serious consequences.

This approach to information reveals an important law — the role of bonds in creating the structure or organisation in the system. When the bonds between the molecules of an ice crystal disappear, its structure will disappear, too. Similarly, when the bonds between the members of an institution are lost, it will "dissolve" first into a weakly organised group and then into a group of disorganised individuals.

The analogy above reveals another aspect of this approach to information: the Universe is organised into a hierarchy of information levels. An institution consists of its members, each member's body consisting of physical constitutions that themselves have their parts, organs consisting of cells that have quite complex structure. On the lower level there are chemical compounds, molecules, atoms and quarks. Information can organise not only matter and energy, but also information itself and thus it can be organised into levels with increasing complexity.

Stonier, following L. Boltzmann and E. Schrödinger, derives relation between information *I* and entropy *S* as follows: $I = ce^{-S/k}$, where *k* is Boltzmann constant and *c* is the information of a system with zero entropy. This relation results into a view of the Universe evolution different from the one of contemporary physics. The Big Bang means a state of pure energy, infinite entropy and zero information. Due to the processes that change the energy into information, the information content of the Universe gradually grows, the basic natural forces differentiate and finally the matter originates in ever more complex forms. From the state of zero entropy self–organising systems arise and life up to the phenomenon of intelligence. This view presumes the possibility of ever accelerating development of information rich systems into new complexity levels, rather than the heat death of the Universe.

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8. Information Technology Development

Keywords: *von Neumann's architecture, Moore's law, qubit, superposition*

8.1 Bit and the Conventional Computer

Science is based on reality perception that originates in perceiving binary opposites: day — night, hot — cold, up — down. We reduce the more complex problems into more simple ones by using *Yes/No* questions. It reminds us of an old joke about a mathematician, who catches a lion in a big savannah. He builds a fence, dividing savannah into eastern and western part and then he finds out, in which part the lion is. That part he divides again in the north–south direction and finds out again, in which part the lion is. After a finite number of steps, the lion will be in a fenced area of a desired size.

A bit is a logical unit of information. It equals the situation when we know whether the answer to a certain question is *Yes* or *No*. Bit is used to measure the size of information. Classical logic had developed a calculus for mechanical or automatic processing even of very complicated logical operations using the truth values *Yes* and *No*. Physics, chemistry and technology succeeded to gradually reduce the size of the physical forms of the bite. Babbage's programmable mechanical computer from the 19th century, which he had not succeeded to finish himself, contained logic gates of a size that that could be measured in metres. Later on, different materials were searched for that would enable further reduction of the logic gates' size. Today we use integrated circuits, size of which is measured in nanometres (10^{-9} m).

The main representative of current information technologies is a standard computer. Its physical side consists of the so–called hardware (processor, memory and input/output device) and it uses von Neumann's architecture.

The computer functioning is quite simple. The control unit reads instructions from the computing memory, decodes them and creates a sequence of signals. The necessary data are obtained from the computing memory or the input device. When the instructions are carried out, the results are saved into memory or written to the output device. After that the control unit proceeds to the next instruction. The procedure is repeated until the instruction to finish is received. Originally the instructions were written in binary code that is why programming and using first models of computers were a matter of a small group of specialists. Today instructions have the form of software. The basic level of the programmes is still the binary code; however the user interface being more adapted to the needs of an ordinary person. A programme can be successful if the user interface is pleasant, intuitive and easy to manage.

8.2 Qubit and the Quantum Computer

Moore's law deals with an estimation of continuous development of smaller physical forms of logic calculus. It is an empirical rule, which was formulated in 1965 by a chemist and co–founder of *Intel*Company Gordon Moore. In its original form it was as follows: "number of transistors, which can be placed on integrated circuit doubles approximately every 18 months, while keeping the same price."This type of growth is exponential and if it continued

further, we would have exceeded the subatomic level by 2017. At the same time, it means that from the realm of ordinary physics we jump into quantum physics. And that is a world that can seem strange in many aspects, with laws that radically challenge some of our common experiences.

The theory of quantum computers and quantum information originated in the 1960s in the work of Rolf Landauer. Later it was sharpened by Richard Feynman. There are simple models of quantum computers existing today; still the theory is currently more advanced.

A quantum computer should run data operations so that it would directly use quantum mechanical phenomena in its operation, of which **superposition** and **quantum entanglement** are the most important. In a conventional computer, the amount of data is determined by bits, while in quantum computer qubits orquantum bits are used. The basic principle of quantum calculations is that the quantum characteristics of particles can be used to represent the data and structure and quantum mechanisms can be used to run operations using these data.

