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The Episteme of Knowledge Civilisation

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Abstract

The paper starts with a discussion of the concept of knowledge society, economy or civilization, while stressing possible different interpretations of several issues: the reasons of emergence of knowledge societies, the issue of perceiving knowledge as capacity of action versus perceiving it as intellectual heritage of humanity, the issue of public versus private ownership of knowledge as the source of the basic socio-economic conflict of the knowledge civilization era. In general, these differences of perception rely on different epistemic assumptions and axioms, even on different hermeneutical horizons. After these preliminary discussions, the paper proceeds to a short review of recent advancements in micro-theories of knowledge creation, in particular, related to the COE Program Technology Creation Based on Knowledge Science in JAIST. This is followed by comments on the role of technology in the knowledge civilisation era. Main attention is paid to the need for and a proposal of a new episteme for the knowledge civilisation era, called evolutionary constructive objectivism. The paper is concluded by indications of possible use of theories of knowledge creation in stimulating regional innovation.

Keywords: Knowledge society and knowledge civilisation, micro-theories of knowledge creation, divergent episteme, falsificationism, paradigmatism, postmodern subjectivism, evolutionary constructive objectivism

1. Introduction

In the last decade of 20th century some researchers realized that knowledge becomes the decisive productive resource which will lead to great changes in global economy. A path-breaking publication was "The Texture of Knowledge Societies" (Stehr 1994), stressing that "the most common denominator of changing economic structure is the shift away from an economy driven and governed by material inputs into the productive process and its organization, towards an economy in which the transformations of productive and distributive processes are increasingly determined by symbolic or knowledge-based inputs." With this diagnosis we fully agree, even if we disagree with the opinion of Nico Stehr that the change was only evolutionary, not revolutionary. If we admit that a revolution is only a period of accelerated evolution, then the last two or three decades were clearly a period of informational revolution, which brought about a dematerialisation of work, thus enabled a change towards a "social world in which more and more things are made to happen", where "knowledge as a capacity to act" (Stehr 1994) can be decisively exploited.

The combination of the concepts of knowledge economy and information society or information revolution has lead later to the concept of knowledge civilisation, see, e.g., (Wierzbicki and Nakamori 2006), understood as a new civilisation era resulting from information revolution. With this broader concept comes also a different interpretation of several issues. As we already stressed, the reasons of emergence of knowledge societies are seen as founded on information revolution; it was computer technology applied in automation and robotics that limited the role of hard labour as one of principal productive resources, led to a dematerialisation of work, with all its consequences. This de-legitimized the conflict between labour and capital, thus enabling the dissolution of the communist system; this also enabled the growth of the role of knowledge as decisive production resource, however, preparing the emergence of the next basic socio-economic conflict of the knowledge civilization era.

From a purely economic point of view it is natural to define knowledge as capacity of action, but such definition in a sense legitimizes the trend towards privatization of knowledge, observed today on strongly increasing scale in many aspects of knowledge economy. However, knowledge can be also defined as the intellectual heritage of humanity, since – as we shall show later - the tendency of hard science and technology to highly value objectivity and truth can be rationally explained in terms of caring for future generations, providing them with best tools for dealing with highly unknown and uncertain future. This outlines the issue of private versus public ownership of knowledge: one side will say that knowledge, as a capacity of action and the main productive resource of the coming era, should be privatized to a largest possible extent. The other side, however, will say that knowledge is not a degradable resource, it does not decrease but increases with use (Lessig 2004); therefore, the old arguments justifying privatization in terms of tragedy of commons are not applicable to knowledge. And anyway, free access to ideas is a cornerstone of democracy (Jefferson 1813); moreover, the access to knowledge and education should be provided at reasonable prices to all, not subject to oligopolistic practices. Thus, main part of human heritage of knowledge should remain public property.

These differences of perception are related also to essentially different epistemic assumptions and axioms; these are not just different paradigms, but much deeper differences in hermeneutical horizons. The concept of hermeneutical horizon was used by Martin Heidegger and Haans-Georg Gadamer, see, e.g., (Gadamer 1960); but it was recently given a more basic, rational interpretation by Zbigniew Król (Król 2005, 2007). It is also related to the theory of truth in formal languages. According to Kurt Gödel (1931) and Alfred Tarski (1933), the question of truth cannot be answered inside a given formal system; we must use of a formal metalanguage in order to meaningfully address the issue of truth in a given language. However, Zbigniew Król stresses that it is impossible to create and study mathematics as a purely formal, meaningless game: there is no mathematical theory which is absolutely formalised. To have a strictly formal language one needs a formal metalanguage, to have a formal metalanguage one needs a formal meta-metalanguage, and so on – an infinite recursion. Thus, the only possible way is to stop and study fundamental assumptions in a non-formal, intuitive meta-environment. This intuitive environment is called hermeneutical horizon; Król shows that hermeneutical horizon has been changing historically, that "Euclidean geometry" has been understood differently by ancient Greeks, differently in times of Descartres, Newton, Kant, differently today. If this can be observed in mathematics, it applies as well in other parts of science: different paradigms use not only different, incommensurable languages, but – much more fundamentally - are also based on different hermeneutical horizons. This phenomenon is called horizontal change.

