Paper

Socio-Economic Challenges from and for Future Internet

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Abstract—There are several papers available addressing the challenges *for* Future Internet that result from socio-economic aspects; such challenges must be obviously taken into account when constructing and developing Future Internet. This paper, however, takes an opposite view that *from* the dynamics of the development of Internet itself (or Future Internet) result challenges for the socio-economic development and even for the paradigm of understanding economy; such challenges must be taken into account first, then – in a feedback loop – lead to the modification of socio-economic challenges *for* Future Internet. This change of perspective is necessary because the analysis of socio-economic challenges for Future Internet is typically based on a classical paradigm of equilibrium economics. While useful, this paradigm is limited and has been shown incomplete, e.g., by the recent world-wide financial and economic crisis. This paper shows that the informational revolution – including but not limited to the development of Internet – has already changed the behavior of main socio-economic agents as well as of economic markets and our understanding of them; thus, new perspectives are needed. The paper also shows that a useful perspective is that not of expected *benefits* from Future Internet – there are many such benefits and they will surely motivate enough economic development of Future Internet – but of socio-economic *threats* resulting from the dynamic development of the Internet. There are several such threats and conflicts that can be foreseen: the conflict between corporatization and governance; the conflict between direct and indirect limits to freedom; the trend towards elitarism inherent in Internet development dynamics versus democracy; the threat of network and computer domination over people, etc. Some of such threats and conflicts are discussed in the paper.

Keywords—Future Internet, informational revolution, socio-economic changes and challenges.

1. Introduction

The beginnings of informational revolution can be dated not from the development of computers, but from developments that enabled broad social use of computers and computer networks, thus from the development of an inexpensive personal computer (Apple II, 1977) and from the de-classification of Internet (1983), thus around from 1980. Computers were invented 40–50 years earlier: analog computers in 1931 (by a telecommunication engineer, later presidential advisor Vannevar Bush), digital computers in 1936 (by a telecommunication engineer Konrad Zuse, not by a mathematician Alan Turing, whose theoretical paper was published after the engineering patent of Zuse). This is similar to the dating of industrial revolution in around 1760 with the inventions of James Watt – who only made possible a broad social use of a steam engine (dangerous because unstable before Watt) invented by Newcoman at least 40 years earlier, by supplementing the engine with a feedback control system of rotational speed, thus making it safe for a broad use.

Here I should make clear my basic assumption about the development of new technologies. The popular theories of a co-evolution of social attitudes and technological solutions (see [1], [2]) are applicable only to a continuous near-equilibrium evolution, certainly not applicable to such events as the invention of James Watt, the emergence of Internet, or even the construction of a Future Internet. By this I do not mean that Future Internet should be a *clean-slate* solution; I mean only that a technological solution of this magnitude of social impact was until now – and should be in future – based on a vision that hopefully would meet social expectations at least 40 years from its conception. Internet was based on such a vision, even if its success has outgrown the scope of that vision. Every radically new technology (computers, transistors, mobile telephony, digital television, see [3]) is usually conceived at least 40 years before its broad social use and is based on a vision, not on a co-evolution of social attitudes and technological solutions.

Today it is clear that a broad social use of personal computing and of computer networks (Internet, WWW) has changed essentially the social fabric of developed societies, and has created many new opportunities and challenges (see, e.g., [4], [5]). The informational revolution is manifested in its three main megatrends [6]:

- the technological megatrend of digital integration (also called convergence);
- the social megatrend of dematerialization of work and changing professions;
- the intellectual megatrend of changing perception of the world.

We shall not discuss here these megatrends in detail, I quote them only to illustrate that we can take for granted tremendous socio-economic and even intellectual changes resulting from informational revolution, even if this revolution was enabled by technological developments.

Thus, when the authors of an extremely interesting book *Towards the Future Internet: A European Research Perspective* [7] include several papers addressing the challenges *for* Future Internet that result from today's socio-economic needs, I respond with the question what are the challenges

from Future Internet, the aspects that the Future Internet will add to the informational revolution and socio-economic developments in the future. To analyze this issue, I will follow the *dynamic programming* paradigm: imagine what would be the world in the year 2050 and then analyze challenges resulting from the dynamics and conflicts of the development. The choice of the date 2050 is substantiated because we see – already from the examples of delays quoted above, but the mobile telephony had a delay of about 50 years before its broad social use, the digital television even more, the transistors about 40 years – that new technologies achieve its full social impacts with substantial delay, amounting today to 40–60 years; this delay might shorten in the future, but not immediately. Therefore, in 2050 we shall count with a broad social use of technologies that we start to develop today. The issue is what social needs they will satisfy and what socio-economic conflicts or threats they will create; to analyze this issue, we need a vision of the year 2050.