Modern society spends increasing amount of energy (mostly electric energy) for data processing. Rolf Landauer conducted a research in the 1960s with the aim to decrease energetic demand during data processing. At the same time, he realised that each form of processing information in the real world is a physical action that consumes a certain amount of energy. He formulated his findings into a statement "Bit from it." His aim was to express that information always has a physical side, it is something physical.

8.3 Peculiarities of Quantum Information

An important characteristic of subatomic world is the so–called **quantum noise**. Particles of this world i.e. electrons are constantly moving. The noise can initially seem as major obstacle to decreasing the size of the computers. As it happens, the solution seemed unattainable for a long time. At the end, by changing perception, by shifting a paradigm, new unexpected journey emerged.

Quantum physics had to accept one more peculiar characteristic that was in contrast to all of the then–physics' endeavours. The aim of classical physics was objectivity — a way of research and tasks solving, where observer can be ignored, because he/she does not influence the subject examined. However, quantum physics discovered, that subatomic world can be understood only by radically changing this presupposition: the observer influences the examined subject in a significant way. The best known demonstration of this law is the so–called **double–slit experiment**. When the objects of the micro world are shot to the wall through two slits, they behave either as particles or as waves, depending on what we ask about, focus or observe, which information we aim to get. That means that objects' behaviour– whether photons or matter — cannot be fully described neither by classical concept of a particle nor by a classical concept of wave. That is why we speak about **wave–particle duality** and, on a more general level, about **complementarity principle**.

It is also hard for us to imagine the consequences of the principle of superposition in quantum mechanics, because they are in contrast with our common experience. Erwin Schrödinger put it in the most practical way in his article from 1935, in which he described his famous thinking experiment with a cat, known as the "Schrödinger's cat". In the experiment a cat is closed into a box, together with a deadly mechanism, in which there is a radioactive nucleus. The nucleus will dissolve with probability of 50% within one hour and activate the mechanism. After this time, the cat in the box

is either alive or dead, both with 50% probability. From the point of view of quantum mechanics the nucleus is in a superposition of two states after one hour: "dissolved" and "not dissolved", because for the quantum object it is possible to be in two states in parallel that would be from our macroscopic point of view mutually exclusive. On the other hand, the cat could hardly be at the same time in the superposition of the states "alive" and "dead". By this thought experiment Schrödinger wanted to point out that quantum mechanics needs to be complemented by its relationship to classical mechanics ruling common macroscopic processes around us.

On top of that, quantum objects have this peculiar quality of non–locality, so that their characteristics can directly depend on something that we consider far away, even millions of light years. This is what we call quantum correlation or particle cohesion.

Logical unit of quantum information is quantum bit alias qubit. Unlike a standard bit with a value either 1 or 0, *Yes* or *No*, qubit can have the value of 1 and 0 simultaneously, so it can be a superposition of 1 and 0.

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9. Information Transmission and Noise

Keywords: *transmission, information noise, coding, compression, information overload*

9.1 Information Transmission Process

Even the old cultures used simple ways of transmitting information, for example, using the sound of drums heard for long distances or using fire and smoke visible from long distances. Lighting a fire could be an agreed signal that the expected situation happened (i.e. the enemy was close). In reality, such channel would transmit only 1 bit of information (the situation happened or not). In this case, the process of encoding and decoding meant that the enemy was close.

In the 19th century there was an unusual expansion of communication technologies. Regular mail and newspapers were still using the written or printed form for the information transport, while telegraph and telephone became a major change: it was possible to transfer bigger amounts of information long distance without someone actually carrying them. In the 20th century radio, television and fax started to be used, as well as different types of audiovisual media, computers and most importantly their connection to the worldwide web of the Internet and GPS. The way of information transmission has developed from wired cables to optical ones and then wireless transmission, first close to Earth and then using satellites later on. Today the communication networks converge, so it is common that mobile phones can be used not only for

phone calls, but also to listen to music and radio, watch films and television, GPS navigation, read our own books and newspapers from the Internet, shopping and paying bills, as a notepad, camera, sound recorder, for reading e–mails, as a watch and alarm clock, dictionary and encyclopaedia, to find information about weather, as a travel itinerary, address book and many other things.

From technical perspective, it is very important to suggest effective ways of encoding and decoding, as well as specify the capacity of a transmission channel. Mathematical model of information transmission is the key of Shannon's Theory of Information. Its outcomes were a theoretical base for continuous development of more efficient ways of transmission.

9.2 Communication Noise and Protection Against It

No communication channel is perfect. For example, in case of the fire information transmission it could happen that a forest fire started and based on that the tribe wasted the energy preparing for a fight. It is sometimes impossible to hear other person's voice during the telephone conversation because of transmission imperfection. It can be caused by natural forces or device failure resulting into lower quality of output signal compared to the input signal.

