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THE NEW TECHNOLOGICAL AND INFORMATION REVOLUTION AND THE FUTURE OF HIGHER EDUCATION

The intensity and the consequences of transformations of the educational system and particularly of higher education's depend on a number of factors. These include global, regional and national political, demographic, socio-economic, technological and cultural changes. They depend also on the development level and the structure of the given economies. In the present era of global transition to knowledge based societies and economies higher education is playing a centrally important role much beyond the educational system on graduate, post graduate level and lifelong learning-also in Hungary. The strategies for its development should include the triangle of its task: educate, research and innovate.

Throughout history, higher education has evolved in a contrasting way. It was in most cases innovative promoting the development and spread of science and it was however often too conservative. Different factors, including the policies of governing institutions, governments or built in ideologies slowed in many cases blocked the required the necessary changes.

The strength of factors stimulating of its innovative role increased substantially since the second half of the 20th Century. The fast growth of science and the rapid technological progress resulted in the development of research universities in the US and in Europe. The evolving new technological era, resulted in new sectors in the production and services of the countries, the functioning of which required much more highly qualified people. This resulted in the expansion of the mass universities and the fast increase in the number of higher education institutions with growing number of students. Some of the changes have been the results of individual needs. The university diploma became an important instrument for promoting social mobility for the lower strata of the population. An important factor in expanding higher education have been political changes, those government policies which promoted the expansion of higher education institutions and supported the increase of participation of students in many countries. One may add to this an important factor: the consequences of the decolonization process.

The ongoing global changes include ecological, geopolitical and geo-economic factors, territorial shifts in global habitat, output and consumption. The most important source of global transformation, which has the greatest influence on all the major changes including the future of higher education of is the ongoing transition to a knowledge based socio-economic system. The important underpinnings of this process has been the fast growth of information and knowledge, the creation and fast increase of capacities for its analysis, storing, combining, spreading and introducing into the system of production and services,² Buckminster Fuller an American scholar introduced

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² The speed and outcome of progress toward a knowledge-based economy in all countries depends mainly

an indicator, a “Knowledge Doubling Curve.” He noticed that until 1900 human knowledge doubled approximately every century. By the end of World War II knowledge was doubling every 25 years. Today things are not as simple as different types of knowledge have different rates of growth. For example, nanotechnology knowledge is doubling every two years and clinical knowledge every 18 months. But on average human knowledge is doubling every 13 months. According to IBM, the build out of the “internet of things” will lead to the doubling of knowledge every 12 hours

In the global techno-economic system a new technological era is unfolding. It is, based on seven fundamentally important science and technology blocs, which emerged since the late 1960-s, namely: microelectronics which are the foundation of the information technology, new materials technology, new biotechnology, particularly the revolution in genetics, propulsion and space technology, power technologies and the nanotechnology. All these are multipurpose and interrelated technologies. Their development and global diffusion are at different stages and in different clusters in different countries and sectors. As the result of the technological changes major structural changes are going on in industry, services, world trade. Historically new technologies, especially information, communication and transport have facilitated the division of labour through different stages of production and marketing, with value added in several countries. By the 21st century they resulted in the emergence of globally interconnected and in many areas integrated production and service systems. They comprise the foundation of the international production-innovation system. Those technologies are primary important in those changes in the economy which are shaping skill and employment patterns, investment needs, the functioning of the global markets and international competition. As they are becoming dominating technologies they influence the style and quality of life, transform the system of organization, infrastructure, information and entrepreneurship and the choices available for the society. There are rapidly introduced into all military instruments. This is a particularly dangerous change which is transforming national security policies and influence military doctrines. All these changes contribute to the unfolding new stage of globalization. The transnational firms are particularly important drivers of all these processes.

A very important characteristics of the new technological and information revolution that all its underpinning new technologies are science-based. Science is playing a multiple role: it is a source of new ideas, discoveries, new products and processes. It is also facilitating the most effective use of the existing technologies, stimulating and promoting innovations and it is preparing

on the following factors:

-The economic and institutional regime and policies that provides incentives for the progress toward knowledge-based economy, since only strong economic incentives and institutions can deploy these resources to productive uses and take advantage of a strong educational and R and D base.