2. A Personal Vision of the Year 2050

This is obviously a personal vision, expressing my personal views and experience in future studies. It is true that during the informational revolution everything flows, the world is a collection of chaotic systems from which new patterns of order emerge. Thus, many unpredictable changes can occur and every detailed, quantitative forecast should be treated with suspicion. However, the dynamic of social changes is slow, people do not change their accustomed modes of behavior, the *qwerty* keyboard will be used in 2050 even if it is not optimal.

Moreover, the stories about full unpredictability of the world, about the phenomenon of *black swan*[1], are means of brainwashing people. Internet was not a *black swan*, already in 1970 Arpanet (although classified) started its functioning, protocol IP and e-mail (together with using the sign @ in addressing) were devised in 1972, Internet was de-classified in 1983, and the fact, that after 40 years only about 1/6 of world population uses Internet is a small delay compared to mobile telephony or digital television. Thus, until 2050 we shall certainly have many novel inventions, theories or even scientific revolutions, but they will not have a broad social impact before 2050. Imagine, for example, that somebody invents today an *avio-car* (a flying car), sufficiently efficient and with low emissions. Before it will be developed to a sufficiently inexpensive and safe version (together with appropriate traffic regulations) for a broad social use, certainly more than 40 years will be needed. On the other hand, some inventions or developments known today might be developed for a broad social use before 2050.

[1] *Black swan* is a metaphor of an unpredictable phenomenon (see [8]). The main example of this phenomenon was supposedly the emergence of Internet. Already in early 80-ties, I tried to convince my Polish colleagues about the inevitability of the development of social importance of Internet, only very few believed me. Thus, we have not the phenomenon of *black swan*, rather the phenomenon of *Cassandra*.

Thus, if we guess correctly which rudimental developments or inventions known today will meet in future broad socio-economic needs, we can if not forecast, then at least construct a probable vision of the world in 2050. I use the words *constructing a vision of future*, because humanity always constructed future based on some visions; if we build a house, we construct future following some vision.

In such a vision, I see three main development forces that correspond to main socio-economic needs and will shape the future society. These are:

- *the need of living in a clean environment*, expressed by the idea of *sustainable development*;
- *the need of boundless communication*, expressed by the *informational revolution* with all its derivative consequences;
- *the need of prolonging life*, expressed by the idea of *bio-technological revolution*.

The last one – the bio-technological revolution – is also related to the concept of *radical evolution*, or human evolution reinforced by technology (see, e.g., [9]). However, I do not believe that major social needs will contribute to the start of radical evolution, or full bio-technological revolution (with similar or even larger controversies than those associated with the information revolution today), before 2100. Until 2050, on the other hand, the need of prolonging life will support a broad implementation of some elements of bio-technological revolution, particularly for elder people.

The second one – informational revolution – started around 1980, as we noted above, and already has tremendous impacts. It will continue; together with other main development forces, it will determine the socio-economic impact *from* the Future Internet.

The first one – sustainable development – expresses a major social need of living clean and preserving environment for future generations. It was perceived earlier than the other major needs (see, e.g., [10]), thus the concept of sustainable development is well known and broadly discussed. However, I believe that the problem how and in what proportions we should support development caring about its sustainability and clean environment at least in the interest of our children will remain a fundamental one at least until 2050 and will determine the solutions of related problems such as energy provision, transportation, life style, details of environmental protection. Both the informational revolution and the rudiments of bio-technological revolution will contribute to the solution of such problems.

Before turning to the issue of challenges *from* the Future Internet, we shall analyze shortly what might be the impact of these three major socio-economic forces before 2050. However, I must stress – before this analysis – a fundamental assumption: until 2050 we will not be faced by a major global catastrophe, economic larger than the current crisis,

military of world-wide character, or cosmic. This assumption is obviously optimistic, and it can be fulfilled only if we increase *global governance*; thus, I will also discuss shortly this issue.

2.1. Sustainable Development

Without a major catastrophe, the world economy will be forced – by public opinion and preferences of consumers – to take into account increasingly more demands of sustainable development, to limit harmful emissions, etc. This is fully possible when using technologies known rudimental today – it requires "only" money and time for their detailed development, which will not happen spontaneously, because free market promotes technologies that bring fast returns, is bad in long term rationality. Therefore, we will face slow but inevitable restriction of free market by the character of demand, but also norms and regulations imposed by "green" consumers.