A metaphorical use of the expression "noise" has been adopted to express the fragility of information transmission. We naturally enjoy the sound of the sea or forest in the background when relaxing, we do not really notice this "noise", and it reinforces the atmosphere of well–being and relaxation. This is an experience common with our ancient predecessors. After technology, especially communication means, developed, the word "noise" gained a new secondary meaning. For example, it can be an unpleasant sound that we sometimes do not notice and at other times it disturbs our

telephone conversation so much, we can barely understand what the other person wanted to say. In the context of sound transmission it is that part of the sound that is undesirable. By generalising this experience we have broadened the meaning of the expression "noise".

Noise in the Theory of Information is a decrease in quality of information in the transmission process. A part of information can be either lost or the transmission channel can generate information that was not transmitted. Shannon's mathematical model gives a theoretical answer to the question how to decrease the risk of information depreciation in the transmission process to a minimum, while keeping the maximum capacity of the transmission channel.

The results intuitively correspond to our simple experience. For example, if you make a phone call with an English person and you are not always sure if you heard the word correctly, you can ask him/her to repeat or spell the word. You can minimise the probability of a mistake to a minimum, by asking him/her to spell and repeat everything. In this case, your communication would be very slow.

When H. Ch. von Baeyer explains the phenomenon of noise during information transmission, he shows that the formula for calculation of information channel transmission capacity is not a continued proportion of signal / noise ratio, but the logarithm of this ratio. He also mentions older people like himself. If he wanted to watch television, he would need to increase the volume so much that the others could leave the room. If someone's sound audibility decreases by half, it is not enough for the signal/noise ration to double, it has to increase exponentially. For example, if this ratio was 5, it would not be enough to increase it to 10; it would have to be increased to 25.

9.3 Encoding

The theory of encoding is an important part of the Theory of Information. It is possible to encode a certain phenomenon or data representing it, each in a different way, while these ways can vary substantially, even by the amount of information (number of bits).

For the technical part of encoding, some specific tasks are important. The first is an attempt to compress the information to a minimum. We know it from working with compression programmes on the computer. The basic concept of such programmes is simple. Instead of 30 zeros in a row, it will encode number 30 as number of repetitions and zero as a symbol that should be repeated. However, specific algorithms can be complicated. We talk about zero–loss compression, if we are able to extract the complete original information from the compressed version. On the other hand, loss–making compression is a way of compression that consciously selects certain criteria, according to which the less valuable part of the information will be lost. A typical example would be music conversion from CD and DVD media into MP3 format. It is perfectly enough for listening to music while reading in the train, a regular listener will not recognise lower quality and in this way it is possible to record into a player ten times more music.

A second useful task is encoding enabling error correction. If we can estimate the error rate of the transmission channel, we will expand the encoded information by some form of correctness check of the transferred information. It is understandable, that the more we will attempt to decrease the risk of errors, the more information we will need to add to the original message.

9.4 Positive Task of Noise

From the philosophical point of view it is interesting that when we try to solve the technical side of information transmission and we seek how to approach the issue of noise, we reveal laws that are related to our very nature.

If there is too much information, even if the transmission is technically correct, it will become a noise. We live in a world, where this kind of information noise continually increases. You know it: advertisements and announcements are everywhere and they attract us to watch them. Only to involve us, television, radio, internet and newspapers offer competitions to win prizes. If I leave everything behind and seclude into a room to work on educational text, there are still mobile phone, Skype, Facebook and e–mail ready to connect me with others even through the walls and in great distances. Even if I switch off everything and leave only the lines I am currently writing on the monitor, still the information noise will not disappear completely. The noise in me, in my head, cannot be switched off by pressing the button as the TV news.

If I create certain conditions, my inner silence will speak. If I listen to myself and tune the communication channel to a minimum of noise, only then I can start writing. I become a receiver of the message, even if I do not know the sender. I only allow a very small information noise in my head, similar to sound of the forest leaves, around the topic of noise and texts and experiences connected with it.

Philosophy, science, art and religion began, when some people were more attentive and noticed things or connections invisible to others. They saw, perceived and understood more. It seems, today the situation is changing. N. N. Taleb, who likes equivoques, says: "*A prophet is not someone with special visions, just someone blind to most of what others see.*"(Taleb, p. 60) To put into information language: what we considered information can thanks to our human maturing, become a noise and vice versa, what has been noise, will become important information.

If the information transmission was not on principle restricted by noise and we were able to acquire arbitrary exact information encoding, measuring and transition, only one ring, for example, of an exact diameter (exact to the number of decimal positions needed) would be enough to transmit information of any richness and all the libraries in the world could be encoded into the length of its diameter. But we are finite beings that are not accustomed to receive and process infinite amount of information.

