Skills of the future

How to thrive in the complex new world

GLOBAL EDUCATION FUTURE

ПРОФЕССИИ БУДУЩЕГО
FUTURE SKILLS

worldskills Russia

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How to thrive in the complex new world

Authors:
E. Loshkareva, P. Luksha, I. Ninenko, I. Smagin, D. Sudakov.

Authors wish to express their gratitude to the organizations
which have acted as partners of foresights and expert sessions:

Contents

Introduction

The making of this Report

This Report is a product of a long-term cooperation between Global Education Futures and WorldSkills Russia, which aims to determine the image of a workplace within the economy of the future. The Report contains the results of a foresight cycle and expert meetings co-hosted by GEF and WS in 2014-2017. A considerable contribution to the success of this Report is largely attributed to the cooperation with event co-hosts, including the International Labour Organization, the BRICS Business Council, the Agency for Strategic Initiatives and the SKOLKOVO Moscow School of Management.

The Report is designed to track global changes and transformations underway in most developed and developing countries. Key trends and patterns are usually visible to a certain extent. It depends on distinctive features of the economy under consideration and its degree of integration into global chains of added value and labour division. One way or another, the changes have an impact on every country of the world.

We do not make a detailed analysis of a particular country, or macro-region in this Report. However, the materials presented might serve as a basis for subsequent work in that direction. The Report pinpoints global trends inherent to all countries in their transition towards a post-industrial society.

Documentation and events at the core of this Report

AGENCY FOR STRATEGIC INITIATIVES
Since 2012: future skills for 25 existing sectors of Russian economy + 9 emerging sectors of National Technology Initiative Network of learning platforms & STEM clubs for next generation of engineers
Ca. 200 jobs of the future (leading carrier guiding tool that stimulated transformation of Russian secondary & tertiary education)

ATLAS OF EMERGING JOBS
Ca. 200 jobs of the future (leading carrier guiding tool that stimulated transformation of Russian secondary & tertiary education)

MOSCOW SCHOOL OF MANAGEMENT SKOLKOVO AND INTERNATIONAL LABOR ORGANIZATION
Methodology of skills anticipation. Pilot applications in Vietnam, Armenia, Tunis, Tanzania, South Africa, Argentina

GEF Discussion of skills of the future involving industrial & TVET leaders from ca. 50 countries of the world

BRICS Business Council Skills development strategy with focus on Industry 4.0 since 2015

Critical background

The technological revolution is rapidly changing the social order

The ever-growing number of experts argue that mankind will soon face a radical change of economic and social way of life. These changes will be driven by an accelerated development of technologies and related social novelties.

In particular, Klaus Martin Schwab, the founder and executive chairman of the World Economic Forum, made a comprehensive reference to the idea of the IV industrial revolution in his speech in Davos on 20 January 2016. According to Schwab, we are to see forthcoming changes of the scale and complexity yet unknown to mankind.

In a long-term perspective the new technological transition may lead to a revolutionary breakthrough in labour efficiency and economical development. However, in a short-term perspective it may cause a substantial imbalance in the world economy, thereby aggravating inequality and encouraging the risk of global structured unemployment.

Requirements for new types of specialists

Most tasks currently assigned to employees in various sectors of economy will be automated or disappear due to the change in the way of social organisation. New economy will require new specialists. They will be tasked with assignments requiring a creative approach and an ability to work with other people and artificial intelligence. The very approach to work will be changing too. Instead of a familiar linear career in one occupation, individuals will work on the true realisation of their vocation by trying various specific activities.

Challenges to forecasting the future

Any future forecast inevitably carries a risk of an error. This research is no exception. This is why we want to bring your attention to a series of methodological assumptions and solutions that our Report is based on.

>> The life cycle of occupations is getting shorter. In this regard, it seems more sensible to form a new skill-set rather than to forecast specific occupations. These skills, once acquired, will help employees ensure their position within a particular activity of the future as they will be ready for subsequent retraining.

>> There are plenty of methods to forecast skills of the future. These methods are built upon existing data and past trends. They do not forecast any qualitative shifts. Our assumption is that society is on the brink of a substantial turning point. Therefore, a simple extrapolation of current trends does not suffice to answer the question about what the world of a job of the future will look like. Our Report is based on essential methods (foresight-sessions, interviews with experts, trend analysis) supported by an overview of the most relevant quantitative researches.

>> Any forecasts on the skills evolution in this Report are secondary and derived from suggestions about changes in the environment of the future. Still the future is variable and may take any direction. In this work we rely on a series of basic trends which will direct a markable transition in society, economy and technologies.

>> Even if a specific trend is correct for the purposes of such forecast, it is also subject to variation. Hence, the variety of scenarios within any given trend. If we had tried to forecast the future of jobs in the digital sector in the late 70s of the past century where the so-called mainframes constituted the principal paradigm (large stations with many connected terminals), we would have struggled to forecast the role PCs and mobile phones are playing today. In this connection we deliberately try to omit any specific skills

required for a specific activity. We pay more attention to skills that are tailored for a variable world and help prepare for that kind of variation.

>> There is an ever-growing complexity and polarisation of the world around us. There are still people in our world who remain ignorant of basic technologies and there are, of course, those living in highly developed societies. It is impossible to forecast skills necessary for all people on earth.

For the purposes of our analysis we narrowed the focus and opted for a sectoral approach. We attempted to watch the evolutionary line of skills in manufacturing, social services, and economy of knowledge in various countries which have already stepped into the transition towards a post-industrial social and economic way of life.

Our position

We believe that mankind should take a serious approach towards the formation of a desired image of the future. One should not treat the future as a simple continuation of the present, as if tomorrow does not differ from the previous day. Education and skill development is one of the most conservative areas. Sometimes training programmes remain unchanged for decades. We believe that this approach will lead us nowhere. We hope that this Report will contribute to the formation of a probable positive image of the future, which in turn will require conscious joint efforts of many actors of modern economy.

1. Key trends defining future of work

1.0 Key trends

We set an ambitious and challenging goal: to determine what skills will be in demand in the 21st century. This means that we need to bring to light the processes that are changing society in the 21st century and demonstrate the ways in which these changes will influence specific people at specific workplaces. In other words, how the term “work” will change and what the term “work activities” will represent.

At Global Education Futures and Future Skills expert sessions, we have distinguished and verified a variety of trends that significantly influence all sectors of the economy and determine what the working process will look like in the foreseeable future. These trends are to some extent familiar to the majority of experts wondering about the economic and societal organization of the future.

Getting our report started with a review of the trends, we would like to summarize existing predictions and find a perspective that offers a clearer picture of the 21st century workplace. It is possible to project the development of these trends on both a specific workplace and enterprise or the sector of economy, and, thereby, we can get an understanding of how one or another trend manifests itself on each level. This will be done in the subsequent sections of the report.

We suggest dividing existing trends into several categories. Technological trends (automation, digitalization) are easily visible since they appear on a physical level and immediately influence the surrounding environment.

Social trends, as well as the trends at the intersection of social and technological fields, might not be that visible because they are less apparent in everyday life. However, it is these trends that form the organization of society, and they set the demand for different goods, services and even forms of labour organization.

Based on expert session outcomes, we have determined seven trends that form the future economic model, with two key trends in each of three categories and one common meta-trend.

Diagram 1. Key trends

Source: Authors of the report

The key trends:

TECHNOLOGICAL

Digitalization of all areas of life
The amount of digitalized data is growing, the Internet is becoming more accessible, and digitalization technologies are mastering new areas of human activities;

Automation and robotization
Development of autonomous systems that are capable of complex physical and cognitive activities transforms the role of human labour in all sectors of economy.

TECHNOSOCIAL

Globalization (economic, technological and cultural)
Value chains, consumer goods, scientific knowledge and cultural codes emerge and exist in an ultra-connected world, where the role of transnational cooperation intensifies;

Environmentalization
Growing consumer and manufacturer attention on ecology is accompanied by the transformation of the very concept of environmental friendliness and the widespread dissemination of environmental metaphors in business.

SOCIAL

Demographic changes
Growth of life expectancy, continuing urbanization, the growing role of women in the economy, and the changing model of childhood determine a new social landscape;

Formation of a network society
Emergence of new, more flexible ways of managing companies and communities is supplemented with the development of network technologies and expansion of solutions based on blockchain technology.

META-TREND

All the listed changes occur under the influence of one common meta-trend which is the increasing **rate of change**.
New technological solutions and social practices emerge at an increasingly rapid pace.
This meta-trend not only influences specific changes but also sets the rate of world renovation — a rate that the majority of existing social institutions are not ready for.

We realize that in different countries the influence of these trends will be received differently. In some places it is already visible in the majority of sectors of the economy, while in others the deferred effect will be observed. But even being contained, these changes sooner or later are going to significantly affect each individual, regardless of their physical location, and form the economic and social pattern of the 21st century.

In the following section of this report, we will give a brief description of each of the trends. Their joint influence leads to **the increased complexity of the world**, and it is this increased complexity that will become a main influence in the workplace of the future.

1.1 The digitalization of all areas of life

Digitalization, i.e. the transfer of all information types into digital form, penetrates absolutely all areas of activity. It changes our approach to enterprise management as well as management of cities and even one's life.

In the analogue reality that we are accustomed to, an absolutely exact copy cannot be created, we can only try to get as close to the original version as possible. It is impossible to draw a perfect boundary between real objects in it, as it will always depend on the degree of approximation as well as on measurement tools.

Unlike analogue data, numerical data is discrete, it can be stored, copied, analyzed and sent practically without any restrictions[1].

We create a brand new dimension of reality, in which the data of the external and internal world (images, music, heartbeats, trajectory of movement, etc.) is transferred into a single format consisting of zeros and ones. And if data in analogue formats degrades over time, digital data can be stored without losing quality for as long as there can be information carriers. For digitalized data, there is no difference between the original and a copy, and copies themselves are created with a minimum expenditure of resources. Numerical data is convenient to analyze, comparing an unlimited amount of data coming from billions of devices in a single digital format.

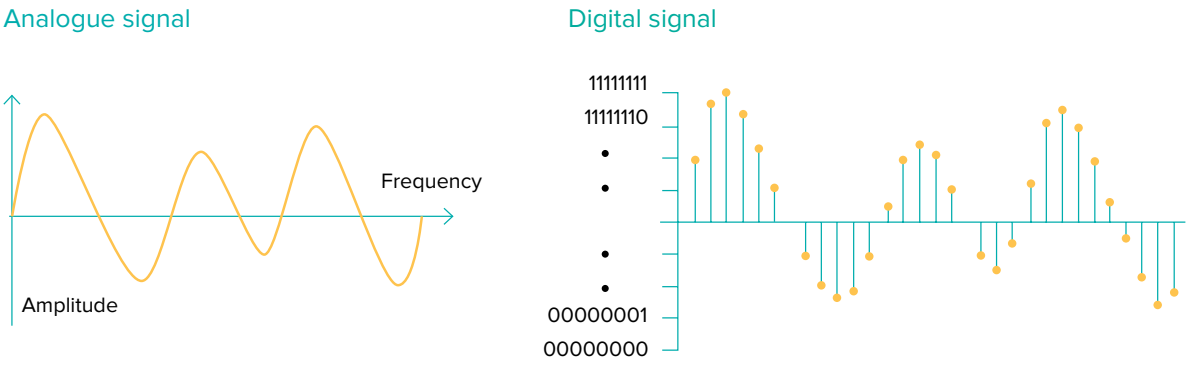
For now, we are not able to fully comprehend what it means to live in a digital world. Most likely we will be taught by the “digital generation” (digital natives[2]) — those who were born and grew up in the “world of numbers”.

[1] Post, D. G., & Eisen, M. B. (2000). How long is the coastline of the law? Thoughts on the fractal nature of legal systems. The Journal of Legal Studies, 29(S1), 545-584.

[2] Prensky, Marc. “Digital natives, digital immigrants part 1.” On the horizon 9, no. 5 (2001): 1-6.

Diagram 2. Digitalization

UNLIKE ANALOGUE DATA, numerical data is discrete, it can be stored, copied, analyzed and sent practically without any restrictions.



Source: Gartner (2011) Strategic Information Management for Competitive Advantage

The Internet of things and the Internet of everything

The emergence of computers, and subsequently technology unifying them into networks, has become one of the most important technological breakthroughs of humanity. Exponential growth of the Internet suggests the scope of the digitalization trend. Based on Cisco's estimations,[3] by 2021 the global annual Internet traffic will grow 127 times compared to 2005 and reach 3.3 zettabytes[4]. At the same time, due to the development of machine-to-machine (M2M) communications, or the Internet of things, 10 billion new devices will appear in the world's IP networks, meaning for each inhabitant of the Earth there will be 3.4 devices connected to the networks.

The Internet is no longer just a network of computers, it is a network of all kinds of devices, from a cell phone and a smart watch to cars, traffic lights, robots, transport drones and automated industrial machines. The Internet is becoming “the network of everything”.

Big data, machine learning and artificial intelligence

Universal industrial and household computerization has led us to the era of big data.