Even today, there is an intensive research on diverse technologies either of car engines that are environmental friendly, or of limiting harmful emissions from power plants, foundries and chemical factories, or of alternative energy sources. In 40 years, many new inventions accelerating this change will be made, but decisive will be the confrontation of short-term interests of corporations and long-term interests of humanity, leading to slow and gradual, but inevitable sharpening of environmental norms and regulations. It might appear that the interests of consumers and entire humanity are less strongly represented, are doomed to loose in opposition to the strength of large corporations; but the history of last 40 years shows the opposite. If children in schools are taught to consider environmental protection as a higher value, then as young consumers they will not buy products of corporations that do not show sufficient environmental care, and a corporation might end as, e.g., in the case of Chrysler.

It might be optimistic, but I believe that diverse sources of environmental pollution will be until 2050 several times reduced – at least, in developed countries, but the developing countries will catch up with environmental protection, even if with more difficulty. I am not sure that this will be sufficient to preserve the natural environment on our planet in an acceptable state, but it gives a chance. Nevertheless, it will be a difficult process, with many controversies and consequences. This process requires using new technologies, increasing automation and robotization, supports and is supported by the transition towards knowledge economy, but on the other hand it means also the dematerialization of work, thus global escape of some industries towards developing countries, social disorders related to large unemployment during the period of strong structural change – and all next 40 years will be such a period. Thus the process of adapting to sustainable development and to new, "green" technologies will not be easy, it will require a permanent re-education of societies.

This is the basic challenge before the society of entire globe: *if sustainable development can be realized only by developing knowledge-based economy, then global education level must continuously increase*. We might expect that in 40 years a condition of employment in developed countries – with the exception of clearly subsidiary, supporting service work – will be higher education which will be practically universal in developed countries. This does not mean that the proportions of educational profiles will precisely meet the demands of labor markets – just the opposite, we must become accustomed to the idea that a taxi driver with education on the master of management level is not a singularity, only a perturbation of fate and not a social waste – because a highly developed society should be able to support an excess of learning.

The development in this direction will be not uniform around the globe. Countries such as Finland, that devote a large portion of national income to education and science, will win the competition towards sustainable development and knowledge-based economy. Countries such as Poland, where the government systematically cuts the funding of education and science, relying rather on the private efforts of citizens educating themselves mostly in private universities, will be doomed to marginalization and the role of civilization peripheries. They will be overtaken, e.g., by the countries of the Far East, such as China, Korea, Vietnam, who devote much more attention to science and education.

Sustainable development requires also a substantial change of professional proportions in society. This does not mean that in 2050 we shall observe globally the same proportions that we observe today in the USA or Japan. For example, the issue of a large part of society living in villages and from agriculture can be resolved in diverse ways, not only through the reduction of the number of farmers, increase of farm area and the escape of remaining people to slums around big cities. It might be resolved by a redistribution of work and living to rural areas, aided by network technologies and new Internet.

Nevertheless, it is expected that less people will work at the production of food and, at the same time, we can hope that regions of endemic hunger will be eliminated from the globe. Similarly, less people will be employed in industrial production. The rest will be employed in diverse services, such as education, health service and old people care.

Generally, the idea of sustainable development is based on respect for nature. We can have the optimistic hope that until 2050 the global environmental situation will be improved, despite a further increase of the world population (which, according to prognoses of United Nation Organization (UNO) based on the research of International Institute for Applied Systems Analysis (IIASA), in these decades will be slower and will attain a maximum precisely around 2050, with an irreversible increase of the proportion of old people). It will not be easy, an increased international cooperation towards this objective is necessary, helping the developing countries to avoid environmental pollution excesses known to developed countries. But the essential con-

dition is the stress on ecological responsibility in education, creating the domination of green-friendly consumers.

It is also important to understand well the relation between nature and technology: technology in itself does not kill nature[2]. All conflicts concerning environmental protection are in fact not conflicts about technology proper, only about its use – often occurring between short term interests of market entrepreneurs (obviously using technology with harm for nature, if this brings profits) and long term interests of protecting nature, e.g., by local communities.

On the other hand, we observe a slow progress in propagating and understanding environmental values: ecological responsibility is taught world-wide and some large corporations – e.g., in Japan – gradually stress environmental values. We can thus expect that the impact of green-friendly consumers and local communities will gradually extend to global scale and will help in improving global ecology.

However, this will not occur without strengthening global governance, which I discuss separately. Global governance might be also needed for other aspects of protecting global environment. In long history of our planet there were several cosmic catastrophes which changed global environment radically. Humanity might decide that we are rich and wise enough to prevent in future such catastrophes; initial research in this respect is already conducted, but and intensification of such activities would require, e.g., establishing an international base on the Moon with the purpose of observation of approaching cosmic bodies and suitable reactions (changing their trajectories).