However, even if historically changing, the perception of truth via hermeneutical horizon is not subjective, nor even intersubjective: we do not decide in social discourse what are the components of a hermeneutical horizon (at least, not in mathematics, technology, and hard sciences; the situation in social sciences and humanities might be slightly different). The formation of a hermeneutical horizon is a process of a long duration; since, on one hand, the hermeneutical horizon is intuitive, on the other hand it is common, say, for all mathematicians working in a given age, then its formation must be unconscious but related to the canon of teaching the given discipline – say, mathematics - in that age.

As an example of the difference of hermeneutical horizons between, say, postmodern social sciences and technology, let us consider the basic postulate of postmodern, especially poststructuralist philosophy: that language is not only a tool, but the only tool of communication and cognition, that knowledge is socially constructed in a discourse, see, e.g., (Foucault 1972), (Derrida 1974), in more extreme attitudes coming to the conclusion that reality is also constructed and only language exists. This is actually based on horizontal, intuitive assumption that the use of language defines humanity, reinforced in long duration terms since Ludwig Wittgenstein (1922) declared that the limits of our language are the limits of our world, through the works of Martin Heidegger, Hans-georg Gadamer, to poststructuralism and postmodern sociology of science, taught today to all human and social scientists. Such an assumption is, in a sense, natural for sciences working mostly with texts; but it is obviously alien to hard sciences and technology. For example, a technologist must see that a tool constructed by him actually works; and (s)he understands how the tool is working by seeing, by visual cognition (including such enhancements of vision as oscilloscopes, electronic microscopes etc.), while expressing such knowledge in words is its' obvious simplification. Thus, a technologist would insist that humanity is defined also by tool-making; and a hard scientists would add also human curiosity – going beyond individual evolutionary survival needs – to this definition what is human.

Thus, we come to the conclusion that a deep cultural cleft emerged between the social sciences, hard sciences, and especially technology towards the end of the industrial civilisation era. Almost fifty years ago, Charles Snow (Snow 1960) pointed out that there are two cultures – that of hard science and technology and that of the social sciences and humanities. While Snow correctly stressed the differences, we think that he used the word culture imprecisely, a better description would be cultural sphere. In addition, he did not note the difference between the cultural sphere of the hard sciences and that of technology, which we shall discuss in more detail later, nor did he observe that the differences essentially concern the hermeneutical horizons and the episteme of these spheres – anyway, the concept of historically changing episteme, the way of creating and justifying knowledge characteristic for a given cultural era or sphere, was introduced later (Foucault 1972). Following the ideas of Foucault, we should expect a slow formation of a new and unified episteme in the new era of knowledge civilisation. But this formation will take much time, mostly because of the widely diverging epistemic beliefs of different cultural spheres and, especially, the resulting strongly divergent situation inside the episteme of the social sciences; see also (Kozakiewicz 1992), (Wierzbicki 2005), (Wierzbicki and Nakamori 2007a).

This is the motivation of our paper: to contribute to the formation of a new episteme, hopefully more unified or at least more tolerant and understanding to a natural epistemic diversity.

2. Recent Advancements in Micro-Theories of Knowledge Creation

The demands of knowledge based economy resulted recently in the emergence of many micro-theories of knowledge creation for the needs of today and tomorrow, as opposed to classical concentration of philosophy on macro-theories of knowledge creation on a long term historical scale. Historically, we could count the concept of brainstorming (Osborn 1957) as an early example of such micro-theories. Since 1990 we observe many such new micro-theories originating in systems science, management science and information science, beginning with the Shinayakana Systems Approach (Nakamori and Sawaragi 1990), the Knowledge Creating Company and the SECI Spiral (Nonaka and Takeuchi 1995), the Rational Theory of Intuition (Wierzbicki 1997), the I5 (Pentagram) System (Nakamori 2000), the OPEC Spiral (Gasson 2004) and several others. All such recent micro-theories of knowledge creation processes take explicitly into account the interplay of tacit, intuitive, emotive, and preverbal aspects with explicit or rational aspects of knowledge creation.

Additional results concerning micro-theories of knowledge creation were obtained also in the 21st Century COE Program Technology Creation Based on Knowledge Science at the Japan Advanced Institute of Science and Technology (JAIST). For example, the brainstorming process was represented as the DCCV Spiral (Kunifuji 2004) due to the research in this Program. The concept of Creative Space (Wierzbicki and Nakamori 2006) developed in this Program tries to provide a synthesis of such diverse micro-theories. Related to this synthesis is the concept of the Triple Helix of normal academic knowledge creation processes that combines three spirals: the Hermeneutic EAIR Spiral of analysing and interpreting scientific literature, the Experimental EEIS Spiral of performing experiments and interpreting their results, and the Intersubjective EDIS Spiral of debating and discussing research results. The idea of Nanatsudaki Model of Knowledge Creation Processes (Wierzbicki and Nakamori 2007a) tries to derive pragmatic conclusions from such analysis and synthesis, by combining seven spirals (objective setting OPEC, hermeneutic EAIR, socializing SECI, brainstorming DCCV, debating EDIS, roadmapping I-System, and experimenting EEIS) in an order useful for organizing large research projects, particularly for cooperation between academia and industry.