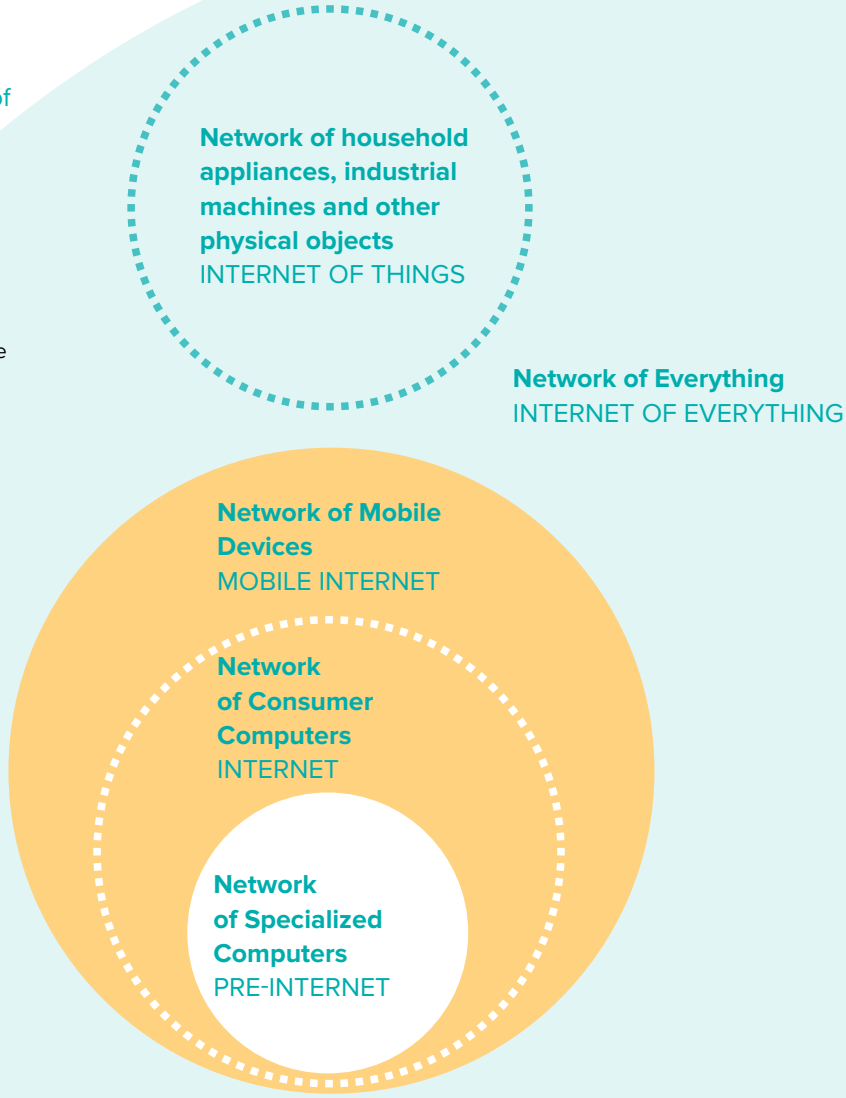
This in turn opens up new opportunities for the development of artificial intelligence technology[5], implying the ability of computing devices to solve complex problems independently.

Continuous growth of computer productivity and the development of machine learning technology made it possible for huge flows of quantized data to become the material for artificial neural network learning. They are already actively used as recommendation systems for making decisions in finance, medicine, education and other fields[6].

[3] Cisco Visual Networking Index Cisco.com

[4] One zettabyte equals 1,0007 bytes or one billion terabytes

Diagram 3. The Internet — Network of Everything



THE INTERNET will include the usual Internet existing as a network of connected personal computers and mobile devices. However, it will be supplemented with the Internet of things- physical objects equipped with the technology to interact with each other and the external environment, and capable of making independent decisions based on incoming information.

Source: Authors of the report

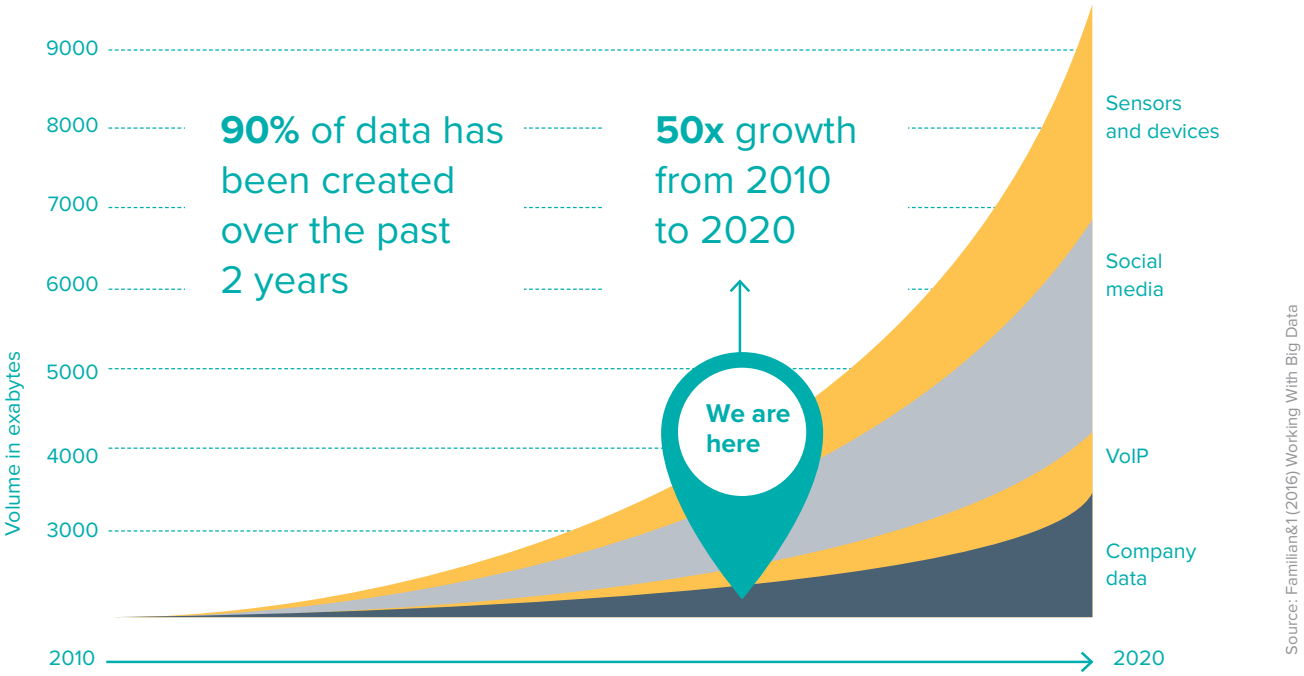


Diagram 4. The growth of quantized data

The lack of possibilities for interaction with machines in natural language remains a bottleneck of computer systems, limiting their presence in our everyday life. Nevertheless, big developers continue to make an effort to solve this problem. Apple, Google, Microsoft, Amazon and other leaders of the digital market have already brought to market products that have the ability (at least partially) to understand natural human speech. This means that they get access to even bigger amounts of data, which, in return, will be analyzed and used for artificial intelligence learning.

[5] In the report, the term "artificial intelligence" refers to computer systems that are capable of performing complex intellectual tasks and have the capacity to self-learn. These are systems that simulate the work of weak artificial intelligence and do not meet all the characteristics of intellectual activity. Examples of such systems are Microsoft Oxford, IBM Watson, Google DeepMind, and Baidu Minwa. The authors of the report observe with interest and participate in discussions about the nature and the boundaries of realization of computer artificial intelligence, but such questions go beyond the scope of this report.

[6] Why deep learning is suddenly changing your life. Fortune.com

The switch from general digitalization of the external world to digitalization of personal space

Another crucial aspect of digitalization is a gradual "superstructure" of normal reality with a digital, augmented or virtual reality.

Virtual reality technology intensifies the digital world, while augmented reality technology erases the boundaries between the worlds. The game Pokemon Go, which gathered more than 100 million users all around the world over a very short period of time, has demonstrated the possibilities of augmented reality and the readiness to apply this kind of technology. Augmented reality is already applied at workplaces in complex productions, forming new ways of work, communication and cooperation within a business.

SINCE 2011, AIRBUS CORPORATION has been introducing a Smart Augmented Reality Tool for quality control in its production. Tablets with special sensors and software impose schemes on the real objects, providing immediate access to databases that contain all the necessary information. At the moment, over 1,000 Airbus employees are using the Smart Augmented Reality Tool in their work.

The next step of digitalization is the development of bio- and neurointerfaces

The simplest biointerfaces, such as smart watches and electronic sports bracelets, have already become a common phenomenon in our everyday lives. They enable us to quickly analyze and transmit information about our own condition. The continuation of this technology package will be implantable sensors, transmitting data on the state of the organism (for example, on sugar level, hormones, and organ function) to a personal smart phone or to the treating doctor.

In the foreseeable future, this technology will be reinforced by the development of neurointerfaces, which allow for the reading and interpreting of brain signals. Researchers see an important technological frontier in the development of neurotechnologies, the overcoming of which can radically change society in the coming decades.

In 2017, a famous entrepreneur-innovator Elon Musk declared the creation of the Neurolink company, which will be working on the creation of a fully-fledged “brain-computer” interface.

Since 2014, the NeuroNet Group of the National Technological Initiative in the Russian Federation has been working towards a radical increase in the productivity of mental work through the integration of the human brain and computers. The rapid development of this initiative can begin after completion of the decoding (mapping) of brain work by analogy with the biotechnological revolution that started after decoding of the human genome.

There is a possibility that NeuroNet, as a concept of connectedness, will become the next stage of development of today's Internet, where the interaction of agents (human-human, human-machine) will be carried out on the basis of neurointerfaces. Neurointerfaces offer us an opportunity to create a new language of communication, but this will require users to increase their ability to manage their own nervous system, regulating brain rhythm and holding attention. To some extent, this can be compared to the active development of fine motor skills that was required by the majority of people during the second half of the 20th century to use the keyboard, and then a mouse and touch screens.

Diagram 5. Augmented and virtual reality

Source: Authors of the report

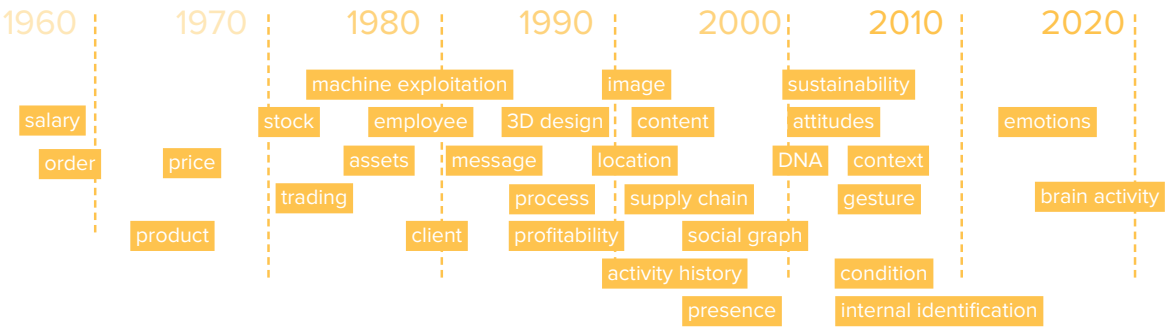


Diagram 6. A gradual transition to digitalization of personal and even internal worlds

Source: Gartner (2011) Strategic Information Management for Competitive Advantage

It is worth mentioning that during the switch to another toolkit the previous skills might lose their relevance. This way, people who are constantly working in front of a computer start losing the skill of handwriting.

Now we can only guess what kind of skills will start to disappear with the full development of NeuroNet, but soon this issue will be the subject of close scrutiny.

STUDY THE TREND:

Deloitte (2016) **Artificial Intelligence Innovation Report**
OECD (2016) **Science technology and innovation outlook**
OECD (2015), **Data-Driven Innovation: Big Data for Growth and Well-Being**
Sogeti VINT (2014) **Empathic things: Intimate Computing from Wearables to Biohacking**
WEF (2015) **The Global Information and Technology Report 2015: ICTs for Inclusive Growth.** Geneva: World Economic Forum
Agency for Strategic Initiatives to Promote New Projects (2015) **Approaches to the formation and launch of new industries in the context of the National Technology Initiative ... (in the field of neuroelectronics)**

1.2 Automation in industry and the economy

Technical changes that mankind faced at the end of the 20th century led to various reflections. Numerous researchers have expressed their opinions on the process of automation, from K. Marx to G. Altshuller. In their interpretations, they tried to conceptualize relations between humans and technology and to comprehend our mutual roles in the present and foreseeable future.

Today we are witnessing the acceleration of this trend, which is connected to the expansion of automated control technologies and production of material and digital products. We are talking not only about the development of robots designed to carry out various physical tasks, but also about the significant automation of routine cognitive work through the expansion of systems of weak artificial intelligence.

In the following section, a general review of this trend is introduced; and further in the report we will describe the current level of industry robotization in more detail, as well as the possible consequences of automation in different sectors of the economy.