2.2. Informational Revolution and Knowledge Society

All structural changes today, closely related to *informational revolution*, transform the economy towards *knowledge-based economy* (see, e.g., [13]), or even *knowledge civilization* (see [14], [15]). Without discussing these issues in detail[3] I must stress that the force of informational revolution will not diminish until 2050 though it might address different aspects. Two examples might be relevant.

Multimedia record and transmission. Social demand for multimedia record of information and occurrences as well as transmission of such records will grow because of diverse reasons, such as increasing interest in enriched films becoming a substitute of books, the necessity of preparing and transmitting multimedia teaching materials in spreading distance education, an increasing demand for multimedia telephony (such as Skype), etc. We must be aware that even if the methods of recording and transmitting distance education materials are highly developed, the tools for creating such materials are not sufficiently developed, standardized and ready for market penetration. Moreover, social customs in this respect might change slowly (e.g., because of attachment of part of society, myself included, to the traditional form of books). However, a change in this direction is inevitable, because of many reasons, such as the power of *Open Access* initiatives that provide networked free access to educational resources including increasingly multimedia forms. On the other hand, we cannot expect universal multimedia character of record and transmission of information until around 2050, because of large delays of social demands in such cases.

Ambient intelligence or wireless sensor networks. These diverse slogans characterize different approaches (in European Union and United States) to the same problem: how to use universally inexpensive computer tools, such as microprocessors equipped with sensors and radio, to provide for intelligent environment in human habitat. The slogan of *ambient intelligence* was put forward around the year 2000 by the Information Society Technology Advisory Group (ISTAG) of the European Commission as a driving engine of European economy. As a member of this group I raised then the objection that the delays and generally slow dynamics of changing social customs make such a slogan unrealistic before 2030 or even 2050. The social resistance in this respect might be large, because even if the needs of health care of older people might demand continuous and non-intrusive monitoring of the identity, presence, consciousness, breath, heart beat, etc., of people in a given room, not everybody would agree to enter such a room without warning about monitoring and recording his personal parameters. As a result, we can expect until 2050 substantial development of ambient intelligence, but not its universal applications. This is related to the wide-spread fear of Orwellian utopia, of using intelligent environment in human habitat for an excessive social control by too am-

[2]This is very badly understood by most humanists, social scientists and even natural scientists, since they usually do not have courses of technology in their curriculae – while technologists attend courses of all these sciences, e.g., of philosophy. As a result, representatives of these sciences perceive technology through the lens of humanistic philosophy of technology which is unable to understand technology at all because of the lack of a direct contact with technology. This often leads to the basic error, justly condemned in cultural anthropology: the error of cultural imperialism, judging a different culture without fully understanding it. For example, some humanist philosophers of technology condemn technology and technocracy without understanding that they actually speak about an aggregated notion including socio-economic use of technology in market economy, not about technology proper. Technology proper is the art of creating tools and artifacts characteristic for a given civilization era (see [11], [12]), and can be used both for good and bad purposes. This great misunderstanding of technology is characteristic for entire 20th Century, starting, e.g., with Albert Einstein who wrote already in 1917 that "The advance of technology is a hatchet in hands of a degenerated criminal" (see, e.g., [9]). Martin Heidegger described the same issue much more deeply saying that the danger is not in the advance of technology itself, but a dangerous fascination with the possibilities of technology by people, particularly by people in power: "man exalts himself [with the possibilities of technology] and appears to be the lord of the world" [11]. The fact that humans would cease to be human if they stopped technology creation escapes the attention of humanists because they have inadequate education in technology.

[3]Knowledge was obviously used as an economic resource in all civilization eras, but now it becomes – first time in the history – a decisive productive resource, dominating labor and capital, as a result of informational revolution. The era of knowledge civilization will be probably not the last in human history, but it will continue at least for the entire 21th Century.

bitious politicians, or even fear of the domination of networks, computers and robots over humanity, which subject I comment in more detail later.

Beside these two examples, there are many other areas of the impact of informational revolution on economy and society. The great *megatrend of digital integration* (or *convergence*) was not yet exploited fully. Between other areas of digital integration, several decades yet will be required, e.g., until diverse media such as newspapers, radio, television, Internet will become more deeply integrated. Around 2050 we might, however, expect a more deep integration of diverse information media, their networked access in a selective or fully integrated form. Since economic and political power of controlling media is tremendous, only this reason – between several others – is sufficient for the development of several new generations of Internet until 2050; today we work intensively on the techniques of *Future Internet*, a main subject of this paper, but we should be aware that there might be several Future Internet versions.