Parallel to the development of micro-theories of knowledge creation, we can observe the perception of change also in classical philosophy. As opposed to Wittgensteinian concentration on words and language with its prohibition to speak about metaphysics, or to postmodernist and poststructuralist belief that world is constructed by verbal discourse only, philosophy turns back today to metaphysical issues. This trend has already certain tradition, see (Kołakowski 1988), but intensifies recently, see (Żurkowska 2006), (Skarga 2007); Alina Motycka (1998) proposed also a model of knowledge creation during scientific revolutions, based on emotive and mythical, thus in a sense metaphysical knowledge. In relation to this trend, it is important to realize that at least two results of the 21st Century COE Program Technology Creation Based on Knowledge Science – namely, the multimedia principle and the emergence principle, discussed also here in later sections – might have a significant impact on new discussions of metaphysical issues, see (Wierzbicki 2007).

3. The Role of Technology in the Knowledge Civilisation Era

Since the JAIST 21st Century COE Program Technology Creation Based on Knowledge Science focuses precisely on technology creation, we reflect here on some of arguments presented in (Wierzbicki 2005).

The word technology has many meanings: it can mean:

For a post-modern social scientist: an autonomous force enslaving humanity;

For an economist: a way of doing things, a technical or technological process;

In common language: a technical artefact, a product of technology;

For a natural scientist: an application of scientific theories;

For a technologist: the art of constructing tools, an inherent faculty of humanity, motivated by the joy of creation:

Liberating people from hard work;

Helping technology brokers (venture capitalists, bankers, managers) to make money - and if any effect of that is enslaving, the brokers are responsible;

Stimulating the development of hard science by inventions which give it new principles to develop new concepts.

However, since the informational revolution was brought about by socio-economic applications of technology, it is important that the social sciences – and also the philosophy of technology, see, e.g., (Scharff and Dusek 2003) - understand technology deep, not only through their own horizontal perspective; in particular, they should understand also a definition of technology acceptable to technologists.

An acceptable definition of technology at the beginning of the knowledge civilisation era, proposed in (Wierzbicki 2005), stresses that technology is a basic human faculty that concentrates on the creation of artefacts needed by humanity in dealing with nature. As suggested by Heidegger (1954), technology is, in its essence, a truth-revealing, creative activity, thus it is similar to the arts.

The relation of technology and basic science forms a positive feedback loop: technology supplies tools and poses new problems and concepts for basic science; basic science produces theories later applied in technology. Although technology obviously uses results of science, there are many historical examples showing that technological inventions preceded theoretical development of science: the wheel, the telescope, the emergence of software out of hardware, the pseudo-random number generator in computers (preceding the development of modern theory of chaos), etc.

Products of technology, tools must be always used with sufficient care: you cannot fix small nails with a big smith's hammer. But people become fascinated with tools and have the tendency to go beyond the limits of their responsible use. Thus, any evaluation of safety of a technological product must take into account the character of its socio-economic application: even if engineers designing cars test them most rigorously, people's fascination with fast driving results in a number of deaths that exceeds many other causes. This distinction between the safety of a technological product used reasonably and the danger of social fascination with certain aspects of such products seems to be lost to some philosophers of technology – even if this was the essence of the Heideggerian warning that man exalts himself and postures as the lord of the earth.

Therefore, possibly more important is another positive feedback loop between technology proper and the system of its socio-economic applications, which is managed by technology brokers, i.e., entrepreneurs, managers, bankers, etc. This second feedback loop brings about most of the social and economic results of technology, but at the same time it can pose grave dangers, because the processes of the socio-economic adoption of technological novelties in this feedback loop are avalanche-like. Such processes must be controlled and stabilised by additional negative feedback. If this additional stabilisation does not work properly, disasters can occur: people become blinded by social or political fascination with the possibilities of technology (there are many historical examples: the construction of pyramids; the project of reversing Syberian rivers in the middle of 20th century, etc.) and do not see associated dangers of using technological tools improperly or on a too grand scale. An intuitive perception of the threat of such disasters is the essential reason for the condemnation of technology by the social sciences.

In the socio-economic adoption of technology, the stabilisation of avalanche-like processes is achieved by market mechanisms, but in high technology markets these mechanisms do not function ideally and, obviously, markets do not resolve ethical issues of technology adoption and application. Since technology brokers are educated mostly in the social, economic, and management sciences, the responsibility for the socio-economic applications of technology, for overseeing the effective limitations of blind social fascination with technology, lies also with the social sciences. Future will bring almost unlimited possibilities of products and services of information technology. We must thus repeat and strengthen, under new conditions, the Heideggerian warning about the human fascination with technological possibilities: we must take care in the knowledge civilisation era not to become blinded by the seemingly unlimited possibilities of products and services offered by technology; in particular, we must take care to preserve our intellectual environment, the intellectual heritage of humanity.