Industrial revolution

The production sector, as it developed, experienced stages of significant technological leaps, which are usually called industrial revolutions. Nowadays, the industrial society is going through another transformation, which some scientists suggest should be called the third (J. Rifkin[7]) or the fourth (K.Schwab[8]) industrial revolution. This moment might also be considered the beginning of the sixth economic cycle (according to Nikolai Kondratiev's model[9]).

We will consider the trend of automation in the context of the image of “Industry 4.0” that was introduced at Hannover industrial fair in 2011.

The fourth industrial revolution is characterized by universal digitalization and the blurring of boundaries between physical, digital and biological fields. The changes taking place involve the intersection of several trends, but still the key focus is on the automation of industrial and management processes.

"The fourth industrial revolution” presumes that this is just another event in a series of industrial revolutions. However, there is every reason to believe that a qualitatively more serious transformation than anything we have come across awaits the industry.

For now, the very notion of “Industry 4.0” does not have a clear definition, therefore, we can only talk about a set of prospective technological packages that provide the primary basis for it, as well as about scenarios of development in business, economic and social fields. Individual national programmes preparing for the new industrial pattern have already emerged in other developed countries such as China (Made in China 2025), the USA (Advanced Manufacturing Partnership), France (Industrie du Futur), Japan (Smart Society 5.0), Russia (National Technology Initiative) and others.

Key elements of the new industrial model

The transition to the new industrial model implies not just an automation of separate conveyor lines of production where separate devices act independently from each other, but rather a creation of complex production systems connecting physical and digital spaces. Several compound elements lie at the base of the new industrial model:

>> The development of industrial robotics will allow for the replacement of manual labor in the majority of routine production operations.

>> The expansion of driverless vehicles will change logistics at the individual company level as well as on the larger economic scale.

>> New materials and additive technologies enable automated systems to print complex details and elements of construction.

>> Direct communication between devices through the development of intermachine communication and the Internet of things creates new communication protocols (for example, “production area — machine — conveyor — supplier").

>> The use of self-learning computer networks will enable the establishment of constant collaboration between subsystems and interaction with

[7] Rifkin, J. (2011). **The third industrial revolution: how lateral power is transforming energy, the economy, and the world.** Macmillan.
[8] Schwab, K. (2017). **The fourth industrial revolution.** Crown Business.
[9] The sixth Kondratieff – long waves of prosperity. Allianz

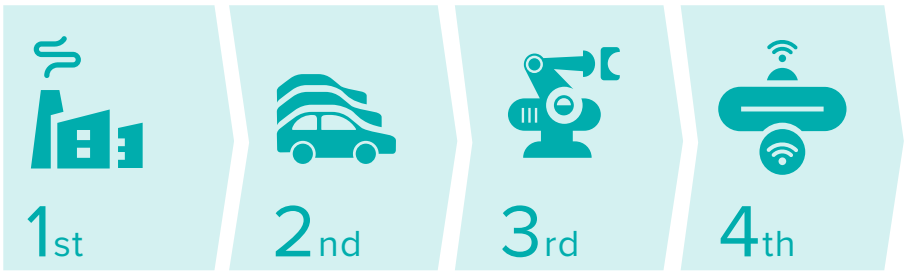


Diagram 7. Technological packages at the heart of industrial revolutions

Source: Christoph Roser, http://www.allaboutlean.com

external systems (for example, with logistics and sales departments). This means that elements of a production system will become partly or fully self-managing.

Robot pilot on the road, in the air, in the field, everywhere

Nowadays, all automakers (and other huge companies) are working on building various self-managing systems.

Significant fame was gained by the robot pilot of Tesla, which is already able to park, maintain its speed, traffic lane and distance between cars, as well as switch between lanes on the road. The introduction of driverless vehicles will rest on technological and legislative barriers, but many automakers promise to sell cars with a full robot pilot by as early as 2020[10]. This will significantly change our attitude towards cars and call into question the existence of the taxi driver profession as such.

Robot piloting is not limited to cars on the road. Different producers of agricultural machinery have already been incorporating various self-managing elements in their production for a long time. So, for example, John Deere tractors are capable of independently excavating a field based on a pre-programmed route, while automatic fertilizer delivery systems make a decision based on sensors that analyze a whole range of information, from the weather to the coefficient of light reflecting vegetables in patches[11].

In addition to a robot pilot for cars, a rapid development of unmanned aerial vehicles is also taking place. Amazon's online store is already testing the delivery of goods with the help of self-managing drones[12]. The inevitable introduction of self-controlled systems for trucks and forklift trucks is going to fundamentally change the logistics sector. The whole process of loading and transporting materials between factories, as well as delivering goods to the sales outlet, can be fully automated.

Robot piloting means not just substituting a driver behind the car's steering wheel; it is the development of capabilities of artificial intelligence to analyze complex flows of incoming information and independently make efficient decisions. This kind of skill will enable the automation of a significant portion of physical activity.

Automation of cognitive work

Automation will affect not only physical labour, but also all routine cognitive work — especially in areas where humans still act as intermediaries between different systems.

A typical example of this kind of work is agents booking and selling airplane tickets. Until recently, an ordinary person could not independently submit a query to databases to learn about the availability of tickets for specific flights, not to mention buy these tickets from home. To do that, a special agent was required who translated the query into a special character system and searched various databases. Nowadays, this work has been significantly simplified due to aggregating websites that enable an ordinary user to search for tickets on all available airline databases at once.

This is not yet full automation, since a user still has to enter limited query parameters. However, now there are electronic personal assistants that are ready to accept requests on tickets in the form

[10] Отчет "The Autonomous Vehicle 50", Disruptionhub,Февраль 2017

[11] "The future of Agriculture", The Economist, 2016-06-09

[12] Amazon PrimeAir programme is available for some users in the UK. More information on the website http://amzn.to/primeair

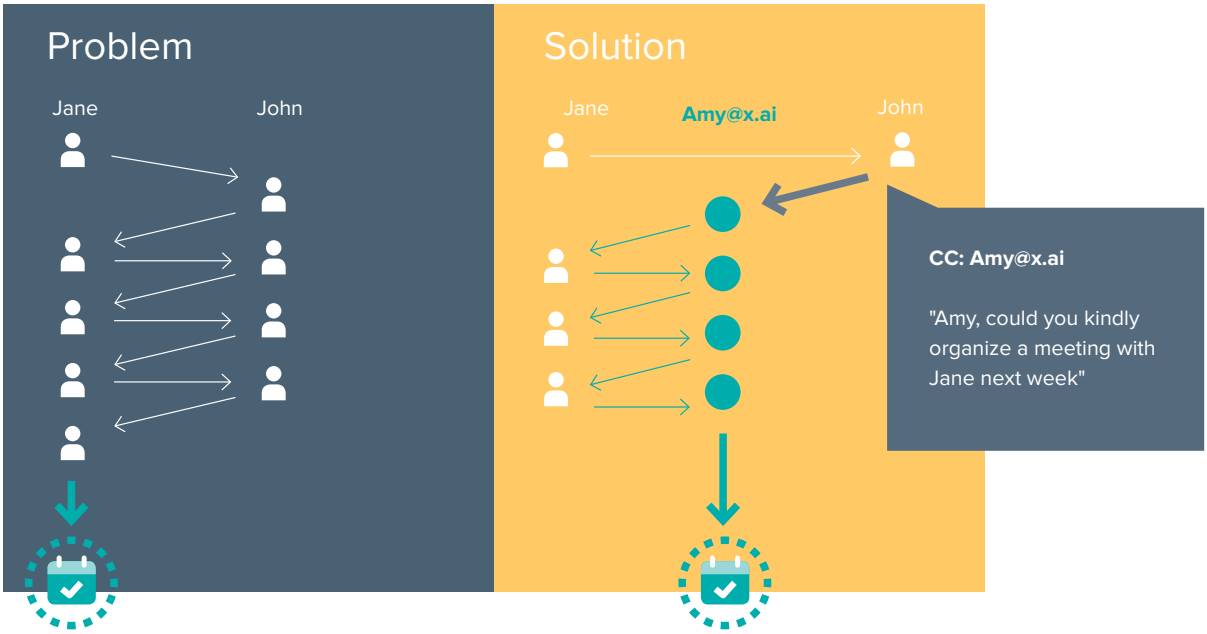


Diagram 8. Virtual secretary Amy by x.ai

Source: x.ai

SINCE 2016, COMPANY X.AI offers virtual secretary services. Artificial intelligence is capable of communicating via mail, using regular phrases in English. It coordinates the time and meeting spot, taking into consideration your preferences and your current agenda.

of regular speech and conduct a search of the relevant options. In the very near future, such digital assistants will become a universal phenomenon in all offices. Booking agents, as well as many other assistants performing routine tasks, will no longer be necessary. Automation will also affect accountants that keep and coordinate different databases, as well as architects that draw and copy routine sketches.

It is important to realize that gradual learning by various artificial intelligence systems, which is currently taking place in various sectors, from face recognition to controlling a swarm of driverless vehicles, has a cumulative character and the further development of artificial intelligence will occur based on previously gained data.

In other words, having taught computer systems to effectively manage business accounting, we will no longer need to teach other programmes to do so (unlike with new employees).

STUDY THE TREND

BRICS Skill Development Working Group (2016) Skill development for Industry 4.0 (Whitepaper report)
Schwab, K. (2016). **The Fourth Industrial Revolution.** Geneva, Switzerland: World Economic Forum.

1.3 Globalization of the economy, knowledge and technology

Globalization became a reality a long time ago. In most countries, you can buy popular clothing or electronics brands and eat in famous fast food restaurants — essentially, McDonalds, KFC and Starbucks are still perceived as the primary symbols of globalization.

The value chain of many goods have already transcended national barriers. It is increasingly difficult to tell exactly where a certain product was produced, since different parts might have been produced in different areas of the world. But this is only the very top of the globalization iceberg.

All of mankind consistently agrees on general protocols for the routing of physical cargo (mail, air communication) or information (the Internet, telephony). Modern scientific research is based on the collective knowledge of mankind and is carried out by international groups of scientists from all over the world. Cultural globalization has led to the fact that new films and episodes of TV series have to be broadcast in different countries literally by the hour, so that pirates do not distribute them around the world before official distributors do so.

During last years we observe a change in some aspects of globalization. Global supranational institutions losing their former powers and authority. United Kingdom initiated the process of withdrawal from the European Union and new president of the USA Donald Trump puts “Americanism over globalism”. But there are strong trends in economical, scientific and cultural integration that will keep strengthening connections around the globe.

Global value chains

The chain of production and sales of even such a seemingly simple product as the chocolate spread Nutella covers the whole globe. Raw products are supplied from Brazil, Turkey, the USA, Malaysia and some African countries. Production sites are located in Canada, Australia, Brazil and several places in Europe. Sales offices are spread all over the world. However, regardless of the continent in which the chocolate spread is produced, its taste will remain the same everywhere.

Almost any complex product involves a chain of manufacturers from dozens of countries. As an example, let us examine the case of the Boeing 787 Dreamliner. For its production, component manufacturers are involved all over the world. Diagram 8 demonstrates that various details of the vehicle are produced in both the Americas, in Europe and in Asia.

Global suppliers of Boeing are full partners and invest their resources in the development of components for the aircraft with the expectation of sharing revenues with the American corporation in the future. At the same time, the planning horizon for all participants in the scheme is equal to the duration of the aircraft production programme (which takes about 30 years to complete).

Connectivity of companies is available around the world, meaning not only the synchronization of business processes and technological standards, but also similar requirements for personnel on different continents. One of the key requirements that global companies seek in potential employees is the ability to interact across cultures.

Globalization takes place not only in terms of goods but also in terms of knowledge and culture.

Over recent decades, there has been a change in the nature of labour division: flows of goods and financial capital moving from economy to economy slow down, while flows of knowledge and technology, on the contrary, increase[13].

More and more often, scientific works are written by co-authors from different countries[14]. The increasing complexity of problems facing modern science requires new levels of cooperation. The very production of knowledge becomes distributed and global; in such projects as the Large Hadron Collider[15] or Human Brain Project[16], hundreds of scientists from dozens of countries are simultaneously involved.