There will be also an inevitable impact of informational revolution on the paradigms of economic science. There are many aspects of this impact, but most important appear to me the *oligopolization of economy* and the *conflict about property of knowledge*. Oligopolization of economy results from the fact that the increasing role of knowledge and intellectual property in production costs inevitably leads to an increase of positive effects of scale and decrease of relative marginal costs; the cost of duplicating a DVD plate is much smaller than the cost of a film production. Therefore, the relation of market price to marginal cost, a paradigmatic foundation of free market theory, is lost in informational revolution era. A possible explanation is the domination of oligopolistic economy (or monopolistic, but this form is tightly regulated). This issue might be studied using classical mathematical game theory to compute how many times an oligopolistic market price without collusions can exceed ideal free market price, given market share and elasticity of demand (and how much actual prices indicate tacit collusions on the oligopolistic market), but for some reasons such investigation is treated as a tabu in neoclassical market economics and oligopoly theory is not taught in detail in economic departments.

The conflict about property of knowledge occurs between a classical equilibrium relation of individual knowledge and the intellectual heritage of humanity on one side, and the new, perturbing the classical equilibrium trend of *corporate privatization of knowledge* – including both the individual knowledge of employees of the corporation and as much of intellectual heritage of humanity as can be privatized by a corporation. This conflict is very serious even today, large corporations do everything to maximally privatize common knowledge of humanity and engage in this respect the neoliberal interpretations of intellectual property rights (see, e.g., [16]). This conflict will probably intensify and might become the basic conflict of knowledge civilization. This conflict is also dangerous, because – in opposition to all classical paradigms of economics – common knowledge is not a degradable good (it usually grows, is not diminished by a common use). Hence the classical argument of *the tragedy of commons* (used to substantiate privatization of common resources)[4] is not applicable to knowledge: *it is better for a society, if as much knowledge as possible remains public property*. This means, however, that knowledge based economy requires a fundamental change of the paradigms of economics.

Even larger, than on economy, is the impact of informational revolution on society, even if a part of this impact is related to economy. The *great megatrend of dematerialization of work* during informational revolution, substituting people by automata and robots in hard productive work, leads to an increase of the share of services in economy and has many positive consequences. Among most important among such consequences might be the creation of material conditions for equality of women (it is the computer and the robot that enable such equality); actual equality of woman might be distant yet because cultural relations and customs change slowly, but around 2050 we might expect that women will achieve globally significant progress in actual realization of their equal rights. However, this megatrend has also obvious negative consequences that must be continuously counteracted: the dematerialization of work leads to a change of professions, disappearance of old ones and emergence of new ones that will continue until and beyond 2050, and results in so called (misnamed)[5] *structural unemployment*. Such unemployment is not a temporary phenomenon, it can be counteracted only by intensive reeducation of labor force, in which distance and electronic education might be decisively used.

Possibly the most important aspect of the social impact of informational revolution is *the annihilation of spatial constraints in the access to information and knowledge and communication between people*, i.e., the gradual spread of multimedia access and network communication. This aspect is possibly more important than the Gutenberg revolution that made the access to information and knowledge universal through books – since books do not fully annihilate the spatial constraint: one has to buy a book and bring it to a small village, or to travel to a great library in a city, while in Internet it is sufficient to have a broadband access from anyplace. Depending on the conclusions of the conflict about the property of knowledge and the success of initiatives such as *Open Access*, after the spatial annihilation might follow at least a partial annihilation of the economic constraints (costs). Multimedia character of the access to information and knowledge, and also multimedia character of communication, might have a positive impact on creativity in using these sources and on the spread of distance and electronic education (see, e.g., [15], [17]). In total, this is a great social revolution which will change not

[4] A common pasture in a local community is degraded by its too intensive use, hence it is better to privatize it.

[5] Structural unemployment implies that the structure of economy has changed and labor force must adapt to this change; but what if the structure is continuously changing due to informational revolution and the speed of change is limited precisely by the speed of adaptation of labor force?

only the conditions of social life and customs, but also will influence the trends of spatial agglomeration and regional policy.

Until 2050 it might come to a reversal of the trend of urbanization of the world, to the beginnings of an actual realization of the idea of *global village*. This idea was originated much too early and until now found only derision between regional economists: all around the world, the trend of urbanization continues. However, people are already tired of everyday long travel between the place of living and the place of work; the larger a metropolitan agglomeration, the more probable are many hours of travel to work. The idea of distance work was also premature, such changes require long time of social adaptation, but until 2050 it might become a social reality. This means that regional policy should seriously consider the possibilities of regional socio-economic development based on the spread of Internet connections, used for the activation of villages and an attraction of out-migration from large cities.