A world without noise would overload us with information. And so the noise protects our mental health. Paradoxically, in the most general sense, noise is not only an obstacle that prevents concentration, but it also creates conditions, so we can focus on the small amount of information we are able to receive and process.

H. Ch. von Baeyer says that as the time is the God's way to guarantee that everything does not happen at the same time, the noise is a way of the nature to guarantee that we will not notice everything that is happening. Paradoxically, noise is protecting the information.

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10. Systems and Automation

Keywords: *technology, cybernetics, feedback, artificial intelligence*

10.1 Development to Automation

A social organisation of work is a characteristic feature of human society from its beginnings. People created increasingly complex tools throughout the history, so we could achieve our goals more efficiently. The effective influence of people on the production processes is called management. From the 19th century there was initially a rapid development of technical equipment helping people in their work and later on it was designed to operate on many tasks automatically, without human support.

Technology development can be divided into three phases. The first is the specialisation of tools. With their support human could work manually and manage the activity at the same time. To make the physical work easier, they started to use draught animals, kinetic energy of water, lever, etc. Efficiency of this kind of work was very small and productivity low. The second phase is mechanisation. It is about replacing the manual human work by machinery. Technological equipment not only replaces the human activity, but also increases productivity. If not only individual production operations, but the total production processes are mechanised, we talk about complex mechanisation. Natural abilities of people were not enough to manage such complicated processes.

Even the managerial aspect of human activity needed to be supported by technology. This requirement was fulfilled in the third phase of technology development, which is automation. The work automaton comes from the Greek origin of *automatos* meaning working by itself, self–sufficiently. The need to deal with the topic of automated management initiated the development of different technical disciplines, the most important being cybernetics and artificial intelligence later on. In this phase of development, there is an apparent need to analyse production and even more managerial processes as information exchange processes.

10.2 Cybernetics and Expert Systems

Cybernetics examines behaviour and management of complex organised open systems — technical, biological or social. The American mathematician Norbert Wiener (1894–1964) is considered to be a founder of cybernetics. His foundation work is called *Cybernetics: Or Control and Communication in the Animal and the Machine* (1948). The name of this discipline comes from the Greek word *kybernétes* (a man at the wheel). For ancient Greeks cybernetics meant an art of steering the ship. The connection between information and modern cybernetics lies in understanding management as an information process. Only due to the information exchange, elements can be organised into a complex system and thus create a higher quality unit. From this point of view, a run of an antelope can be understood as an complicated coordination of bones, muscles, neural, blood and digestion systems and animal's senses, "coordination" meaning information exchange among the individual subsystems. It happens by passing the nerve impulses, secretion of certain specific substances, with specific physical phenomena as electricity, pressure, density etc., as well as chemical

reactions hidden behind. At the same time, each of the subsystems is a complex system in itself. Blood circulatory system consists of blood vessels, heart, blood, the other subsystems being cells of different kinds and their parts, chemical compounds and elements, molecules, atoms and quarks.

Information technology is the basic technical foundation of cybernetics, because the size of memory, speed of calculations and reliability of the computers exceed the possibilities of the human and enable substantially higher quality of those aspects of management that can be written into algorithms.

The main task of technical cybernetics is to reach an optimal management, by which we will be able to achieve planned goals with the minimum of work, time, material, energy and information investment. The key question of cybernetics is whether the dynamic system is able to keep its behaviour and development under the changing conditions and disturbances. Such behaviour needs a certain structure and way of doing things, while principle of feedback is one of the basic principles helping to achieve optimal behaviour.

An example of such simple technical system is heating system with thermostat. When the temperature in the room drops under a certain critical value, a sensor will sense it and send out a signal for the heating to switch on. The heating will switch off after certain time or after exceeding certain temperature (again sensed by the sensor). The information connection between the sensor and the heating body provides feedback, due to which it is not necessary for a person to react to the changing temperature. This kind of automatic regulation is more than a heating system management and it differs in the process of information exchange between the managing body (thermostat) and the constant regulated (temperature).

Expert systems are applications that help to make decisions based on facts, rules and logical judgment. They can involve: investments, travel itineraries and travel planning, management, complicated equipment repairs, etc. By integrating such systems, multilevel hierarchical automated systems are gradually developed, within which each level of automated management takes care of certain sets of managing functions.

10.3 Artificial Intelligence

If humans use tools to simplify their work and cybernetically manage complex technical systems, could they move to an even higher level? The core of the automated management is putting the decision processes or certain aspects of thinking into algorithms. It leads to a question if it is possible to simulate human thinking as such, if we are able to create artificial intelligence.