Finally, we should stress here the reasons of our belief in the distinct episteme of technology and that of hard sciences. Intuitive, artistic creation of tools implies also that we cannot fully formalize this activity: no matter what quality control we apply in technological processes, a new tool might always be dangerous. Therefore, tools are tested rigorously, subjected to destructive tests. It is well known, e.g., in the case of cars; that the safety of their use must be checked by crash tests; but actually all tools are tested that way to some extent, e.g., laptop computers are tested by being dropped to the floor to check their reliability. Testing technological knowledge, embodied in tools as products of technology, relies on direct applications, including destructive tests to check their safety and reliability. In its everyday practice, technology values and follows the falsification concept of Karl Popper – see, e.g. (Popper 1972) - more than the paradigms of Thomas Kuhn (1962), although Popper did not note this and postulated falsificationism rather as a methodology for science, which was correctly criticized by social philosophy of science starting from Kuhn. Thus, science is paradigmatic while technology is pragmatic but falsificationist, see also (Wierzbicki and Nakamori 2007a). This distinction between the episteme of technology and that of science is also overlooked by most philosophers of technology – and the concept of technoscience (Latour, 1987) is thus a misnomer, even if there are obvious relations between hard science and technology.

4. The New Episteme of Evolutionary Constructive Objectivism

We should stress first that the concept of episteme, in its contemporary understanding introduced by (Foucault 1972), cannot be restricted to historical studies; it also can be used to analyse the current situation and future developments. We already observed that after the middle of the 20th Century, the episteme of the industrial civilisation era was disintegrating and three essentially different episteme of three cultural spheres were developing divergently. This concerns the separate episteme of the hard and natural sciences, the distinct episteme of technology, and the episteme of social sciences and humanities (which is itself internally diversified, with some extreme versions represented by post-modern social philosophy). Here we address the need for and the possibility of a new integration of the episteme for all sciences, humanities, and technology.

The need for a new integration is obvious in the new era of knowledge civilisation and has been stressed even by social scientists, e.g., by

(Latour 1987) and (Jackson 2000). Here, however, we present the arguments for such a need from the opposite side, that of hard sciences and technology, which might lead to different conclusions. The main argument from our perspective is that in the knowledge civilisation era, we need social science that thoroughly understands knowledge creation in the hard sciences and technology, and we, the representatives of the latter cultural spheres, cannot find such understanding in the arguments of social scientists today.

In particular, we feel that the elements of the episteme of our cultural spheres are often misinterpreted or even sometimes presented in a distorted way by the representatives of social sciences. For example, pedagogy is, no doubt, a social science, though it borders on the humanities. The pedagogical theory of instructional design distinguishes three approaches: behaviourism, cognitivism, and constructivism, see, e.g., (Mergel 1998); the first two are called objectivist and constructivism is counterposed to them as a new, better approach, see, e.g., (Jonassen 1991). We do not doubt the merits of constructivism, but we have severe doubts as to whether objectivism as described in these papers truly represents the essential elements of the episteme of our cultural spheres. Specifically, (Vrasidas 2000), following (Jonassen 1991) and (Lackoff 1987), lists the following elements that supposedly define objectivism:

There exists a real world that consists of entities which are structured in their properties and relationships

The real world is fully and correctly structured thus it can be modelled

Symbols are representations of reality and are meaningful as far as they correspond to reality

The human mind abstracts symbols in computer-like fashion so that it mirrors nature

Human thought is symbol manipulation and is independent of the human organism

The meaning of the world exists objectively, independent of the human mind, and is external to the knower

Each of the above points can and has been debated in the history of philosophy. Here we make only three critical remarks:

The above points are a mixture of the epistemological beliefs of positivism and logical empiricism. They belong to the episteme of industrial civilisation, which lost its validity around 1950, and to the cognitivist belief in the analogy of a human mind to a computer that lost its validity around 1990 (see Wierzbicki and Nakamori 2006).

One of the best descriptions of objectivism, given by (Popper 1972), is quite different from the points listed above. It admits that knowledge is constructed by humans, but nevertheless stresses the roles of objectivity and of the third world of ideas and knowledge. This third world exists independently of human minds, in our libraries etc.; today we call it the intellectual heritage of humanity, and it is the domain of existence of the meaning of the world.

Anyone who has constructed and used computerised models of outside reality, such as any good telecommunication engineer should do, knows that these models are only approximations of reality, thus the assumption that a correct and full structure of the real world is needed for modelling is erroneous.

One could say that the six points supposedly describing objectivism are presented only as the end of a spectrum of beliefs, but this is precisely the problem: they create a distorted caricature, constructed in order to be criticised; they do not describe what objectivist beliefs a technologist must have today in order to be successful when constructing technological artefacts. Thus, they do not help in – in fact, they prevent – a correct understanding of technology by social scientists.

One could also say that these six points serve only as a background for presenting the opposite concept of constructivism, which is better suited to serve as the basis of an educational theory. Let us quote how (Vrasidas 2000), following (Jonassen 1991) and (Lackoff 1987), characterises constructivism:

There exists a real world that defines boundaries to what we can experience. However, reality is local and there are multiple realities.