Perhaps the most important social consequences of informational revolution concern already mentioned, fundamental change of educational systems. It is necessary to make universal not only high education, but also continuing education, to large extent realized via distance or electronic education. This must be based on a networked, multimedia access to sources of information and knowledge, must use this type of access to stimulate creativity, prepare new generations for life in a new society. This also means a necessity of changing educational paradigms and of a deep reform of all levels of education, starting with elementary schools. This will be not an easy change, the most paradigmatic or even dogmatic is the educational science that successfully resists all changes. This will not be an inexpensive change, it will probably begin with most developed or most forward-oriented countries (such as, e.g., Finland). Countries that will try to resist or economize on this change will find themselves marginalized.

Another basic aspect of informational revolution is that it enables an improvement of the relation between people and nature. For example, diverse distributed sensors connected in wireless networks can much better monitor the quality of natural environment. Moreover, in knowledge based economy it is easy to promote environment-friendly innovations. This positive feedback between informational revolution and knowledge-based economy on one side and the protection of natural environment on the other side is the reason of my optimism concerning the idea of sustainable development discussed above.

This does not mean that the informational revolution does not bring environmental threats. The main such threat is an excessive exploitation, in a sense over-saturation with signals, of the natural electromagnetic environment of Earth. This does not result as yet in serious dangers for human health, the so called electromagnetic compatibility of electronic equipment is a subject of severe tests and norms, and the electromagnetic spectrum management (allocation of frequencies for commercial and other uses) is an important subject of governmental control. However, diverse other possibilities of utilizing electromagnetic spectrum, such as radio-astronomy, are seriously constrained by the commercial saturation of this spectrum; this is one of the reasons for the necessity of constructing a permanent base on the Moon. Until 2050, the issues of management of electromagnetic spectrum might become an area of socio-economic conflicts, similar to today's environmental conflicts.

However, the main effect of informational revolution in the relation of people and nature is the annihilation of spatial constraints in the access to knowledge and communication discussed above – which might result in a choice of living place in a close contact with nature, not only in a village but also possibly in a forest. Thus, the idea of a *global village* might become actually the *global forest*. This does not mean that until 2050 cities will vanish – just the opposite, they will grow at least until that date. However, until 2050 we might observe the beginnings of the opposite trend, the trend of *global forest*.

2.3. Biotechnological Revolution

Elementary biotechnologies, such as genetically modified crops, have already strong impact on the global economy; it might be also argued that biotechnology is as old as agriculture.[6] However, we are far away from an actual biotechnological revolution, including radical technological changes in human evolution. The speculations about *radical evolution* – the vision of a cyborg as a result of a new, mostly artificial product of biotechnological revolution – are already frequent, but far from realism and such revolution will not occur for sure before 2050, probably also not before 2100. This is because even today we observe a significant social resistance against excessive or unjustified automation of actions customarily reserved for people, against domination of human subjectivity by computers, networks and robots, or generally domination of computer over people. These attitudes will not favor radical biotechnological evolution that inevitably will include implantation of microprocessors into human body; we can expect serious social resistance that will significantly delay radical evolution.

The beginnings of biotechnological revolution and radical human evolution we might observe in areas, where the social demand will be nevertheless substantive: such an area is *health care for elder people*. The implantation of a microprocessor only to stimulate heartbeat or the use of artificially developed bone cells in order to rejuvenate old bones encounters much less social resistance, if it is evidently needed and helps. Such technologies will encounter strong economic demand, which is necessary for their gradual improvement, decrease of costs, universal accessibility. Together with elements of ambient intelligence for the non-intrusive monitoring of the health of old people mentioned

[6]What is the production of beer or whisky, if not a biotechnology?

above, or even with mobile robots taking care of elder people, socially acceptable elements of biotechnological revolution will become a natural enhancement and continuation of informational revolution. However, their broader spread will be restricted to the cases of obvious need and helpfulness. The health care of older people, according to demographic prognoses, will become a serious problem around 2050 and thus might be an engine of economic growth, particularly in developed countries. First after a longer time of broad social use of such elements, social resistance might be lowered and some form of radical evolution might take place – but probably not before 2100.