Popular culture already transcended national boundaries a long time ago. Even before the Second World War, Hollywood became the main supplier of movies around the world, and with the

[13] Digital globalization: The new era of global flows, McKinsey Global Institute, Февраль 2016
[14] Measuring the Globalization of Knowledge Networks
[15] CERN member states and observer states CERN website
[16] Human Brain Project Partners on HBP website
[17] How “Game of Thrones” became TV’s first global blockbuster SALON.com

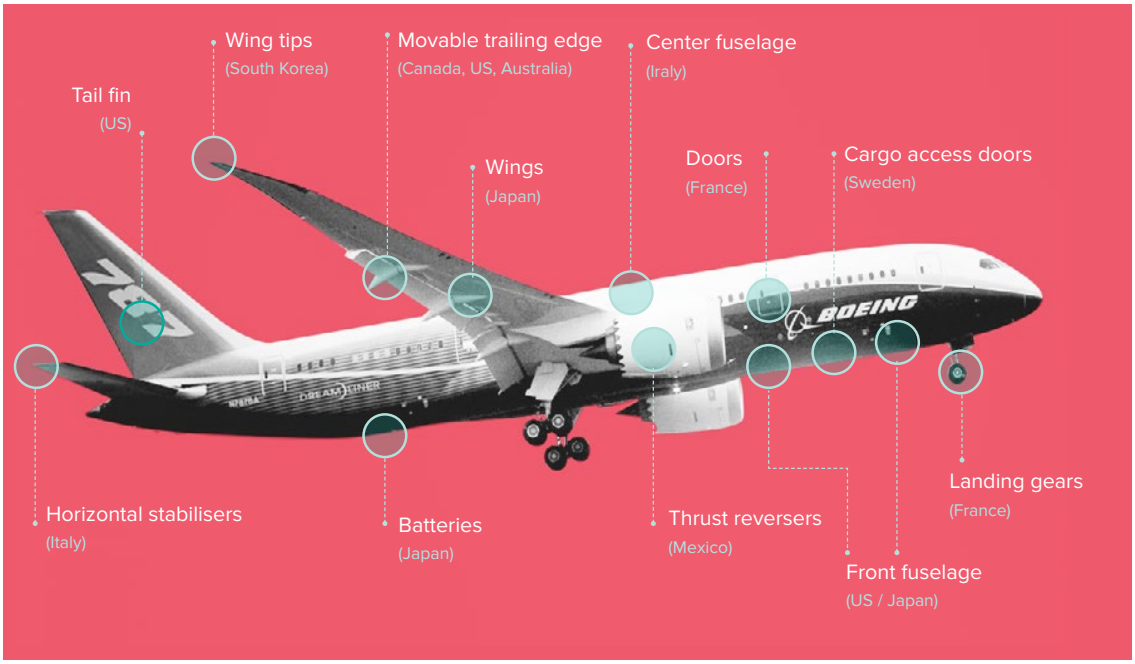


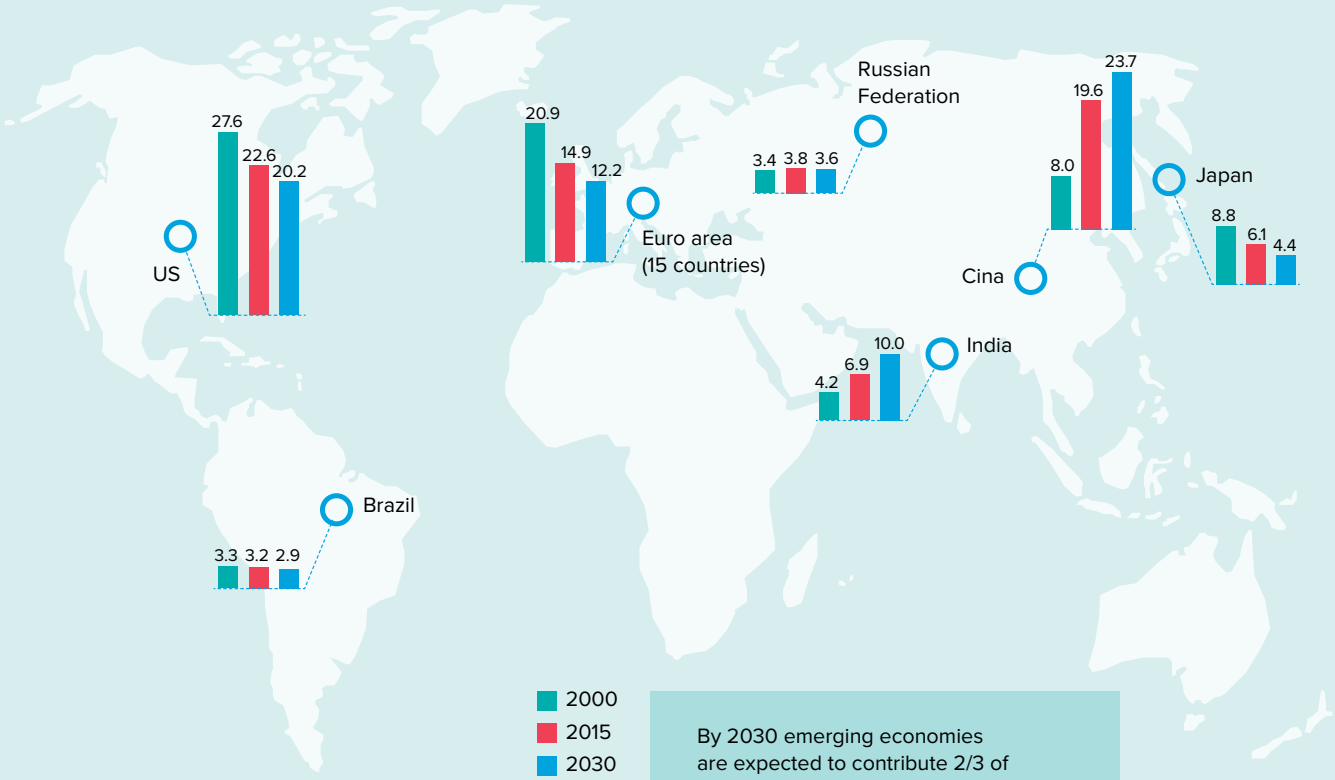
Diagram 9. Global component suppliers of the Boeing 787 Dreamliner

Source: Reuters

Diagram 10. The centre of the economy switches to the South-East.

Percentage of world GDP, 2000, 2015 and 2030

Source: OECD (2016) Science technology and innovation outlook



development of new media, its position has not weakened. Due to digital television, new episodes of leading TV series are watched by millions of viewers at the same time all over the world[17].In addition to the cross-border distribution of habitual cultural phenomena, we are witnessing the emergence of a new digital culture which has no national boundaries. Network computer games gather millions of fans all over the world.

A vivid example of modern globalization is the emergence and rapid expansion of the Pokemon Go game in the summer of 2016. In a matter of months, this game, based on augmented reality, attracted millions of users around the world[18]. A vivid example of modern globalization is the emergence and rapid expansion of the Pokemon Go game in the summer of 2016. In a matter of months, this game, based on augmented reality, attracted millions of users around the world.

In the middle of the 20th century, the centre of global economic activity switched from Europe to North America. Since the Second World War, the USA has significantly outperformed European countries in terms of GDP. However, nowadays, the economic role of the USA and the EU is declining, and the centre of world activity is gradually shifting to Asia.

By 2030, developing economies will account for more than ⅔ of global growth and most of world trade. The countries of Southeast Asia will become flagships of the global economy, primarily China and India. It is expected that in addition to an increase in economic activity in the region, there will also be an increase in activity in the field of knowledge creation and technological innovations.

China already ranks second in terms of R&D costs among all countries, second only to the USA[19]. The change in the balance of power in economic and technological development will also have an impact on the global labour market. Transnational corporations are able to transfer their activities from one country to another in a very short period of time. This spurs development in territories where new activity is rapidly expanding; however, at the same time, it is a threat to those places that have to deal with a massive decrease in labour opportunities due to the fact that the number of jobs diminishes.

Emerging glocality

Gradual changes in the lives of people and communities of the 21st century are taking place largely due to the advanced ability to instantly transmit and receive information about what is happening around the world — including in the most distant corners.

While previously we could come together in the community, frequently meeting up with each other in designated places (churches, clubs), nowadays, communities of interests appear on the Internet and afterward seek opportunities to meet in real life[20].

The same technology can also be an effective form of communication for residents of a common area that share the same interest in maintaining local well-being. Life becomes both global and local, and to describe this phenomenon the word “glocal” was introduced[21] (glocal = global + local).

STUDY THE TREND:

McKinsey Global Institute (2016) **Digital globalization: The new era of global flows**
OECD (2016) **Science technology and innovation outlook**

[18] Why Pokémon GO Became An Instant Phenomenon, huffingtonpost.com
[19] Science, Technology and Innovation Outlook 2016, Organisation for Economic Co-operation and Development
[20] Ridings, C. M., & Gefen, D. (2004). Virtual community attraction: Why people hang out online. Journal of Computer-Mediated Communication, 10(1).
[21] Sharma, C. K. (2009). Emerging dimensions of decentralisation debate in the age of globalisation.

1.4 Environmentalization

The request for “greening” can be seen both “from below” (the increase in popularity of a healthy lifestyle, careful consumption) and “from above” (the introduction of various state and industry environmental policies and standards). Up to a certain moment, ecology was primarily perceived as a restriction imposed on economic activity for the sake of maintaining the cleanness of environment. “Green” skills were necessary only to those who worked in the field of nature preservation or control over the emission of waste.

Nowadays, we are witnessing a gradual switch to a more complete understanding of the Earth’s ecosystem, the role played by mankind and the technology created in the evolution of the biosphere. Integration of environmental thinking is taking place in almost all fields of life

The question of limits in population growth

The request for environmentalization partly evolves as a systemic response to environmental problems in different parts of the world, which are becoming increasingly apparent.

According to the Living Planet Report[22], two-thirds of wildlife will disappear from the face of the Earth by 2020. The significance of environmental risks is indicated not only by environmentalists, but also by organizations such as World Economic Forum.

In the Global Risk Report 2017[23] various threats faced by humanity are assessed by their degree of influence and their likelihood. The majority of risks rated high in degree of influence and likelihood are environmental. Serious preventative actions are needed to avoid natural disasters created by man and failure to control climate change.

The most comprehensive analysis of environmental risks features in the Planetary Boundary Study[24], relying on the systemic theory of the Earth. A group of researchers led by the Swedish scientist Johan Rockström and Australian Will Stephen have proposed defining the boundaries of the planetary system in which it can persist. As a result, these experts have highlighted nine different dimensions that could lead to the departure from a “safe existence zone”, resulting in the destruction of the entire system. According to recent data, pressure on the planet in two of these nine dimensions is already in the high-risk zone, and the risks in the other two dimensions are rapidly increasing (see Diagram 11).

The highly discussed issue of climate change is evaluated to be in the zone of uncertainty with increasing risks, but they highlight two other risks — biogeochemical flows and biosphere integrity — which are less known to the general public.

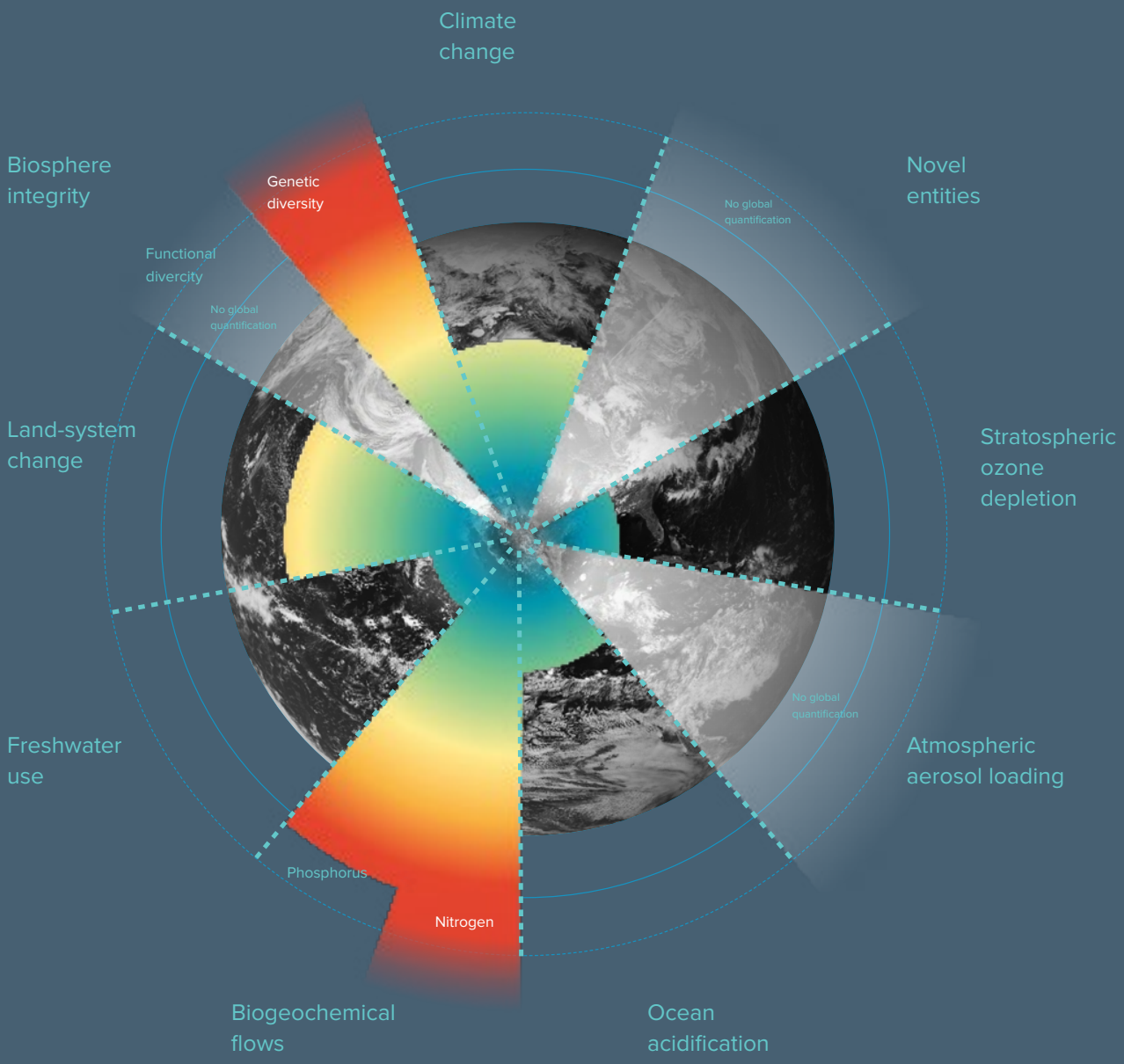
Discussion on the limits of growth of the industrial civilization began in 1972 in a report of the same name by experts of The Club of Rome.