-An educated and skilled population that can create and use knowledge.

-A dynamic information infrastructure that can facilitate the effective communication, dissemination, and processing of information.

-An effective innovation system comprising a network of firms, research centers, universities, consultants, and other organizations that can tap into the growing stock of global knowledge, assimilate and adapt it to local needs, and create new knowledge.

-The quality of international cooperation and the multilateral cooperation regimes which can promote global knowledge sharing on a more equitable way.

the society to the risks and potential advantages of the future. The role of science has become more wide spread, more pervasive and multidimensional than ever before in human history. It has also major influence on the social changes. The system of education has been always important for the proper understanding the content of the new knowledge in its dissemination and use. This had never been an easy task.

Here I mention only some of the interesting and important historical interactions between the past industrial revolutions and the system of education. The first industrial revolution and the global spread of its components depended on the spread and the quality improvement of primary education. It also stimulated progress in secondary education. The second industrial revolution had been closely interrelated with the spread of secondary education, promoted its diversification and it had been a factor in the growing importance of universities. The third industrial revolution paved the road to the fast global spread of the universities and doctoral research programs. Contributed to the fast increase in the number of university graduates in almost all the 193 countries of the world and increased the role of post graduate education.

The analysis of relations between the system of learning and education and the needs for implementing and developing further the social and economic potentials of the technological changes in any given era revealed, that those countries were more successful, which correctly focused on the specific needs is their educational policy and developed the system on this basis.

At this stage interrelations between the fourth industrial revolution and the system of education much more complex and comprehensive. Major changes became necessary in the knowledge content at all level of the system.

In an increasingly knowledge based society an educated highly qualified person must be first of all a good professional, with a core competence, corresponding to the needs of the given profession. Beyond the core competence however, the graduate will have to be equipped with social, science, communication and ecological literacy.

Social literacy means the understanding the causes and consequences of the main external and internal processes of the society. This should not be considered however only as an intellectual exercise, but should help them to get read of their prejudices, illusions, aggressiveness and individualism and other sources of alienation. The awareness of past experiences, a broad comprehension of the new problems, new forms of motivations, based on social ethics, commitments for social actions, understanding the multicultural character of the world, the better knowledge about the decision structure of the planet should also be considered as components of social literacy.

Science literacy means a profound knowledge about both the basic facts and the process of science and technology in order to understand the functioning of the knowledge based system. The basic facts means the knowledge about the body of knowledge, the process is the “process of discovery” the validation and the use of what we know.

Communication literacy is an indispensable component in the knowledge structure of a highly qualified professional in the age of information and knowledge revolution. This is more than computer literacy. It means the capability of managing and using the rapidly growing mass of information in the age of the “big data”. It also includes the knowledge of at least two languages beyond their own, including a widely used international language.

Ecological literacy means the understanding the essence of the complex interrelations between human beings and the nature, particularly the conditions of preserving the life sustaining capacity of earth in any given era and socio-economic environment.

The all these would not imply the return to the educational model of the Renaissance man or the predominance of a modified liberal arts orientation. The 21 century demands well trained, intellectually better balanced open minded professionals, who are flexible enough to be able to change and committed enough to be agents of the changes. While the development of the educational system requires major change at all levels, the tertiary or post tertiary sectors are playing a centrally important role due to the ongoing and interrelated transformations

According to the anticipated changes by the UN by the middle of this century the world will be more crowded. People will have to share the shrinking resources of earth with about 10 billion „fellow citizens”. About 90 per cent of these people will live in the presently developing countries mainly in urban areas, The global employment landscape is becoming ever more complex and its structural changes are evolving ever more rapidly due to the changing geography of production and services and local skill requirements. Approximately 25,000 new workers will enter the labour market in the developing world every day until the mid-twenties, and more than 200 million people globally continue to be out of a job; yet, simultaneously, there is an expected shortage of some 50 million high-skilled job applicants over the coming decade. There will still be about 100 million children without access to primary school, 150 million children unable to attend secondary school and many millions of young people who cannot afford to go to university, while the world is experiencing a shortage of 4 million qualified teachers per year The average age of the population will be higher, since the number of those over 65 will grow almost twice as fast as the global population, in the less developed part of the world there will be still many young people looking for education and jobs. It will be at the same time a better educated world, with a much larger number of people with secondary and higher education. International migration pressures and counter-measures will be even much important political, social and economic issues than today. Demand for social services will be rather high due to aging, urbanization and the greater participation of women in the labour force. This will certainly influence the resources, the societies will devote to education. The inter-generational distribution of social expenditures will be an important issue, a source of social conflicts in all countries.