The structure of the world is created in the human mind through its interaction with the world.

Symbols are the products of culture used to construct reality; the mind creates new symbols by perceiving and interpreting the world.

Human thought is imaginative and develops out of perception, sensory experiences, and social interaction.

Meaning is a result of an interpretive process and depends on the experiences and understanding of the knower.

Again, each of the above points can be debated, but we agree with some of them and do not argue against the thesis that a constructivist approach such as characterised by the points above might result in better theories of teaching, eventually giving more freedom to talented students. Suppose, however, that a teacher is convinced by the above arguments of constructivism and uses it in constructing her/his courses. Will the teacher refrain from propagating the constructionist epistemological beliefs among her/his students? We think that this would be impossible because epistemological beliefs, like a system of basic values in a hermeneutical horizon, define a personality, which is one of the most important characteristics of a teacher. And even if the teacher "impartially" characterises the objectivist and the constructivist epistemological beliefs as described above, the education of the students will be biased; as noted above, the description of the objectivist episteme is distorted, does not teach the kind of objectivism truly needed by, say, a student of telecommunication engineering. The alumni of such teaching courses will either fail in the construction of telecommunication devices and systems (for example, through the belief that the reality of the telecommunication network is local to their local area networks), or – if they turn to management instead of engineering – will fail to understand the truly good engineers who work with them.

This type of caricature construction resulting in distorted views about technology and hard sciences occurs, unfortunately, rather frequently in the social sciences, in effect preventing their understanding of either technology or hard sciences.

4.1 What technology and hard science can propose as an emerging episteme of the knowledge civilisation era

The emerging episteme that we propose below – following (Wierzbicki and Nakamori 2007a) - must take into account, even if we construct it from a mostly technological perspective, diverse differences between three divergent episteme: of technology, of hard and natural sciences, of social sciences and humanities. We are aware that the formation of a new episteme will take its own historical time; but we believe it is our duty to attempt and present at least the outline of a description of such an episteme – to be criticised and modified by future research.

Let us begin with three basic principles that we believe will be decisive for the change to the new episteme of the knowledge civilisation era. These are the Popperian evolutionary fasification principle, the emergence principle, and the multimedia principle. These principles have been described in (Wierzbicki and Nakamori 2006, 2007), but we repeat them stressing their fundamental character.

The concept of falsification, important for the new episteme, requires some comment. We use this concept not in its early, rather naïve sense of abandoning a theory after finding a counterexample (Popper 1934), but in a more mature sense, as already indicated in (Popper 1972), and further developed in discussions with representatives of social sciences:

Evolutionary falsification principle: hypotheses, theories, or models develop evolutionarily, and the measure of their fitness is the number of either attempted falsification tests that they have successfully passed, or of critical discussion tests leading to an intersubjective agreement about their validity.

In fact, this falsification principle applies not only to a hypothesis, theory, or a model; especially in technology, it also applies to tools and artefacts, while the falsification tests are either tests of practical adequacy or even destructive tests. In fact, the above principle applies also to social sciences, only empirical tests, difficult in social settings, must be necessarily supplemented or even replaced by critical discussions (see also Jensen et al. 2003).

A conceptual comment is necessary here. While in his early work Popper (1934) concentrated on the inadequacy of the concept of logical induction and proposed the concept of falsification as a replacement for it, in his later work (1972) he used the falsification principle as a part of his general epistemic description of human knowledge development. His epistemic beliefs are evolutionary. He assumes that knowledge is amassed in the third world (or rather world 3), which we later called the intellectual heritage of humanity (Wierzbicki and Nakamori 2006). Theories are preserved in the heritage independently from individual minds, which only interpret the heritage. Popper did not specify the sources of new theories, only admitted that they might come from human intuition. However, theories evolve and compete in an evolutionary fashion, while their validity (we could also call it a measure of fitness) is evaluated according to the falsification principle. In a sense, human learning is evolutionary while its intellectual heritage plays the role of memory.

Popper, however, was so much against induction that he did not note how his description of the evolutionary learning principles of human knowledge development might be also interpreted as another, more contemporary description of an evolutionary induction process. As an ironic result, the same principles were actually rediscovered and called induction by (Holland et al. 1986), then developed in more detail as evolutionary inductive reasoning by Brian Arthur (1994). Naturally, today we would add many details to the original Popperian concept of the evolutionary development of objective knowledge. The evolution of knowledge is punctuated, and includes revolutionary periods as described by Thomas Kuhn; this might be related to the principle of emergence (see later comments). The source of new ideas is human intuitive and emotive knowledge, cognitively much stronger than logic; this is related to the multimedia principle, as discussed below. But the original concept of the evolutionary development of objective knowledge is due to Karl Popper, though he was no doubt influenced by the concepts of the competition of scientific programmes by Imre Lakatos (1974) and others (after all, Popper also interpreted the intellectual heritage of humanity).