This is mine reservation to the typical fantasy about radical evolution: they do not consider social forces and conflicts that will accompany biotechnological revolution. We can expect, however, a slow but dramatic change of social structure and inter-generational relations in the 21st Century as a result of informational revolution. Already in industrial civilization, but especially during informational revolution, together with the change of social role of women, a significant change of the social model of a family is taking place. The traditional model is a large number of children as an insurance for the old age of parents. Professional careers of women resulted in delaying the birth of children to an older age and generally in a smaller number of children per family. The insurance for the old age was expected in the form of a social insurance system; this system, however, in its classical form does not endure the growing share of old people in a society. Old people with a small number of children do not expect from them significant material help, they at most limit their respective help. Nevertheless, the return to the classical model of family is not possible: educated and professionally active women will not return to their classical roles. However, the collapse of traditional social insurance systems implies a new conflict: who should finance the living of old people? Therefore, financing the beginnings of biotechnological revolution is also questionable – who will finance it, if not old people?

One possible answer is so called *netocracy* (see [5]): only the new rich that will have both the financial and political power in the networked society will enjoy the possibilities of biotechnologies. However, I do not believe in the inevitability of destruction of democracy by informational revolution. Each revolution of such magnitude creates of course new social divides and new rich; but the industrial revolution did not destroy, only helped to create modern democracy, and the informational revolution has many aspects that support further development of democracy. The conflict about the property of knowledge will draw attention to the necessity of preserving democracy, as noted already by Thomas Jefferson (1813) [18]: a free access to ideas is both a necessary condition of democracy and helps to strengthen it. I do not believe, neither, that the new rich will so easily take the risks of testing new biotechnologies.

There are no definite answers to such questions. However, with respect to the new model of family, it is clear that a less inter-generational integrated model will gradually emerge, with lesser obligations between generations. This does not mean a clear cut of such obligations, but elder people will try to use diverse methods of increasing financial security, including a prolongation of professional activity, taking advantage of their life-long experience. Clearly, this also will provoke socio-economic conflicts: entrepreneurs might prefer employing only young people, older people might raise an issue of non-discrimination (not only because of race or sex, but also because of age) and fundamental rights of people.

Such problems might have also an impact on the reversal of the trend of urbanization of the world or the beginnings of *global forest*. Already today, the cost of living in villages and small towns is significantly smaller than in large agglomerations; an *escape to the forest* might be strongly motivated economically. In conclusion, the biotechnological revolution will be possible when humanity will overcome ecological threats and if this revolution will help in achieving a relative (obviously not absolute) ecological equilibrium.

2.4. Global Governance

The most important challenge, however, facing humanity before 2050, is in my opinion the issue of *creating new world order or global governance*. In fact, this is a direct consequence of information revolution and resulting globalization: people of the world perceive increasingly more their responsibility for global issues. Information technology and biotechnology will drive the changes of the world, responding to the broad social needs and demand. However, if we leave the satisfaction of this demand to big corporations (not to the free market which, as noted above, does not exists any more in its classical, ideal form on high technology markets) then we should expect next big crisis, a successive big bubble of artificially created demand motivated by the profits of oligopolistic market, not by solving the problems tormenting the world. Big corporations will of course do everything to hinder the emergence of a global governance – by promoting, e.g., the self-serving theses that the less government the better, that best brains require biggest rewards (and biggest compensations in case of failure), etc. But I hope that the lessons from the last crisis will show the emptiness of such neoliberal slogans and arguments.

The vision of the world governed by big corporations is not acceptable, leads to instability. As long as one big country – the USA – dominated the world order, dealing with the excesses of big corporations could be left to it, even if European Union and other big players often represented other interests. However, once a larger role in the world economy will be played by the most populous countries – China, India, Brasilia – a new world order and new institutions for global governance, a forum for

achieving consensus between the biggest players will be needed.

There are many possible ways of creating new global governance, but two are the most probable. One is a renewal and strengthening of the role of United Nations Organization. If this organization will not address (because either of internal weakness or of lack of commitment of biggest players) new goals, entitlements and obligations, then another organization, perhaps between existing today, will have to fill out this void and help to create a new order. The tasks of such organization should be partly political, concerning global security (limiting armaments, eliminating military conflicts, alleviating diverse local and regional conflicts, etc.), partly economic regulatory (control of oligopolistic collusions and monopolistic aspirations of large corporations, regulation of international banking, etc.), partly globally developmental (supervision of global projects such as on the Antarctic or the Moon, other planets, etc.).

The creation of new global governance is a big challenge, larger than, e.g., emergence of European Union. But humanity must rise up to this challenge if we want to look to the future with trust.