Universities including post graduate education have already become the most important and relevant institutions in the system in the progress of the so called knowledge triangle, the acts of, providing high quality education, promoting research and innovation

From among the different institution in education the development of science and technology and its diversification will have probably the greatest influence on the future development of higher education

The University based technology and research centres, university-industry-government research and development alliances will gain even greater importance in shaping the supply and satisfying the demand trends in the world of work. Their number is going to increase, but probably at a somewhat slower rate in the past. The global gaps between and within countries will not disappear. By 2018 about 60% of the universities are servicing 10 countries in the world and concentrating about 50% of the student population. These are not necessarily the richest countries, but also those, which consider the development of their higher education as a fundamentally important condition for their development. Even the smallest of the 193 members of the UN has at least on national university.

As the consequences of the changes particularly since the mid- 20th century the university system became and will become more multiple. Over-crowded “diploma factories” which grew out from the needs of the post Second World War needs will remain the largest institutions particularly

in developing countries financed from public sources. A great number of cheap regional institutions on tertiary level will be spreading to satisfy the local demand for post-secondary general and specialized technical training. The gap between these institutions and wealthy high prestige private or state universities will grow. The number of universities founded and funded by corporations which developed for training their new staff or retraining them will remain important, due to the fast structural changes in the economy and consequently the given corporation. The major churches are not only sustaining their higher education system, but increasing their number and expanding their base, and secularizing also their curricula due to the changing demand and of their efforts to increase their global influence (In 2018 there have been about 600 Catholic, 350 Muslim, 105 Baptist 55 Lutheran and 50 Jewish universities working in the global university world).

The top 100-150 “places” in the global ranking of the university system are “occupied” and protected by the large and prestigious universities in the developed countries. Their competitive position remains strong not only because of their wealth and brand name, but because the quality and structure of their staff. They can combine research and education, graduate courses, post graduate programs and life- long learning institutions. They not only disseminate but develop new and high level knowledge. They could also attract the best talents both within their country and from abroad. These universities could adjust also much faster to the new demands of the society and particularly of the most important stakeholders, the students, the firms, the governments and their state or private owners. The accessibility and convenience, the costs, are of course limiting their services to the wealthier parts of the society.

Beyond the top 150 institutions there are of course excellent state and private universities also in a number of other states, including smaller countries, attracting excellent national and international staff and students.. In their cases the historical traditions, their financial strengths specialization in the core curricula, the degree of internationalization and government, or private financial support are indispensable sustaining and even increasing their relative competitive position.

The global differences between universities in the access to new knowledge and information will be probably somewhat moderated by the development of global information networks, but they will be still quite large. In the poorer countries many local universities will still remain basically poor and isolated from the mainstream of global science by the lack of financial and human resources. Many of them is trying some form of integration with transnational university enterprises and international distant learning networks. The efforts of international organizations, particularly UNESCO, and the United Nations University are also trying to help the integration of the universities of the poorer countries into the global knowledge networks and helping their internationalization in many other ways: external funding, providing international staff and modernizing their curricula.

There are and will be important innovations in the system of higher education, reacting to the changing conditions, in demand, and as the consequences of competitions. A trend which started already in the past century, but will certainly accelerate, has been the expansion of the virtual universities. This was facilitated on one hand by the development of information and communication technologies and on the other hand the growing needs of adult education, which is often called as distance education. Since its beginnings the system substantially expanded too many countries. It has resulted in growth in numbers and types of providers, curriculum developers, modes of delivery and pedagogical innovations. As the studying population will grow larger; and becoming older, on average, and has additional obligations – mainly work and family the demand will increase for

a flexible learning framework, one that does not tie the learner down to a specific time or place. Differences between individuals also require an adaptable pace and mode of study, suited to personal abilities and distinct learning styles. A new type of adult learning market is developing. This may provide opportunities, both for existing institutions and for new entrants.