> The American mathematician and logician Alan Turing (1912–1954) is considered to be a pioneer of artificial intelligence. He reflected thinking and understanding in the context of computer development. In 1950 he published his famous article *Computing machinery and intelligence*, in which he suggested that if a computer fulfils certain criterion, it could be considered to be intelligent. This criterion is called *Turing Test* today. In brief, he claims that we can consider a machine intelligent, if its linguistic output cannot be distinguished from a human one.

The test could run as follows: The observer communicates with a subject and does not know whether it is a person or a machine. He/she inserts random written questions and gets written answers. Based on the answers the observer pronounces a judgement, whether he/she communicated with a human or a machine. If the observer cannot "fool" the machine, it can be considered intelligent.

The Chinese room argument is a counterargument to the *Turing Test*. It reflects on the possibility of a machine that could simulate intelligent behaviour (responses) without "thinking", using a prearranged set of reactions to all kinds of questions.

The artificial intelligence development went from the initial enthusiasm through a period of uncertainty and scepticism to a realistic evaluation of which cognitive abilities we are able to simulate well on computers and which are far beyond our current possibilities.

Chess is an easily programmable game. Despite that the computer can inspect much more possibilities of game progress than a man; the chess champions had been able to beat the computers without major difficulties. The turning point came during 1996–2006. For the first time, the Deep Blue computer won a chess game with Garry Kasparov — an incumbent chess champion of those days. Later on, computers gained substantial superiority. What more, computers today are able to recognise text and also face; they can read texts quite well and can even simulate a simple communication. However, the translation from one language to another has still a long way to go. The programs can translate simple sentences quite well, but when there is an important context, phraseology or an equivoque, the machine translation can be quite amusing.

Cognitive theory of representation is an approach that has been considerably successful. It enables us to simulate many thought processes. Computers can execute some of these processes in a better way, resulting in the improved understanding of the human cognitive faculty. Up–to–date computers are deterministic machines. There is a promising research that considers computers to be non–deterministic, interactive and capable of self–development. Maybe quantum computers could fulfil these characteristics. However, so far it is only a matter of courageous hypotheses.

Artificial intelligence inspires a lot of questions that still remain unanswered: Are we able to create machines with emotions? Can

machines have some kind of self–awareness? Can they be creative? Could they have a free will and use it against us, for example?

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11. Consequences of the Information Age

Keywords: *information age, information growth, slow and quick time*

11.1 Information Age Side Effects

Fast development of information technologies influences not only those, who use them directly, but the whole character of contemporary society. The exponential information growth results in easier access to information, but also causes side effects, which were difficult to anticipate at the birth of information technologies. They express themselves in seemingly ordinary things, such as watching television, using a mobile phone and sending e–mails, news reading, requesting computer literacy in the recruitment and feeling of inability to manage everything, having too much on the plate.

According to T. H. Eriksen certain things are valid for the current information society as a whole, few exceptions being the unemployed, prisoners, homeless people, etc.: 1) life rhythm of majority of inhabitants of the wealthier countries is affected by shattered and busy time;2) in the modern culture acceleration leads the knowledge production and the way of thinking.

We all are, the unemployed included, under its influence from the moment we open the newspaper or switch on the television. How are the consequences manifested?

The greater the amount of information, the lower the transparency. Nobody has sufficient capacity to process the enormous amount of information produced by contemporary society. Today it is much more difficult than in the past to create a complete picture of reality. It happens, for example, that if someone has more complex health issues, no specialist is willing to give the diagnosis and suggest the treatment. Such person thus can get individual results from different examinations, but no overall conclusion. It reflects our times. We can be good in specific areas of our lives, but we are losing the vision and meaning of the totality.

Due to the information overload, the major challenge for the members of the information society is to present the information in a way that catches others attention. Whether it is an advertisement, a lecture, scientific text, television programme or an Internet page, the information society is characterised by a fierce competition to win the concentrated attention of the target group. We constantly seek new ways to attract this attention. The films that were able to keep the audience on its toes 20 years ago are boring today. The more we let ourselves surrender to seemingly inevitable load of information, the more our attention weakens. People are not able to process the ever changing information, put it into a context of their previous experience and it remains shallow. The number of people with plenty of information is growing, but they are shallow people. It is increasingly difficult to find mature personalities, who are able to select information and build gradually the meaningful whole.

Good filters are much appreciated in the information society. When processing our e–mails, correct spam detection saves time and antivirus programmes are a good protection from malware when filtering the internet pages and different files. All in all, there is no simple solution to information selection.