3. The Challenges from and for Future Internet

From the above vision it is clear that the Future Internet will have fundamental impacts on the socio-economic development. The challenges *from* the Future Internet indicated above include:

- the conflict between global corporatization and global governance;
- the conflict about property of knowledge, thus concerning direct and indirect limits to freedom;
- the trend towards elitarism (or *netocracy*) inherent in current internet development dynamics versus democracy, with related issue of reform of education systems;
- the issue of ambient intelligence versus human rights;
- the issue of radical human evolution versus human sovereignty, with related threat of network and computer domination over people.

The main thesis of this paper is that the solution of and the challenges *for* the Future Internet should anticipate and take account of the predicted challenges *from* its future social application; the Future Internet should be based on a vision how to respond to such challenges. The existing Internet was also based on such a forward-looking vision: it was designed to warrant interconnectivity even under severe perturbations and to protect rights of every user of the network (even if these principles resulted from military considerations of warranting interconnections under nuclear attack and enabling the shift of command to anyplace). This was naturally achieved at the cost of disregarding its future commercial applications and has led to known dilemmas today (e.g., the tussle between peer-to-peer (P2P) and interactive network use, e.g., [19]). However, such design omissions can be solved technologically rather easily, good solution proposals already exist (e.g., the *trilogy architecture* [20]).

Quite different issue is a vision taking into account the challenges listed above. It is not sufficient to take into account some hypothetical scenarios, even if reasonable (see, e.g., [21]) without a consistent vision of the future world and a commitment what type of solutions should be preferred for this world.

Should Future Internet support oligopolization of the future integrated media, leading to direct or indirect censorship of ideas expressing the interests of big corporations, or should it rather promote free exchange of ideas and thus support global governance based on a direct opinion exchange? An answer saying that Future Internet solutions must be politically neutral is misleading: no technology is absolutely politically neutral, it can be used more or less easily in this or that political interest.

Therefore, we cannot dismiss questions such as:

- Should Future Internet help to exact strict intellectual rights and thus help in further privatization of knowledge, or should it rather promote open access to as much public knowledge as possible?
- Should Future Internet take digital divide and the trend towards netocracy as granted, or should it rather promote new forms of democracy and help to spread democracy by supporting educational reforms?
- Should Future Internet (or so unfortunately called real world Internet, see, e.g., [21]) be based on the assumption that ambient intelligence will be accepted by people, because market demand for it will be created by the advertisements expressing the interests of big corporations, or should it rather be based on the question which ambient intelligence applications are most likely to be socially accepted because they respond to true social needs without violating basic human rights?
- Should Future Internet be based on the assumption that a total immersion of a human being into a virtual world is desirable because anyway radical human evolution will occur, including such total immersions, or should it rather respect and support human sovereignty and dignity?

These are only questions, not answers, but I believe that it is not sufficient to limit socio-economic considerations of Future Internet to neoliberal convictions that market mechanisms would solve all problems. Therefore, such questions should be asked before constructing Future Internet.

4. Conclusions

It is difficult to summarize by classical conclusions a paper devoted mostly to a vision. Instead, I will try here to repeat here some of most important theses of this paper.

- The theories of a co-evolution of social attitudes and technological solutions are applicable only to a near-equilibrium evolution, certainly not applicable to such events as the beginnings of industrial revolution or beginnings of informational revolution, the emergence of Internet, or even the construction of a Future Internet. A technological solution of this magnitude of social impact was until now – and should be in future – based on a vision that hopefully would meet social expectations at least 40 years from its conception. Internet was based on such a vision, even if its success has outgrown the scope of that vision. Every radically new technology (computers, transistors, mobile telephony, digital television) is usually conceived at least 40 years before its broad social use and is based on a vision, not on a co-evolution of social attitudes and technological solutions.
- To construct Future Internet worth its name it is necessary to have a vision of the world in 2050. The paper presents such a vision – which is optimistic in the belief that humanity will be able to cope with most challenges and problems, conservative in the belief that social customs and attitudes do not change easily and require special reasons for change, finally radical in the belief that informational revolution already has had fundamental socio-economic impacts, between others invalidating most of neoclassical economics when applied to high technology markets.
- The solution of and the challenges *for* the Future Internet should anticipate and take account of the predicted challenges *from* its future social application; the Future Internet should be based on a vision how to respond to such challenges. This vision might be based on the vision of the world in 2050 discussed in most parts of this paper.
- The challenges *from* the Future Internet indicated above include:
  - the conflict between global corporatization and global governance;
  - the conflict about property of knowledge, thus concerning direct and indirect limits to freedom;
  - the trend towards elitarism (or *netocracy*) inherent in current Internet development dynamics versus democracy, with related issue of reform of education systems;
  - the issue of ambient intelligence versus human rights;
  - the issue of radical human evolution versus human sovereignty, with related threat of network and computer domination over people.

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