Another comment is that technology distinguishes clearly between prescriptive and descriptive models or concepts: a prescriptive model might not correspond to actual practice, but expresses a recipe for how things should be done. Thus, we agree with the social science criticism of the Popperian falsification principle (that any creator of a new theory will look for data to support it rather than make experiments aimed at falsifying it), but only if we interpret this principle descriptively. However, the Popperian falsification principle can be also interpreted prescriptively, explaining how things should be done in order to attain reasonably objective knowledge. And in technology creation, this principle is not only prescriptive; it also describes the actual behaviour of technologists testing their artefacts in extreme conditions.

The second fundamental principle is related to the emergence of new concepts and properties at higher levels of complexity, which was noticed long ago in philosophical metaphysics. A clear formulation of the emergence principle, however, first evolved with the empirical evidence of the concept of punctuated evolution in biology (see Lorentz 1965), noted also by (Popper 1972); then it was rationally reinforced by the concept of order emerging out of chaos (see Lorenz 1963, Prigogine and Stengers 1984, Gleick 1987). In parallel, it was pragmatically substantiated by technology, in hierarchical systems theory (Findeisen et al. 1980), as well as in the concept of seven layers of telecommunication protocols (see, e.g., Wierzbicki and Nakamori 2006).

Thus, the reduction principle of the industrial episteme – that the behaviour of a complex system can be explained by the reduction to the behaviour of its parts – is valid only if the level of complexity of the system is rather low. With very complex systems today, we should use instead:

Emergence principle: new properties of a system emerge with increased levels of complexity, and these properties are qualitatively different than and irreducible to the properties of its parts.

This is a fundamental conceptual change. Even if it might seem that the emergence principle logically results from the principle of synergy or holism – that the whole is more than the sum of its parts (see Bertallanfy 1956, Ackoff 1957) – this is not necessarily a correct interpretation. The principle of synergy or holism does not say that the whole should have essentially different properties than its parts. Thus, sciences of the 20th Century, accustomed to the atomistic or sub-atomistic reasoning of physics, continued to believe in reductionism: a whole might be slightly greater than, but is still reducible to its parts. This is precisely how the sociology of science attempts to reduce objectivity to power and money. However, information technology had already provided a counterexample to such reasoning in the middle of the 20th Century, but its importance has not been widely noted: this is the distinction of software from hardware. Software cannot function without hardware, but its functions cannot be explained by analysing hardware; it is simply a quite different level of complexity. Thus, the emergence principle stresses that with an increased level of complexity, the concepts of synergy and holism are still applicable, however, the whole is then not only greater than, but qualitatively different from and irreducible to its parts. In this sense we are saying that the emergence principle expresses the essence of complexity and means much more than synergy or holism.

It is also a fundamental intellectual challenge. The new concepts that emerge on higher levels of complexity are obviously constructed by people and are products of culture in a historical, long-term sense. But how do we use the emergence principle in a pragmatic, not in a historical sense? In other words, how do we recognise that an increased complexity substantiates the introduction of new concepts? We are so accustomed to reductionist thinking that we use it subconsciously – most of our logic is in fact reductionist. However, we should be aware that if our reductionist arguments grow too complex, it is time to look for new metaphors expressing new needed concepts. This is best expressed by the often quoted words of Albert Einstein: “good theories should be simple – but not too simple”. This also indicates that much what was written in the second half of the 20th Century needs to be critically evaluated or even revised precisely from the perspective of the emergence principle. We are so accustomed to reductionist thinking that, for example, even though psychology and psychoanalysis long ago found (see, e.g., Storr 1972) that the concept of creativity is too complex to be reduced to basic instincts (such as sexual, survival, etc.), the legacy of reductionism is so strong that psychology persists in attempting such reduction. Another example: the principle propagated by Ludwig Wittgenstein (1922) that the limits of my language constitute the limits of my world is clearly reductionist, reducing human perception to words. But this issue concerns the next fundamental principle.

The third fundamental principle is related to an evident trend in web communications and in the recording of our intellectual heritage: to include more multimedia messages and records. It might take a few more decades for this trend to fully mature. However, an understanding of its full significance is related to the rational theory of powerful but fallible intuition (Wierzbicki 1997, 2004; Wierzbicki and Nakamori 2006). This theory explains why visual and generally preverbal information is much more powerful than verbal: images require at least ten thousand times more processing capability, and while the human mind has such capability it has been suppressed to the subconscious by verbal reasoning and, for the lack of words to describe it, called intuition. The multimedia principle combines these arguments:

Multimedia principle: words are just an approximate code to describe a much more complex reality, visual and preverbal information in general is much more cognitively powerful and relates to intuitive knowledge and reasoning; the future records of the intellectual heritage of humanity will have a multimedia character, thus stimulating creativity.

This is perhaps an even more fundamental conceptual change than the emergence principle, since almost all philosophy of the 20th Century attached a great role to words, concentrating on communication to such an extent that it in its poststructuralist versions tried to reduce humanity to discourse. An exception was Martin Heidegger with his being in time (Heidegger 1927) or, in Japan, Kitaro Nishida with his Basho or action-intuition (Nishida 1990); however, even Karl Popper (Popper 1972), although he noted the difference between verbal and other sensory information, was convinced that words are more important. Poststructuralist philosophy even tried to reduce visual images to symbols such as icons and metaphors; but our vision is much more powerful cognitively than simplified symbols. All logic can be interpreted as rules for correctly using words. On the other hand, all tool-making was originally intuitive and preverbal, hence the roots of technology are preverbal.