11.2 Pressure on Speed

Acceleration and quick availability of information create an impression that the distance ceases to exist. When new means of traffic were designed, there were also concerns about a man not being able to perceive the surrounding country. Today the Internet, mobile communication and surfing the many television channels are criticised. Knowing this, the programme authors design many programmes so that at least every two minutes something interesting happens to catch viewer's attention, who is sitting with a remote in his/her hand, ready to switch the channel any time. Watching television and telephoning have probably changed our relation to physical distance the most. Sometimes we are so absorbed by watching or talking that we lose the track of what is going on around us. Many people let themselves be disturbed during the conversation by a ringing mobile phone. T. H. Eriksen expressed it as follows:"*When the remote things are not really that far, neither the close things are actually within reach.*" (Eriksen, p. 138)

In the past, the computers were slower, we had to wait longer for a letter to arrive, if we wanted to call a friend, we had to wait until the person got home, we had to wait for the political news or sport result still the next day or the evening news at least. Now all of this is reachable almost immediately. Our lives are hunted by the "fast time" and it changes how we experience things. Fast time carries us on its wave. The most urgent things come first and so the long–term and slow things are pushed back. When the "fast" and "slow" times meet, the fast one usually wins. "*In the age, where the borders between work and leisure time are blurred, where the highest value of economics, politics and science becomes efficiency, it is bad news for the elaborate work, playing with children or long–term relationships.*" (Eriksen, p. 139)

The kind of speed brought to our lives by information technologies is contagious and addictive. It is contagious, because if there is a major trend, ignoring it would mean becoming an outsider in

personal and social sphere. If we do not have a mobile phone today or a company webpage, we can be considered an old fossil. For example, once we get used to rush at work, all other activities, including our leisure time, will adapt to this frenzy rhythm. The addiction to speed is manifested in our way of experiencing reality: if we have fast computer, it would be very difficult to get back to a slow one. If we are used to a permanent connection to internet and we are left without it even for a short time, we start to show something similar to abstinence syndrome.

When time is cut into sufficiently small segments due to the speed pressure, it ceases to exist as something permanent. We are able to live fully in the present moment only when we are rooted in a wider context of passing meaningful events. Similarly to alcohol or drugs, information technologies can pull us out of a context of our life and gradually cause self–alienation by overloading our attention and tuning us into a fast time mode, in which we lose our purpose and meaning of our journey much faster.

11.3 Protecting the Slow Time

People did not need thorough philosophical analyses to realise the destructivity of fast time, if it "invaded" all areas of our life and started to dictate standard of experiencing. During the 1980s, Slow food organisation was established as a reaction to the fast food restaurants expansion. It has more than 100 thousand members today and its goal is to support the relationship of people to food. It draws attention to the fact that if we pay close attention to what we eat, we enjoy the food more and it increases the quality of our lives. This approach spread later on to other areas of life, as well. So–called Slow movement is becoming increasingly popular. It offers sharing slowness in areas such as: gardening, money, travelling, education, books, arts, media, fashion, science, spirituality and many others.

Slow afternoons became increasingly popular in Scandinavia. People enjoy a longer lunch break at work and except for slow lunch, they use it to visit classical music concerts offered during this time free of charge in churches and concert halls.

Swedish physicist Bodil Jönsson offers in her book *Ten Thoughts on Our Time* some interesting reflections of time in the information society. Many years ago, she had realised, she was not satisfied with her relationship with time. During her childhood she could observe her grandmother living a modest life, but always having enough time. The author attempted to build a new relationship with time by an experiment: she took two months break from all duties and "*the eternity of time slowly started to return*". (Jönsson, p. 17) Her book is not a new type of time management; it is more of a very personal reflection of a personal relationship with time.

The amount of technology in our lives is growing. It causes measured time (chronos) to become increasingly important and it causes segmenting of time, as well. There are no technical solutions for experiencing more of the time that is lived (kairos) and unscattered, allowing a fresh dose of meaning. Human relationships cannot be automated or regulated. A certain amount of time is needed for a person to be touched by something. Biological evolution has been too slow to develop a speed–phobia and that is a call to conscious decision to practise slowness.

In nature, the processes leading to exponential growth are mutually interfering. We cannot rely that it will be the same with the processes initiated by people. The faster our power grows, the

bigger our responsibility should be. The author does not suggest the prevention of the frenzy exponential growth. She allows herself to marvel. It is an expression of her quiet optimism in the background of a description of, especially in the western society, not always pleasant aspects of life.

Some tasks need a preparation time. If we do not see the result of our work, we tend to take it as a waste of time. However, demanding tasks require a preparation time that at first sight can seem unproductive. That is why it is useful to learn not to be available sometimes, allow ourselves to think, although many people would find this kind of message incomprehensible and insufficient: "Please, excuse my unavailability, at the moment I am thinking."