According to an OECD data more than 40% of adults participate in formal and/or non-formal education in a given year across OECD countries. The average age of online learners is now 34, up from 27 in 2002. Distance learning is becoming a critical element of the future educational systems, equipping workers of all ages with the ever increasing range and levels of skills required to maintain competency in an increasingly sophisticated labour marketplace. Such institutions as ICTS, COURSERA, UDACITY, KHAN ACADEMY are interesting examples for distance learning which connects the higher education with the process of lifelong learning. They may offer a partial answer to the key questions „where to learn” „when to learn” and „what to learn” throughout life.

In the coming decades the differences in the content and character of work will increase within the countries and between them. The less developed part of the world will have still a large group of subsistence work and rather slowly growing high quality jobs. In the advanced countries more than half of the jobs will be high- tech, high quality and highly computerized with many new occupations in manufacturing and services. In many cases work will also be more individualized and adjusted to the talents and capabilities of the individuals. There will be at the same time low paying, low-skill jobs for a still large segment of the work force, particularly in the service sector. The efforts for better gender balance, the speed of job changes and the emerging new occupations will sustain a high demand for education, training and retraining. A certain part of the retraining will take place outside the educational system. Demand for higher education will be also stimulated by social and individual needs and competitive pressures. The labour market will be more segmented. . The attraction of the centres of knowledge and innovation is rapidly increasing in the location strategies of the TNCs. From among the migrants the highly qualified people will also move to these centres from countries where their knowledge and skills cannot be properly utilized or is vested.

While it will be easier to find jobs with higher education, there will be still problems with the matching supply and demand in the labour markets even in the highly qualified professional categories. International migration of labour will be difficult and constrained.

Universities, more than any other institutions need a vision about the future and future oriented strategies. They have to prepare their students for the future, and they have to educate people, who are going to play an important role in shaping the future path of the societies in which they are going to work. Even the mass-universities, their founders, managers, and professors should be looking not only the present job market. It is a wrong advice for the universities to train their students as better skilled apprentices for industrial firms. In a countries which depend very much on the global supply chains one must be prepared ,that digital technologies are likely to reduce further the labour content of manufacturing processes In the future an increasing segment of manufacturing will move either toward centres of innovation and excellence in the respective technologies and in the qualification of people Even for those institutions which provide the core competence in any given field from the perspective of the students, who are entering the universities around the end of second decade of the 21st Century, the anticipated changes in the next 30-40 years should be the horizon. They should serve also as the best prepared instit-

utions for lifelong learning. Lifelong learning is no longer a slogan or an option, but a reality – a necessity especially given the rapidity of new knowledge development.

Universities must become or remain centres of excellence in any environment in which they are working. The tasks for achieving and sustain excellence are making the combination of research and education in the universities not only much more important, but indispensable. The two task should be combined in a realistic, rational and flexible way. Both should be assigned greater value and respect; these require also much more skilled educators and new structures in the system of higher education.

All these must be taken into account also in Hungary. In shaping national education and science policies. Since the late 1990s there have been important changes in the Hungarian university system. With the exception of the Bologna program, they have been of domestic origin, the consequences of government policies and actions. It is not the aim of this study to discuss their favourable or adverse consequences. It should still be analysed however: did those measures promote the implementation of the triangle: educate research and innovate? Unfortunately, with the exception of individual initiatives, there have not been any official and comprehensive analysis about the impact of the various measures. Neither the National Strategy, adopted in 2014 nor the OECD report t corresponded to those needs. They did not analyzed for example, how the different changes contributed to the relevant or irrelevant structural changes in the quantity and quality of human capital in Hungary. The preparation for the changes in the status and character of Corvinus University could have been an excellent opportunity for such a general and specific analysis.

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