According to the model proposed by these experts, the continued development of humanity in accordance with existing trends will lead to the depletion of resources and the subsequent collapse of civilization. The best strategy offered was the one called “zero growth”, which requires the active restriction of birth rates as well as capital investments. Emerging at that time, the environmental agenda was based exclusively on pessimistic and alarmist ideas. However, soon after, in the second report of 1974, a “limited growth” model was proposed, and in 1987 the World Commission on Environment and Development published the report called “Our Common Future”, which presented the paradigm of sustainable development, in which “satisfaction of present needs does not undermine the ability of future generations to meet their own needs”.

From limitations to prosperity

Currently there is a shift in ecological paradigms toward positive concepts, implying the possibility of successful co-existence and joint development of mankind, the biosphere and other planetary systems. The thrivability concept, suggested by Jean Russell in 2013, presumes that the prosperity of the ecosystem as a whole implies the shared well-being of each human with all others, as well as “private prosperity” as a basis of this system.

[22] Living Planet Report 2016, by World Wide Fund for Nature, Zoological Society of London and others.
[23] Global Risk Report 2017, World Economic Forum.
[24] Planetary boundaries, Stockholm Resilience Centre, Stockholm University and he Royal Swedish Academy of Sciences



Beyond zone of uncertainty (high risk)

In zone of uncertainty (increasing risk)

Below boundary (safe)

Boundary not yet quantified

Diagram 11. Planetary boundaries

Source: Stockholm Resilience Centre

Buckminster Fuller in 1937 pointed to the phenomenon of ephemeralization — the possibility to do more and more with less and less. According to Fuller, ephemeralization accompanies progress and avoids the depletion of resources.

The practical use of this kind of approach was described in the report called “Blue Economy”, prepared by Gunter Pauli for The Club of Rome in 2010, which became the basis of the book of the same name. Gunter Pauli and his team from The Zero Emission Research Institute (ZERI) selected hundreds of examples of systemic innovations that have reduced environmental footprints and at the same time increased production efficiency.

The switch of paradigms is supported by many ecologists that took part in the formation of green ideology. In particular, Stewart Brand, who used to be a chief editor of the influential compilation “The Whole Earth Catalog”, published his book “Whole Earth Discipline: An Ecopragmatist Manifesto” in 2009: Ecopragmatish Manifesto”.

Brand admits that the alarmist strategy, followed by many environmentalists, including himself, hindered the possibility of using technologies for the benefit of mankind. In his book, Brand encourages ecologists to start using progressive biotechnologies for solving the problems of ecology, for example, for controlling the climate and growing plants that are capable of greening existing cities.

Overcoming the dichotomy “environmental friendliness-development” is very apparent in the ideas of green urbanism. For a long time it was considered correct to divide space into an “efficient” city and an “eco-friendly” village. Suburbs acted as an intermediary. But the European Commission's publication of the Green Paper on the Urban Environment in 1990 changed this approach.

Architects announced the possibility of greening metropolitan areas and integrating environmental practices into urban life. In 2000, this trend was discussed in the book by Timothy Beatley titled “Green urbanism: Learning From European Cities”.

[25] We are talking about electricity produced by solar batteries and ground-based windmill stations. Read more: “Renewable Infrastructure Investment Handbook: A Guide for Institutional Investors”, World Economic Forum

[26] Renewables 2017 Global Status Report , REN21

[27] Global EV Outlook 2017, International Energy Agency

[28] Electric Vehicle Outlook 2017, Bloomberg New Energy Finance

Green alternatives are becoming mainstream

A social request for “greening” is accompanied by technological development that makes many ecological solutions economically effective. What was recently a marginal practice that was interesting only to previously-convinced environmentalists is gradually becoming mainstream.

The most obvious changes are happening in the field of power engineering. Until recently, coal and gas dominated the market, while investments in solar and wind power were mainly focused on research and development of effective technological solutions. But over the last decade the situation has changed drastically. In 2016, the World Economic Forum reported on the accomplishment of a historical moment when the cost of renewable energy[25] became equal to the cost of traditional energy in 30 countries of the world.

Most electricity is still produced by coal and gas, but alternative energy has already been surpassing traditional energy sources for several years in terms of the increase in new generation capacity[26]. China confidently holds the leading position both in terms of the volume of established capacity and new power plants.

The same trend appears in the field of motorcar production, where for many years battery-operated cars have not been taken seriously. In 2008, Tesla introduced the Roadstar model, which drastically changed the perception of possibilities for battery-operated cars. Currently, the majority of prominent car manufacturers are releasing or preparing to release their models of battery-operated cars[27]. According to Bloomberg predictions, by 2040 the majority of buyers will purchase cars operating with electricity[28].

Many countries are pursuing a gradual policy of eliminating disposable plastic by imposing taxes and even prohibiting it completely. Currently, disposable plastic bags are prohibited in Bangladesh, China, France and in dozens of other countries, provinces and cities[29].

Those are just several from a long list of ecological trends of this kind that became mainstream during the past decades.

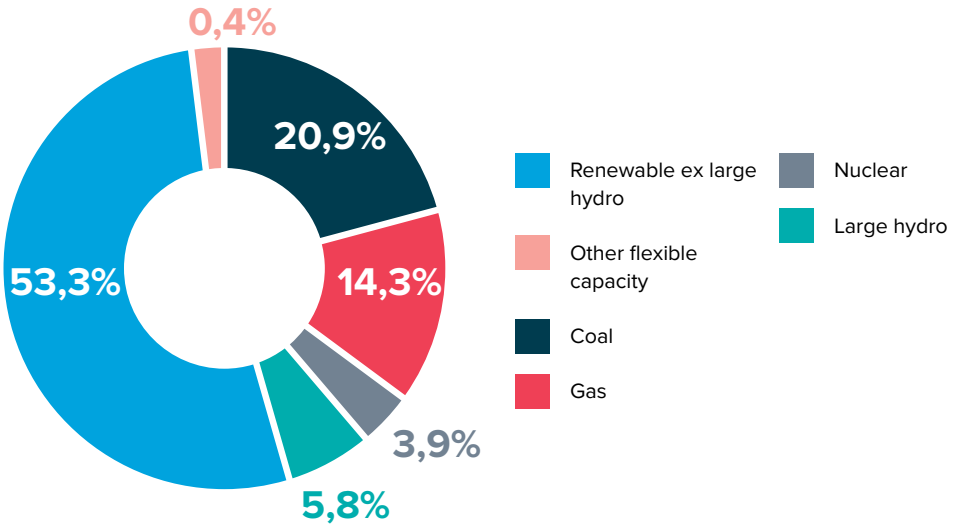


Diagram 12. Distribution of the increase in electricity generation in 2016 by production technology, GW.

Source: Bloomberg Energy Finance. 2017

The ecosystem approach

As our understanding of the possibilities of using environmental methods in urban development or production deepens, so does the "greening" of our thinking. Ecological metaphors are rapidly penetrating our everyday lives and business activities.

In 1993, the Harvard Business Review published an article by James Moore titled "Predators and Prey: A New Ecology of Competition", in which he suggested we consider economic activities as an ecosystem where buyers and producers play complementary roles, co-evolving in a direction led by companies that are at the heart of the ecosystem.

For the 25 years that have passed since this moment, the metaphors "ecosystem", "environment", "niche", and "evolution" have firmly entered the language to describe processes in business and society, especially when talking about digital products. It is difficult to find more suitable terms to describe the activities of companies such as Apple, Google or Cisco.

By creating Apple iOS or Google Android platforms for smartphones and tablets, corporations form an environment in which they invite third-party manufacturers and consumers[30]. Their success significantly depends on whether or not their "ecosystem" will be filled with life. At the same

STUDY THE TREND:

Beatley, T. (2000). **Green Urbanism: Learning from European Cities.** Washington, D.C.: Island Press
Fuller, R. B. (2000). **Nine chains to the moon.** Estate of R. Buckminster Fuller.
Meadows, D. H., Meadows, D. L., & Randers, J. B. WW,(1972) **The Limits to Growth: A report for the Club of Rome's Project on the Predicament of Mankind.**
Pauli, G. (2010). **The Blue Economy: 10 Years, 100 Innovations, 100 Million Jobs.** Paradigm Publishers.
Russell, J. M. (2013). **Thrivability: Breaking through to a world that works.** Triarchy Press.
WEF (2017). **World Economic Forum. The Global Risks Report 2017.**
International Labour Office. (2012). **Working towards sustainable development: opportunities for decent work and social inclusion in a green economy.** International Labour Office.

time, platform makers do not control the direction of technological development, a smartphone can evolve into a robot control element or become a cash terminal — this depends on third-party developers and customer requests.

This requires a different logic for building business processes — one more similar to logic based on "tuning" different organisms (plants, animals, mushrooms, etc.) to each other in the process of ecosystem development, for example, in the rainforest. In other words, each ecosystem participant should think in terms of the whole ecosystem and the benefits of its participants, understand its role in the complex system and assess the long-term consequences of its actions.

It is quite obvious that the ability to think ecosystemically and build processes according to the principles of biomimicry is becoming a necessary skill for managers and developers in all sectors of the economy.

[29] Report on actions to reduce circulation of single-use plastic bags around the world, Clean Up Australia

[30] This process is described in detail in the article by R.Garud et al. (2002) titled Institutional Entrepreneurship in the Sponsorship of Common Technological Standards: The Case of Sun Microsystems and Java http://digitalcommons.wcupa.edu/cgi/viewcontent.cgi?article=1001&context=man_facpub

1.5 Demographic changes

The speed of demographic changes that mankind has faced in the last century has been unprecedented in history. Life expectancy, which has already reached impressive figures, continues to increase in many countries of the world. Urbanization remains one of the key factors determining demographic tendencies. It largely supports the changing role of women and children in the economy and in society.

In general, we are witnessing a steady increase in life expectancy around the world. According to UN forecasts, the average global life expectancy in 2050 will increase to 76 years. These calculations are based on the assumption that the growth rate of life expectancy in developed countries will slow down. Some researchers point out that modern medical technology will allow us to maintain the current life expectancy growth rate.

According to the predictions of Oeppen and Vaupel, a number of OECD countries could overcome the 100-year threshold for average life expectancy at birth by 2050[31]. However, it is not just about increasing life expectancy, but also about extending the period of active life. In OECD countries, people aged 60 or older are no longer limited to a quiet pension, but rather they want to live their life to the fullest.

According to research by the American gerontologist Robert Butler, modern society is not ready to accept active people of older age. Society is influenced by the established stereotype of infirm elderly and it displays ageism. At the same time, the growth of the portion of the population that is aging compared with a decline in the portion of young people creates a number of economic problems in developed countries because it is becoming increasingly difficult to finance pensions for the growing percentage of elderly people. This will lead to an increase in retirement age, while the income level of pensioners will decrease[32].