Everybody has a unique rhythm of thinking and experiencing things. It is a great gift to meet people, with whom we experience rhythm harmony not only on the dancing floor. Rhythm harmony of experiencing and thinking can be more important than common interests, the same culture or religion. The rhythm of the country, the other person or events can be crucial for our work and relaxation.

If we watch our time and we stay attuned, we can notice moments, when chronos changes into kairos. Only then we are able to generously give some of our valuable time. The clock stops ticking, because the eternity is quietly embracing us.

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12. Information Ecology and Ethics

Key words: *infosphere, information as a source, product and goal, ontic trust*

12.1 What Is Information Ecology?

First insights of archaic civilisations realising some information has a great importance for life and some does not, could be considered as the pre–history of information ecology. For example, some texts involving the answers to the deepest questions belonged to the sacred matters and some members of the community learned them by heart. With increasing complexity of the society, people were surrounded by growing amount of information. One of the most important deeds of the ancient times is Buddha's insight into how we process information. In his teachings he shares his own experience: information enters through our senses and mixes with certain stimuli originated in our consciousness. Desire and clinging are the main causes of suffering. That is why Buddha teaches a meticulous observation of what is happening inside of us. We can imagine that we want to become an observer, who sits in the auditorium of his/her own consciousness and carefully observes everything that happens on the stage. It can seem the simplest thing in the world, but who tries it, will find out that it is not so easy. Even wide awake, we tend to do a lot of activities routinely and so there is a lot of free space left in our consciousness, which tends to be filled in quite quickly. Imagine a driver, who is after the years of driving

so routine in his job that he can simultaneously listen to a radio or talk to passenger sitting next to him. Something similar happens in the consciousness of every person. During the days, a stream of thoughts, pictures and melodies starts to flow, many times brought by the emotions, desires and plans. This kind of information flow in us cannot be simply switch off as a radio. We can learn to observe our inner world of information; what kinds of information enter our mind, which of them and how they influence us and most of all, how they influence important decisions and events in our life.

The explosion of information technologies obviously influenced the basic attitude to information of the generation growing with these technologies from early childhood. That initiated the foundation of a new discipline called "information ecology". One of its founders and promoters is a German philosopher Rafael Capurro. As the impulse to establish the classical ecology was an increasing pollution of the physical side of the environment, similarly the impulse for information ecology development was "pollution" of the information environment.

You can imagine a waste dump and distorted country, endangered species of animals and plants on one side and huge number of spams in e–mail boxes, advertisements on billboards and web pages and also distorted information landscape" and extinguishing of some of its species (i.e. LP records) on the other.

With such analogy, each of us can wonder what represents everyday hygiene and eating habits in the information world, which information becomes toxic (similar to drugs, alcohol, cigarettes etc.), what it means to "digest" of "not digest" the information, etc.

12.2 Ethical Questions Related to Information

Besides, we can perceive traditional ethical problems in a new way by focusing on information — i.e. describing ethical situations from the point of view of information exchange between the agents or inside them — using information technologies also initiates completely new ethical questions.

Information can have different roles in these situations. Luciano Floridi contemplates about three ways how information is presented in ethical situations and so becomes a challenge for our decision making and thinking: 1. Information as a resource, 2. Information as a product, 3. Information as a target. Such three–part approach is usually called RPT (resource, product, and target) approach. It is a type of simplified environmental ethics.

If we contemplate **information as a resource**, we mostly refer to using information for decision making and taking action. To act ethically requires, among other things, attempt to gain as much information as the circumstances require. Information that the acting subject was supposed to have, but did not, are considered morally wrong. As opposed to that, accidentally missing information is extenuating circumstance. In other situations, an attempt to gain certain information can be considered morally wrong. With digitalisation of information new ethical questions arise. One of them is trustworthiness of the information resource. Thanks to the information technologies in transportation, it is possible to buy, trade and exchange information very quickly today, even between people that are far away from each other and will probably never meet in person. Unlike mutual interactions in a small village, where people know each other and any deception is uncovered quickly, in the anonymous multiple interactions over great distances, it is increasingly tempting to misuse the situation to one's advantage. It can

mean selling low–quality products, publishing unverified, untrue or consciously distorted information (i.e. on the Internet) and many other situations that can cause that people will make a decision under the influence of biased information that they would have otherwise never made. To prevent this, lists of trustworthy companies and high level scientific magazines are established, product and text reviews are being written. It is increasingly complicated to find out, whether certain information resources are trustworthy. The more important the decision is, the greater the responsibility of a person to verify trustworthiness of information, on which the decision is based. Trustworthiness or untrustworthiness can be assigned to the information only secondarily, in a certain context and these qualities eventually reflect mainly (ethical) approach of the people involved.