This is also a great intellectual challenge: we must learn to speak about intuition (contrary to the classical advice of Ludwig Wittgenstein; note that all three fundamental principles have clearly a metaphysical character), that is, we must devise new concepts that will enable us to analyse the intuitive aspects of knowledge and knowledge creation. However, as indicated in the conclusions of (Wierzbicki and Nakamori 2006), the multimedia principle might imply that all the dichotomies of logical empiricism versus humanistic rationalism, reason versus being, or technical versus practical, that were so pronounced in the history of philosophy during the industrial age, can be explained in the knowledge age in a different way, in terms of the dichotomy of verbal versus preverbal. In particular, the dichotomy of reason versus being is not a sign that human reason is a kind of cancer on the biological development of the universe, nor is it a joke played by the Devil in opposition to the Creator. We can explain this dichotomy simply: our mind is most creative when engaged in preverbal reflection and imagination, thus it always tends to immerse itself in deep thought, in opposition to precise verbal formulations.

The multimedia principle is perhaps even more important than the emergence principle, also more important than other trends such as digital intelligence (which was originally understood only in the verbal sense), and implies that we should use as much multimedia content as possible in order to more strongly stimulate creativity. This will have impacts comparable or exceeding those resulting from the development of printing technology, thus becoming the essence of the new civilisation age.

4.2 Constructive evolutionary objectivism

Based on these three fundamental principles, we can give now a detailed description of an epistemological position that might be called constructive evolutionary objectivism, closer in fact to the current episteme of technology than to that of hard sciences:

People are not alone in the world; in addition to other people, there exists another part of reality, that of nature, although part of this reality has been converted by people to form human-made, mostly technological systems. There are parts of reality that are local and multiple, there are parts that are universal.1

People developed both language to communicate with others and tools to convert various aspects of nature according to their needs; in both these developments, people have been supported by curiosity, which is not necessarily helpful for an individual's evolution, but is essential for the evolution of a group, and has lead to the evolution of science. Humanity can be defined only when taking into account all these three basic human faculties.

According to the multimedia principle, language is a simplified code used to describe a much more complex reality, while human senses (starting with vision) enable people to perceive the more complex aspects of reality. This more comprehensive perception of reality is the basis of human intuition; for example, tool making was always based on intuition and a more comprehensive perception of reality than just language.

The innate curiosity of people about other people and nature results in their constructing hypotheses about reality, thus creating a structure and diverse models of the world. Until now, all such hypotheses turned out to be only approximations; but we learn evolutionarily about their validity by following the falsification principle. Since we perceive reality as more and more complex, and thus devise concepts on higher and higher levels of complexity according to the emergence principle, we shall probably always work with approximate hypotheses.

The origins of culture are both linguistic, such as stories, myths, and symbols, and technical, such as tools and devices used for improving human life. Both these aspects helped in the slow development of science – by testing, abstracting, and accumulating human experiences with nature and other people, and testing and refining the corresponding models and theories. This development is evolutionary and, as in any punctuated evolution, includes revolutionary periods.

The accumulation of human experiences and culture results in and is preserved as the intellectual heritage of humanity (or the third world according to Popper) with its emotive, intuitive, and rational2 parts, existing independently from the human mind in libraries and other depositories of knowledge.

Human thought is imaginative, has emotive, intuitive, and rational components, and develops out of perception, sensory experiences, social interaction, and interaction with the intellectual heritage of humanity, including interpretive hermeneutic processes.

Objectivity is a higher value that helps us interpret the intellectual heritage of humanity and select those components that more closely and

[1] To some of our colleagues who believe that there is no universe, only a *multi-verse,* we propose the following *hard wall test:* we position ourselves against a hard wall, close our eyes and try to convince ourselves that there is no hard wall before us. If we do not succeed in convincing ourselves, it means that there is no multi-verse, because nature apparently has some universal aspects. If we succeed in convincing ourselves, we can try to falsify this conviction by running ahead with closed eyes.

[2] Our *emotive heritage* consists of an explicit part, such as *artistic products* (music, paintings, literature, movies), as well as a tacit part: the *collective unconscious, archetypes, myths, and instincts of humanity.* Our *intuitive heritage* contains, e.g., the *a priori synthetic judgments* of Kant, not necessarily true but nonetheless very powerful in stimulating scientific creativity, determining our hermeneutical horizons. Our *rational heritage* contains all recorded experience and results of the rational thinking of humanity.

truthfully correspond to reality, or that are more useful either when constructing new tools or analysing social behaviour.

A prescriptive interpretation of objectivity is the falsification principle; when faced cognitively with increasing complexity, we apply the emergence principle. The sources of our cognitive power are related to the multimedia principle.