[31] Oeppen, J., & Vaupel, J. W. (2002). Broken limits to life expectancy. Science, 296(5570), 1029-1031

[32] Pensions and ageing populations: the problem explained Financial Times August 26, 2016

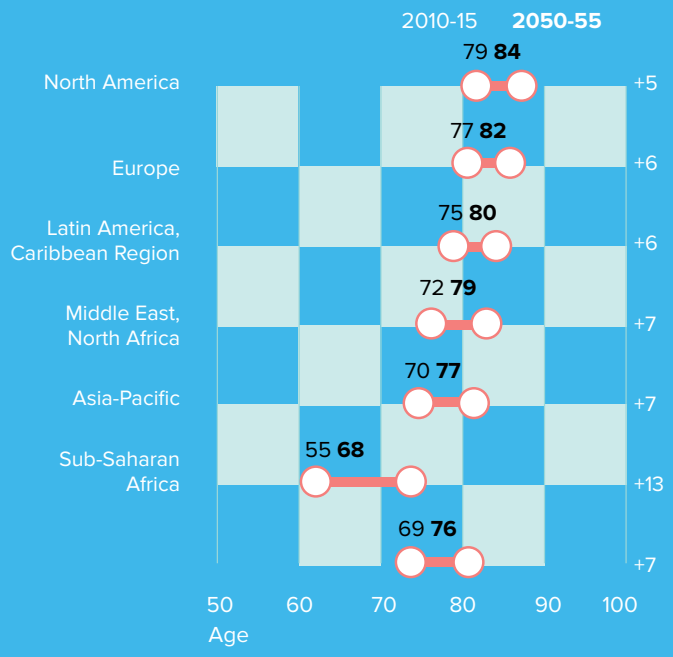


Diagram 13. Life expectancy by region

Data presented in the figure includes the following six countries: Australia, Iceland, Japan, New Zealand, Norway and Sweden

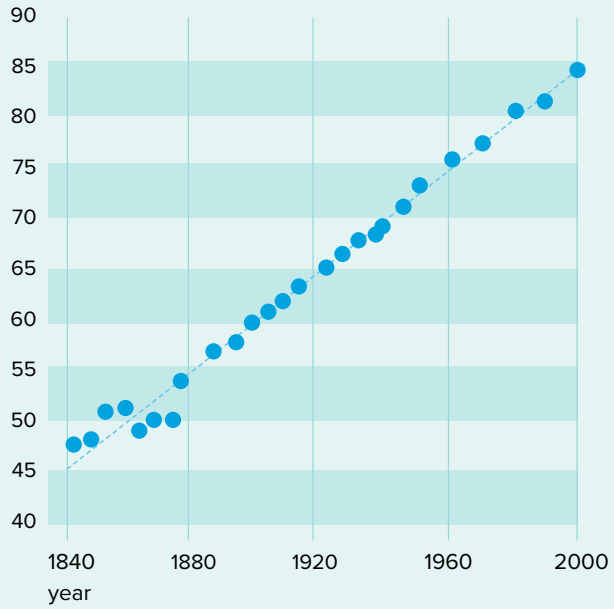


Diagram 14. Increase in the life expectancy of women in developed countries 1840-2000

Source: calculations based on UN data, World demographic perspectives: 2010 edition

Source: J. Oeppen and J. W. Vaupwl, "Broken limits of life expectancy", Science

Changes in the role of women

The role of women in the economy keeps changing. Generally, one can talk about the transition from housekeeping to active participation in the labour market. In most of the OECD countries, attention is focused on women having an equal opportunity to occupy managerial positions and receive equal wages for the same work. In many countries of Asia, Africa and the Middle East, women are only just starting to fully participate in the labour market, while in some countries this participation is still limited. According to the report of the International Labour Organization, urbanization and other social changes will lead to a significant increase in the share of women in the labor market in developing countries[33].

Changes in the childhood model

In modern psychology and pedagogy, there is a trend shifting the perception of childhood as a period of development and preparation for "the real adult life" to the perception of this period of life as a self-valuable, meaningful "here and now"[34]. Children are growing up in a rapidly changing world that is not always understood by adults themselves. It is increasingly difficult to talk about a separate period of "preparation for adulthood," since in most phases of life it will be necessary to constantly learn and re-learn. The new generation ends up in a winning position, since for them most technology is a familiar part of the world in which they were born. This enables them to influence the market by creating demand or even becoming co-creators of the digital world (programmers, video bloggers, gamers, etc.) even before they finish school.

The blurring of childhood boundaries is taking place: previous patterns are no longer suitable for describing this period, while new ones have not yet been formed.

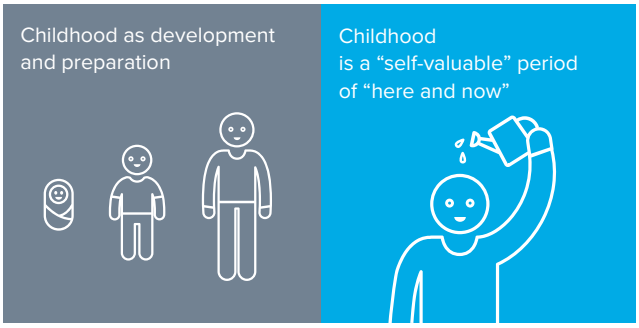


Diagram 15. Changes in the childhood modela

Source: Global Education Futures

[33] Elder, Sara, and Andrea Smith. Women in labour markets: Measuring progress and identifying challenges. International Labour Office, 2010.

[34] Polivanova, K. N. (2016). Childhood in the changing world. *Modern foreign psychology*, 5(2), 5-10

The influence of demographic changes on the workplace

Continuing demographic changes will have a tangible impact on the way jobs look in the future, however this influence will not be as obvious compared to other trends outlined in this chapter.

>> The increase in the number of people aged 60 and older who continue working in their professional niche, creating tension for a new generation of workers.

>> Creation of demand for new services (including training in new skills) by people who continue to live actively at the age of 60+.

>> The increase in the share of working women in countries where parity has not yet been achieved and the equalization of wages in countries where women are already actively involved in the labour market.

>> The increasingly independent role of children in the digital economy (as both consumers and participants in the labour market).

>> The growth in demand for specialists who understand characteristics of the older and younger generations in all areas of the economy.

>> The need for intergenerational communication skills, not only when working with clients, but also when building relationships with colleagues. In the very near future there will be teams in which people under the age of 18 and/or older than 80 will work.

>> The final demolition of boundaries between the lifetime periods “preparation-work-pension” because of demographic changes, which will also lead to the universal recognition of the need to learn and re-learn throughout life.

STUDY THE TREND:

Butler, R. N. (2010). **The longevity revolution: The benefits and challenges of living a long life.** PublicAffairs.

Elder, S. and Smith, **A. (2010) Women in labour markets: Measuring progress and identifying challenges.** International Labour Office.

Mayall, B. (1994). **Children's childhoods: Observed and experienced.** Psychology Press.

Oeppen, J., & Vaupel, J. W. (2002). **Broken limits to life expectancy.** Science, 296(5570), 1029-1031

Zemke, R., Raines, C., & Filipczak, B. (2000). **Generations at work: Managing the clash of Veterans, Boomers, Xers, and Nexters in your workplace** (p. 280). New York, NY: Amacom.

Polivanova, K. N. (2016). **Childhood in the changing world.**//.2016. T. 5.N° 2. P. 5-10. Modern foreign psychology, 5(2), 5-10.

1.6 Network society

The term “network society” was suggested in the 90’s by European sociologists Jan van Dijk and Manuel Castells. They predicted that the expansion of network communication technology will radically change the structure of society and each individual's lifestyle.

In OECD countries, more than 80% of the population[35] is already connected to the global network, and in countries where this indicator is lower, there is a steady growth of users. We are witnessing the expansion of a new network culture, which manifests itself in the changing attitude of people towards work, consumption, leisure and other aspects of life. These changes are accompanied by technological progress, which simplifies distributed resource management and enables us to move away from usual hierarchical administration systems.

Networking

In the world connected by networks, the need to go to an office, follow a consistent schedule, and work for one organization is gradually vanishing. More and more people are becoming freelancers[36]. All sorts of labour markets, from programmers and copywriters to plumbers and nannies, enable direct contact between the customer and the performer. The feedback system helps to build trusting relationships and virtually eliminates the need for centralized regulation.

A new engineering culture is emerging in the network world. Makers enjoy the accessibility of new technologies and create amateur projects, some of which are becoming prototypes for new industrial products[37].

More and more people decide to work for themselves and become entrepreneurs[38], and the Internet helps them to promote their products or allows them to completely switch to the digital economy. The working place of a freelancer and an entrepreneur can be their own living room or a cafe anywhere in the world with reliable Internet access. But many of them prefer working in co-working spaces, where they get access to office infrastructure for a moderate fee, but most importantly, they end up being surrounded by like-minded people.

Intelligent consumption

By constantly participating in the exchange of information with each other and with manufacturing companies, we form a new attitude towards consumption and production.

Ericsson corporation emphasizes five main types of consumption that arise in a network society[39]:

>> Personalized consumption (a consumer adjusts the goods or services to suit himself or herself).

>> Joint creation (a consumer is so seriously involved in the design and production of the product that the line between the consumer and the manufacturer gets blurred).

>> Crowdfunding (consumers take part in financing the business to create new products and services. Consumers not only invest their money but also become participants of the community interested in the implementation of the project).

>> Demand for craftsmanship (against the background of increased mass production, consumers want not just unique goods, but rather objects created by a specific person, with a specific history and meaning).

>> Joint consumption (the purchase of goods for general use or renting products for a short-term period).

[35] OECD Internet users in 2016 Q4 by Internet World Stats
[36] What the Rise of the Freelance Economy Means for the Future of Work. Huffingtonpost.com
[37] Impact of the Maker Movement 2013. By Deloitte
[38] Behind the rise of entrepreneurship. Fortune.com
[39] Disruption of the Old Consumption Logic. Ericsson.com

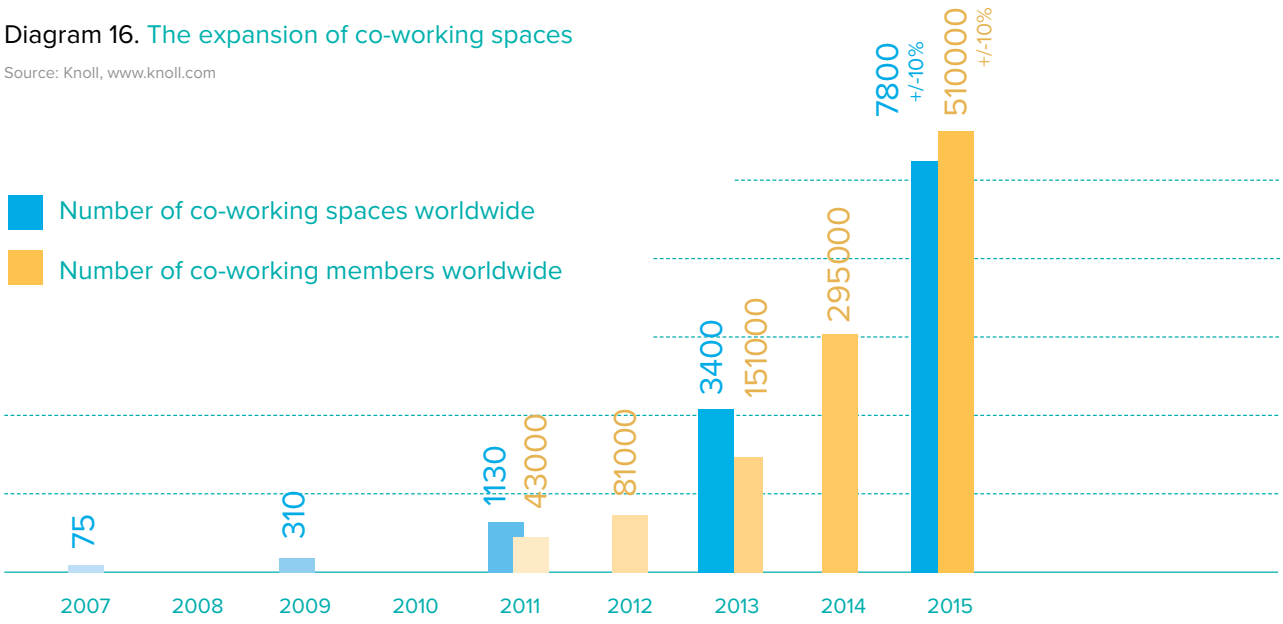
The rapid expansion of the sharing economy reflects the ideas of the network society. Consumers want to use specific products only when they need them and are not willing to own them the rest of the time. This way, they reduce their ecological footprint and reduce the cost of maintaining the property[40].

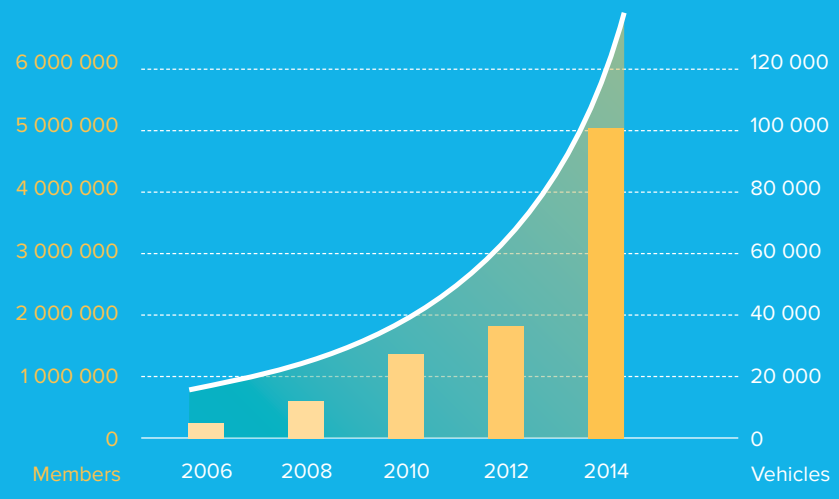
The most apparent breakthrough has already occurred, owing to the expansion of car sharing services. Car sharing can be seen in the majority of big cities of the world. The development of driverless vehicles will increase the convenience of such programmes, since a car can drive up to the right location by itself at any moment.

[40] Hamari, J., Sjöklint, M., & Ukkonen, A. (2016). The sharing economy: Why people participate in collaborative consumption. Journal of the Association for Information Science and Technology, 67(9), 2047-2059.