The ethical aspect of information is even more present, when we reflect on the **information as a product**. These are examples of situations such as: responsibility for information published, false accusations, witnessing, plagiarism, advertising, propaganda, misinformation and lying. Let us take plagiarism. Nobody is able to find out alone, whether a text, for example university diploma thesis, is a case of plagiarism. Libraries and the Internet offer so many resources that it is impossible for an individual to embrace them. That is why majority of countries gradually implements and improves a software that could compare the final thesis to as many texts as possible, in order to eliminate the possibility of plagiarism.

If we consider **information as a target**, we are interested in the ethical aspects of the information influence action has on the information environment. Here we talk about the phenomena that at first sight do not have a clear connection to information, such as: rush and stress, which can contribute to tension and conflicts in relationships. For example: (dis)respect to the right for privacy, unauthorised access to (digital) information (even if they were not misused), safety, vandalism (from burning books to spreading computer viruses), piracy, intellectual property vs. open source

products, freedom of expression, censorship, filtering and content control. While in the past it was quite complicated to follow a person and it required a lot of human resources, the situation is dramatically different today. Our phone calls, e–mails, using social networks and browsing internet pages — everything happens in a huge electronic network, where it is quite easy to trace our activities without many people involved, it can be done automatically. This situation is a subject of a brisk discussion that is looking for the right balance between respect and privacy protection on one hand, and monitoring destructive activities possibly threatening to the society on the other.

12.3 Generalised Information Ethics

Because of the generalisation of ethics, L. Floridi suggests to perceive information as semantic, as well as ontological entity. Agent of the ethical activity is a part of the infosphere, he is an information agent or "inforg". We can look at the activity of the Universe from the perspective of chemistry (and perceive everything as chemical elements, compounds and processes) and similarly we can look at it from the perspective of information (each entity or process is possible to describe through a certain data structure). Such approach represents the most general form of ethics and it is the result of gradual generalisation: from human–focused ethics, through the one, which takes into consideration living creatures, landscape and wider ecosystem to finally the totality of the Universe.

What are the basic characteristics of information ethics? This kind of ethics replaces biocentrism with ontocentrism. To generalise the life value, L. Floridi suggests using a value of being. In classical ethics suffering is a sign of possible life threat that is why ethics suggests rules that should help to prevent pointless suffering. Of course, it is not easy, because when a doctor operates on patient, it can cause substantial pain in the hope that the operation will

lead to improved life condition. As a generalisation of suffering in information ethics, the entropy is understood not only in a narrow physical sense, but as destruction, corruption, pollution or the loss of informational impoverishment of reality. Even here it is not easy to recognise, which action is irreversibly destructive and which leads to a temporary increase of entropy and more harmonised existence. From this point of view, each being (information) has its intrinsic value, speaking not only about natural being (i.e. stars), but also cultural (i.e. paintings, books and artefacts of ancient civilisation etc.). The aim of this kind of ethics is growth and well–being of the infosphere.

Philosopher, Rafael Capurro, also involved in information ethics, articulates some critical remarks against such approach. According to him, perceiving infosphere as dots in the information space means abstracting from physical and time–spatial conditions of our life. He wants to avoid the concept of "ontocentric" when characterising his approach, because he wants it to be decentring and making relative our egocentric ambitions. He remarks that cultural identity, i.e. a spam e–mail, not only does not have its value, more over it is destructive and not worth of the protection by entropy.

> If we protect cultural entities that we created, whether traditional or modern digital ones, their protection is not based on information dignity, but on the dignity of human realities, to which they relate.

12.4. Ontic Trust Hypothesis

Such hypothesis means the attitude to the world that is a generalisation of social agreement theories. "Assets" means the whole world, "donors" are past and current generations of agents, "trustees" are all current individual agents a "beneficiaries" are all current and future agents and patients. All agents and patients are connected by being. Mutual respect comes from recognition of mutual dependency. A man enters his/her life only as a beneficiary of the world, continues as a trustee and ends as a donor. We should act for the wellbeing of the whole world, especially for its future. All existing things have their value, no matter how small.

Albert Einstein referred to this ontic bond in an interesting way. On February 12, 1950 he wrote a short letter to Roberto S. Marcus, a Chairman of the World Jewish Congress, to console him, after his son had died from polio:

"A human being is a part of the whole called the Universe by us, a part limited in time and space. He experiences himself, his thoughts and feeling as some kind of optical delusion of his consciousness, something separated from the rest. An attempt to set free from this illusion is a fundamental question of a true religion. Not feeding this illusion, but an attempt to overcome it, is the way to reach a reasonable peace of mind."

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