While the above general principles are equally applicable to the hard and natural sciences, social sciences and humanities, and technology, they might be differently interpreted by each of them: the hard and natural sciences search for theories that are universal, calling them laws of nature, and are thus influenced by paradigms, exemplars of such theories; the social sciences and humanities concentrate on the local and multiple aspects of reality, thus follow multiple paradigms; technology is the most pragmatic, motivated by the joy of creating technical artefacts, and following the principle of falsification more than paradigms in its everyday practice.

We should perhaps comment more on the sense in which we use the word objective: we know that absolute objectivity is not attainable, but it is an ideal worth striving for. This is best illustrated by the issue of objectivity versus power (or money), raised by postmodern sociology of science. Consider, in a though experiment, a chieftain of a human tribe in early stages of civilization evolution. (S)He would be pragmatic and value knowledge that helped in her/his short term goals, increased her/his power; why should (s)he bother about objective knowledge? (S)He would, if (s)he cared about long term chances of survival of her/his tribe. We can apply here the axiom of uncertainty as used by J. Rawls in his theory of justice (Rawls 1971): in order to determine what principles we should consider just, we must imagine that we do not know in what conditions our children might find themselves and select such principles that would be most useful for them nevertheless. The same axiom is also applicable to the issue what knowledge might be useful in the long term sense: if we do not know in which conditions our children or tribe might find themselves in the future, we value best well tested knowledge, as objective as possible. The same motivates current development of technology and science: we would like to leave to our children best tools for facing highly uncertain future. Thus, objectivity is similar to justice: absolute objectivity and absolute justice might be not attainable, but they are important ideals, values that cannot be reduced to power and money.

We are aware that the contemporary differences between the episteme of the three cultural spheres – social sciences and humanities, hard and natural sciences, and technology – are very great, thus the acceptance of the principles listed above might take a long time. For example, modern history valued objectivity, believing that we should report history following the principles of Herodotus or wie es eigentlich gewesen war.3 However, post-modern philosophy attacked that belief and promoted the slogan winners write the history. We believe that this slogan is ethically wrong: we cannot permit our intellectual heritage to be polluted; our descendants should know history written as objectively as possible. But it will take time until the harm done by post-modern interpretations is undone.

In discussions of the episteme presented above, we expect arguments that its formulations are conservative, that many aspects of this episteme are well known. To this criticism, we answer that we have included on purpose as many known elements as possible, because we believe in the continuity and value of the intellectual heritage of humanity. However, the synthesis of these elements is new and different from diverse accounts supposedly characterizing the epistemic position of technology. Moreover, this synthesis is based on three fundamental principles that all have novel elements: our interpretation of the falsification principle is novel to some extent, the emergence principle is not novel as such, but has novel aspects concerning its comprehensive justification and interpretation, the multimedia principle is novel in its formulation and is opposite to all traditional concentration on language characteristic for the philosophy of the 20th Century.

We are also aware that the principles we listed above might be modified during the discussion and adoption process. We listed them precisely for that purpose, to present them as an object for discussion and possible falsification.

5. Conclusions: theories of knowledge

[3] "As it actually happened" – as formulated by Leopold Ranke.

creation versus stimulating regional innovation.

Instead of summarizing the paper, we present here some conclusions concerning one of possible uses of micro-theories of knowledge creation and epistemic principles.

One of great challenges facing humanity is the use of information technology for stimulating regional innovation. This applies both to highly developed, rich countries such as United States and Japan, where many regions loose competitive advantage and young population, because life in other regions seems more exciting, and to middle developed countries, such as Poland and other countries in Central Europe, and also especially to developing, poor countries. It seems that Internet connectivity can make these remote or poor regions more attractive, but the issue is also related to stimulating regional economic growth. If these regions are not especially attractive for market investments, the only solution is stimulating regional innovation: developing special Internet services, creative environments that would help local small companies, local industry and crafts in creativity and innovativeness.

Can the micro-theories of knowledge creation and epistemic principles discussed above help in the development of such special services? We are convinced that they can, thus we started several applications leading towards the development of such special creative environments. Typically, they are not basic Internet services, such as search engines; they are much more overlays on these basic services, adapting these basic services to local and specific needs. To these belong: constructing ontologies for local scientific or business communities (see Tian et al. 2007); developing an adaptive hermeneutic agent (AHA), based on local and personalized ontology and helping in creative web searches using basic search engines (see Wierzbicki and Ren 2007); using the Pentagram System and triple Helix methodology for supporting creativity, e.g. in in local artistic crafts (see Kikuchi et al. 2007), (Nakamori and Wierzbicki 2007). Generally, not only the hermeneutic spiral of reading and interpreting written texts, but also the creative spirals involving brainstorming, debate, experimenting, involving both the multimedia principle and emergence principle, can be used as an intellectual blueprint for developing such local creative environments. However, a conclusion derived, e.g., from (Wierzbicki and Ren 2007) is that between such an intellectual blueprint and computer implementation of specific creative environments there is a gap that must be filled in by a careful specification of user requirements, definition what functions are most important for a specific, local community of users. Thus, even if there are important universal aspects of such environments (e.g., the importance of visualisation, consistent with the multimedia principle), the local or multi-versal aspects of them are also important and should be carefully studied.

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