Diagram 16. The expansion of co-working spaces

Source: Knoll, www.knoll.com





Data includes the following 33 countries: Australia, Austria, Belgium, Brazil, Canada, China, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, India, Israel, Ireland, Italy, Japan, Malaysia, Mexico, Netherlands, New Zealand, Norway, Portugal, Russia, Singapore, Spain, South Korea, Sweden, Switzerland, Turkey, United Kingdom, and United States.

Diagram 17. The expansion of carsharing

Source: TSRC, Winter 2016 Carsharing Outlook

Game society

Games have become one of the key elements of the new network society. According to different estimations, 2.2 to 2.6 million people play various video games[41,42].

As soon as in 2013 a famous computer game designer Eric Zimmerman published “Manifesto for a Ludic Century”, in which he pointed out that games have a great cultural history, and the digital age simply gives them a chance to go back to where they belong.

The process of gamification has long gone beyond the entertainment industry and now affects all areas of life — from education and relationships, to building a career and society[43]. Games, unlike most other forms of cultural broadcasting, have an important characteristic that reflects one of the key values of the network society: they are interactive, they imply an active consumer participation, and they encourage co-creating.

The game Pokemon Go, which we have already mentioned in this report, is a good example of how games become a reason for joint activity in the real world and can offer an understanding of the prototype of a ludic society[44]).

A new approach to business

Old hierarchical management systems find it hard to survive in a network society. They are replaced by new forms of communities and teams based on the integration of local experience, global vision and integrated approaches to activities that unite creative and work endeavours. In the corporate sector this trend manifests itself in the expansion of new management schemes.

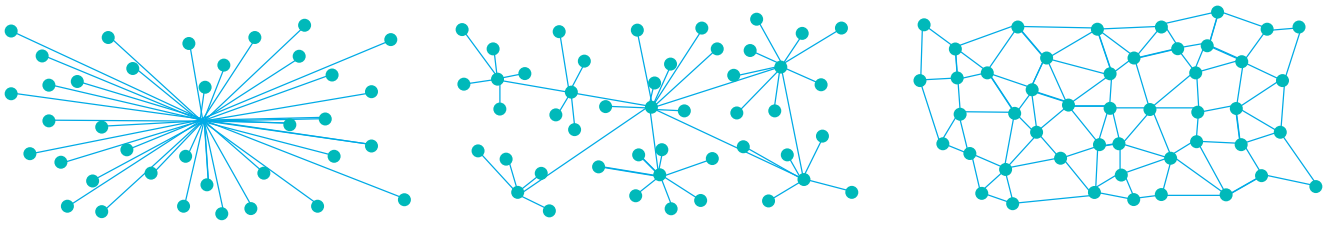
>> Agile-management[45] is the approach that involves flexible project management to create a functioning product using a series of prototypes. It is based on the free co-authorship of participants of the process. This approach originated in the field of development of IT-products, but eventually became applicable beyond the IT field.

>> Holocracy[46] — is an organization management system in which authority is distributed over a network of self-optimizing teams. The main focus is on creating common rules, identifying individual roles, organizing small teams and building interaction between them.

>> Turquoise organizations[47] — this approach is based on the premise that organizations are capable of evolving into self-managed structures. These new organizations fulfill their global missions and each employee invests in it as much as he or she can.

New organizations and communities emerge as a network of interconnected individuals and small groups, creating an environment for the full realization of an individual. External motivation in the form of bonuses and career growth allows for the development of internal motivation to create and implement joint large-scale projects for the benefit of society.

[41] Global Games Market Report. Newzoo.com
[42] Internet Trends 2017. Code Conference. Kleiner Perkins (p 81)
[43] Walz, S. P., & Deterding, S. (Eds.). (2015). **The gameful world: Approaches, issues, applications.** Mit Press.
[44] Mäyrä, F. (2017). Pokémon GO: Entering the Ludic Society. Mobile Media & Communication, 5(1), 47-50.
[45] Agile Alliance
[46] Holocracy.org
[47] ReinventingOrganizations.com



Centralised Decentralised Distributed

Diagram 18. Centralized, decentralized and distributed networks

Source: Baran, P. (1964) On Distributed Communication. RAND

Blockchain and the power of networks

Blockchain technology lies in the base of the well-known Bitcoin cryptocurrency but it has the potential to be applied in all areas of data management. This technology enables the creation of distributed databases with an extremely high degree of security without central nodes or verification agents. In databases built on Blockchain, all information is stored by many users at the same time, making it extremely hard to destroy. Each transaction is confirmed by numerous participants, which protects data from manipulation. In Blockchain, there is no boss, there is not even a responsible secretary or central data storage node — this is the protocol based on which networks of the new generation will grow.

Network society implies the elimination of various intermediaries during the registration or recording of ownership of any property, as well as while closing any transactions with tangible or intangible assets. This will lead to significant changes in national and corporate bureaucracy and full-scale democratization of the finance sector.

STUDY THE TREND:

Castells, M. (2011). **The rise of the network society: The information age: Economy, society, and culture.** John Wiley & Sons.

Gunasekaran, A. (2001). **Agile manufacturing: the 21st century competitive strategy.** Elsevier.

Laloux, F. (2014). **Reinventing organizations: A guide to creating organizations inspired by the next stage in human consciousness.** Nelson Parker.

Makimoto, T., & Manners, D. (1997). **Digital nomad.** Wiley.

Robertson, B. J. (2015). **Holacracy: The revolutionary management system that abolishes hierarchy.** Penguin UK.

Sundararajan, A. (2016). **The sharing economy: The end of employment and the rise of crowd-based capitalism.** MIT Press.

Tapscott, D., & Tapscott, A. (2016). **Blockchain Revolution: How the Technology Behind Bitcoin Is Changing Money, Business, and the World.** Penguin.

Walz, S. P., & Deterding, S. (Eds.). (2015). **The gameful world: Approaches, issues, applications.** Mit Press.

1.7 Acceleration of technological and social changes

Acceleration of technological and social changes is a meta-trend that appears in all six key trends that are described above in this chapter. The world is not just changing, it is changing at an increasing rate.

One of the first people to announce the problem of technological and social acceleration in society was Alvin Toffler in his book “Future Shock” in 1970. Toffler analyzed the problem of the negative effect of accelerating changes on society. Changes make people feel cut off, suffering from “the crushing stress and loss of orientation,” and shocked by the future.

Acceleration of the rate of technological growth is clearly visible when we compare the speed of the expansion of new technologies in the 20th and 21st centuries.

While we needed decades for mastering electricity since its invention, widespread distribution of smartphones in developed countries only took a few years.

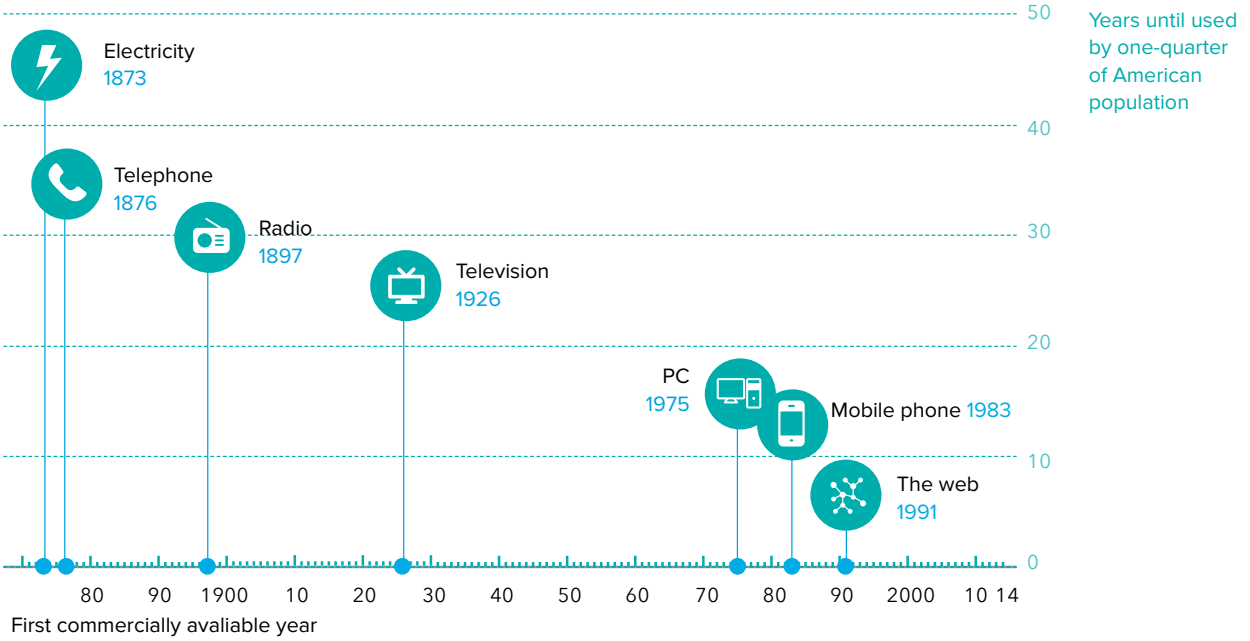
In the 1990s, the mathematician Vernon Vinge, followed by the futurist Raymond Kurzweil, announced that the increase in the speed of development and introduction of technology in the coming decades most probably can lead to technological singularity — a hypothetical moment, after which technological progress will become so fast and complex that it will be beyond the reach of the human understanding.

By this time, there will be a fully-fledged, self-developing artificial intelligence that is going to take responsibility for managing technological and social development. Although this statement seems to us rather controversial, the very fact of accelerating the rate of social and technological change is beyond doubt.

Russian astrophysicist Alexander Panov and Australian scientist-evolutionist Graeme Snooks have come to the conclusion, independently of each other and based on different data sets, that

Diagram 19. Introduction of technology in the USA

Source: Singularity.com



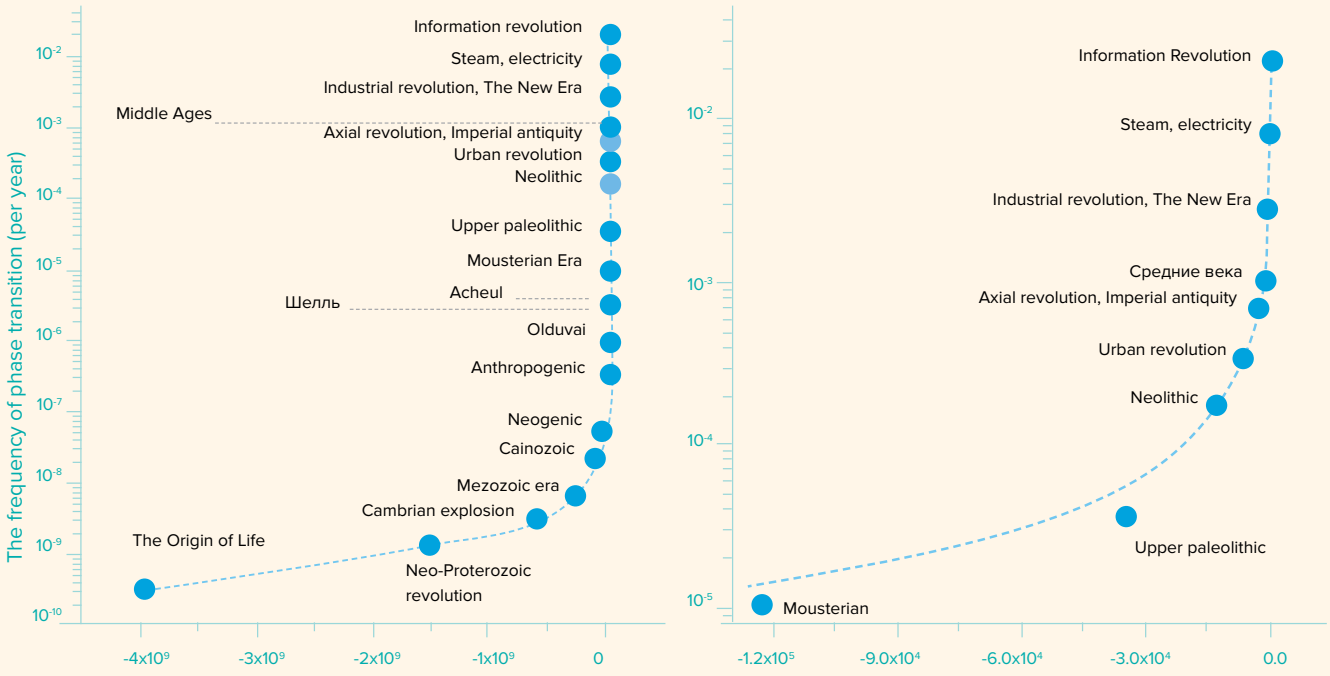


Diagram 20. Panov-Snooks curve

Source: Panov A.D. The singular point of history // Social Sciences Today, 2005b, #1: 122-137

biological and technological evolution is accelerating and that this is an inalienable quality of evolution itself.

In 2008, Russian cultural anthropologist Akop Nazaretyan combined the data of these studies and suggested a “Panov-Snooks curve”, reflecting accelerating growth on the relevant charts.

Given this meta-trend, it is worth taking into consideration that all the changes described in this chapter will occur faster than similar transformations that occurred in the past. Mankind is facing a very challenging task, which is to overcome the increasing rate of change.

STUDY THE TREND:

Kurzweil, R. (2005). **The Singularity is Near.**
Mokyr, J. (2011) **The gifts of athena: Historical origins of the knowledge economy**
Panov, A.D. (2005) **Scaling law of the biological evolution and the hypothesis of the self-consistent Galaxy origin of life. Advances in Space Research, 36 (2), pp. 220-225**
Snooks, G.D. (2008) **A general theory of complex living systems: Exploring the demand side of dynamics. Complexity, 13 (6), pp. 12-20.**
Toffler, A. (1970). **Future shock**. New York: Bantam
Vinge, V. (1993). **The coming technological singularity: How to survive in the post-human era. Whole Earth Review**, winter 1993.
Kovalevitch D.A., Schedrovitsky P.G. (2016) **The conveyor of innovations**

1.8 A brand complex new world

Summing up this section and analyzing the trends described, we believe that the economy of the future is going to face some significant changes. We have picked out the growing and stagnant segments that determine the structure of this new economy.

Growing segments

>> Autonomous cyber-physical production
>> Driverless vehicles
>> Total connectedness
>> Hybrid reality
>> Localization of production
>> Horizontal structures of management
>> Eco-friendly production and services
>> Highly-personalized services
(in the healthcare, beauty and sport industries, education and other areas)
>> Ludic community practices, naturally uniting work, creative work and day-to-day life

Stagnant segments

>> Manual labour in most manufacturing and numerous service operations
>> Centralization of infrastructure, management and development
>> Cities as centres of mass industrial production
>> Routine intellectual work and mediation (employment in sales, marketing, logistics, finance, IT support, etc.)
>> Large industrial plants as large employers
>> Strict boundaries between work, creative work, education, diversion and life

New challenges for humans

Each participant in the economy of the future will exist in a world that is way more complex than the one we are used to. This will lead to the emergence of a new class of complex tasks that humanity and its individual representatives will have to solve.

Now this world is increasingly described with the term VUCA[48].

[48] Bennett, N., & Lemoine, G. J. (2014). What a difference a word makes: Understanding threats to performance in a VUCA world. Business Horizons, 57(3), 311-317.

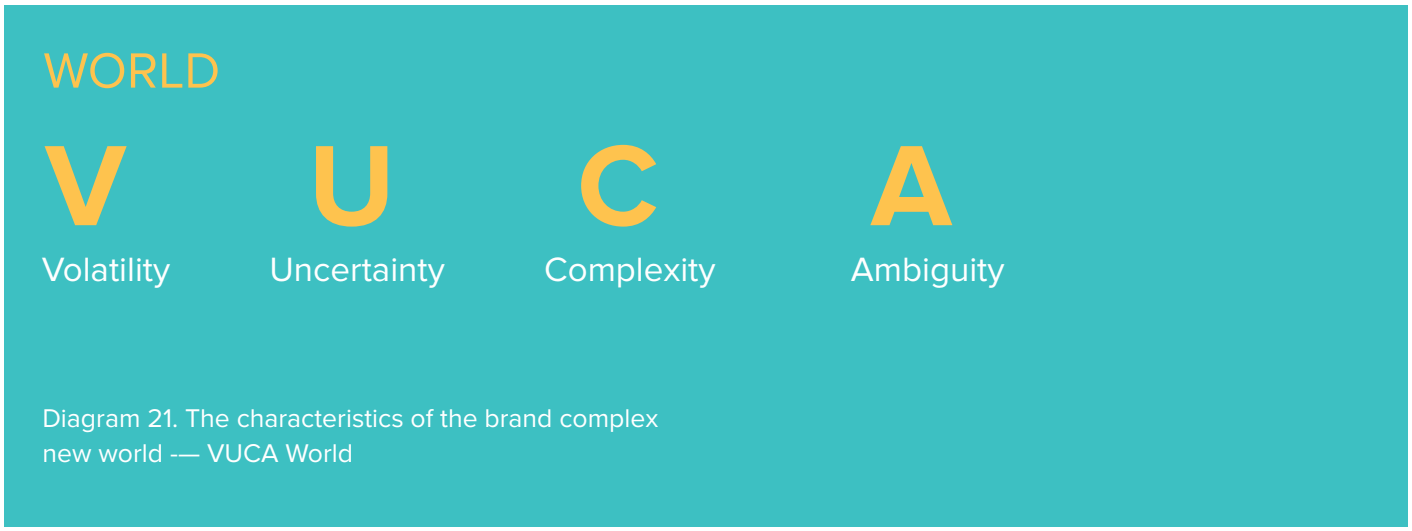


Diagram 21. The characteristics of the brand complex new world -— VUCA World

The world of complex systems

We exist in a world of complex systems, and every day we increase their complexity.

As a result, the interaction of many components leads to the emergence of new characteristics that cannot be reduced to the characteristics of the subsystem level.

The expansion of self-managed agents (machines, drones, robots, virtual assistants), constantly making independent decisions, increases the complexity of systems, which we will have to work with.

yandex.ru/maps

THE REGULATION OF CAR TRAFFIC IN A METROPOLITAN AREA is a typical example of a complex problem in which many individuals compete for a limited resource.
This system has all the qualities that were pointed out by soviet cyberneticist Rastrigin[49]:

>> the absence of a mathematical description or algorithm;
>> “noisiness” due to the abundance of secondary processes;
>> “intolerance” to control, the existence of one's own “intention";
>> non-stationarity, evolution in time;
>> non-reproducibility of experiments with it.

[49] L.A. Rastrigin, L.A. (1981). Adaptation of complex systems: Methods and applications.

"Every success of our knowledge makes more problems than it solves"[50]

As civilization develops, the development of technology addresses challenges that were created by humans themselves.

During most of the history of mankind, technological solutions have emerged in an attempt to solve one of the external problems of survival: protection from cold or from predators, providing oneself with food, or creating new ways of extracting energy or transportation. Each decision of this kind has reduced external threats by increasing the complexity of the “artificial environment” (meaning that there was a negative regenerative connection between threats and the complexity of the “technosphere”). But at the same time, every technological decision, by complicating society, created a lot of internal problems (meaning that there is a positive regenerative connection, a loop of self-enhancement). Weapons to protect against predators appeared, and people started using them to fight each other; people started living in cities, and diseases and poverty spread. Now we live in cities where we are surrounded mostly by inanimate nature and the number of other living species is minimal, meaning that the “interlayer” in the form of the “technosphere” has appeared between us and our natural habitat. At the same time, at the beginning of the 21st century, man himself became the main threat to mankind and even to life on Earth — the main planetary risks are connected to our own activities. We are in a cycle of continuously increasing complexity (see Diagram 22), and the question of our collective success on the planet in this century will be directly related to our ability to “bridle” the growing complexity of civilization.

Nuclear fission is a typical example of such evolution. On the one hand nuclear power allowed humanity to build nuclear-powered icebreakers and reach the North Pole, on the other hand the same power provides an opportunity to destroy life on the whole planet Earth and creates the threat of nuclear terrorism. On a system level this creates two streams of feedback that are affecting the level of complexity. While external threats are decreasing with every new “loop” the internal threats are rising. The system must undergo an evolutionary leap in order to deal with the rising complexity.

[50] Louis de Broglie, a French physicist, awarded the 1929 Nobel Prize in Physics for the discovery of the wavy nature of an electron.

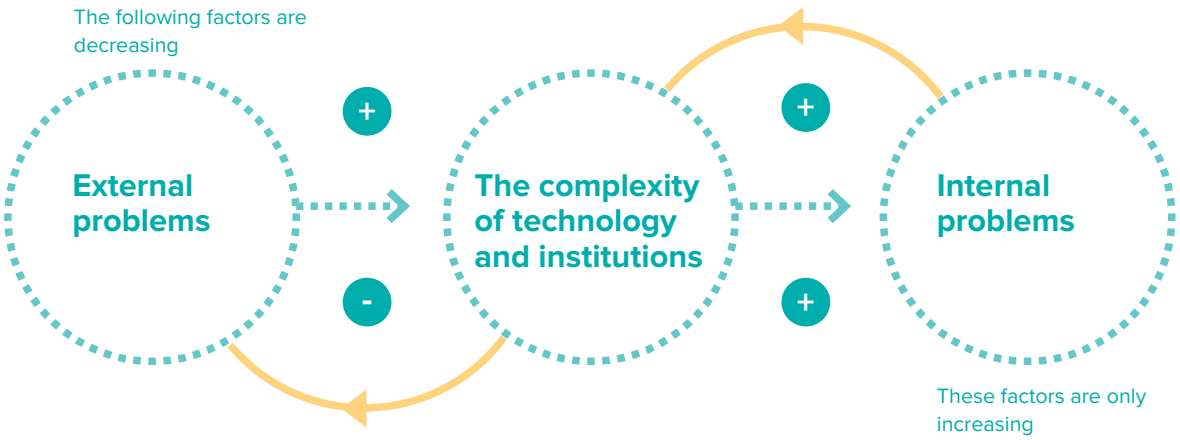


Diagram 22. The logic of the evolution of systems in human society.

Author: P. Luksha

At each stage of technological development, simpler operations are technologically advanced and automated, enabling us to move to a realm of more complex operations. We expect that the replacement of humans from routine work will be accompanied by the emergence of tasks with a new level of complexity.

In the following chapters of our report, we will take a closer look at the impact of trends on jobs in various sectors of the economy. But there are also some common features that will concern all people fulfilling themselves in this world.

In the complex new world:

>> there will be no professions for which skills are acquired at a young age and in the future are not retrained;
>> there will be no simple jobs, meaning the execution of routine operations on a conveyor;
>> there will be no linear hierarchy where the subordinate has no possibility of making a decision and all responsibility falls to management;
>> there will be no routine work behind the computer when it is clear what, from where and to where to copy;
>> there will be no clear boundaries between personal and working time;
>> there will be many new occupations for which there is still no name and which will be constantly changing;
>> there will be work requiring tuning and training in complex systems;
>> there will be horizontal teams working on a common goal;
>> there will be jobs in virtual reality, and augmented reality will become a common phenomenon;
>> there will be an opportunity and even a need to combine creative and professional endeavours.

Welcome to the brand new complex world!

2. Sectoral changes of economy

2.1 Sectors of economy and types of work performed

In order to give a more detailed analysis of the impact of trends on the workplace, we will look at the influence of these changes on various sectors of economy. We will use a model of the economy divided in four sectors[51] — the extractive and manufacturing sectors, the services sector, and the knowledge economy.

Automation, digitalization and other trends will have a strong impact not only on the industrial sector but also on the services sector and knowledge economy. Production efficiency will increase in all sectors but there will be a question about the human role in this economic activity. The impact of trends on the extractive and manufacturing industries will be very similar, so for purposes of our research, the two first sectors can be united. Thus, in this lecture we will focus on the impact of trends on the services sector and knowledge economy.

While observing the impact of trends on sectors of the economy, it is essential to separate two kinds of activity. The first one focuses on standardized production of goods; the second one focuses on unique activity. This division appears to be critical in terms of the industry's demand for people and it shapes a need for skills that workers of the future must possess.

Diagram 23. Sectors of the Economy

DEFINITION USED IN THE REPORT	DEFINITION IN FOUR-SECTOR MODEL	EXAMPLES
Manufacturing	Primary sector	Raw materials extraction, primary processing, production of semi-finished products
	Secondary sector	Manufacturing industry, construction
Services	Tertiary sector	Services, with the exception of those in the Quaternary sector
Knowledge economy	Quaternary sector	Knowledge creation, IT-services, creative economy

Diagram 24. Division of the economy by product type

	MANUFACTURING	SERVICES	KNOWLEDGE ECONOMY
STANDARDIZED OUTPUT	Cyber-physical large-scale industrial manufacturing systems	Digital services with VR+AR and artificial neural network support	Data production and analytics
Examples	Gigafactories, unmanned logistics, on-line sales	Mass entertainment, medicine, accounting, public sector, blockchain-based registries	Analysts, researchers, virtual assistants, neural networks for creating news content, MOOC+
CUSTOMIZED OUTPUT	Customized end-user local manufacturing	Human-centered services	Dealing with chaotic information and complex systems
Examples	3D-Printing, localised manufacturing, neo-craftsmanship, biohacking	Psychotherapy, tourism, fitness, health services	Scientists, social ecosystems curators, and hybrid intelligence teams

2.2 Changes in the manufacturing sector

Automation of the entire value chain

Dominating trends of contemporary industry include automation and robotization. All machines now operated by humans will be automatized. The majority of routine tasks that humans currently accomplish will be taken by robots. Digitalization will allow automatic systems to have access to information accurately describing all aspects of production. A human can no longer operate this large amount of data in real time. Globalization allows producers to distribute their goods in all markets on the planet at the same time. Thanks to large savings in the production scale and to possibilities of global marketing, transnational corporations strengthen their dominance in a mass market, absorbing or driving out national producers.

To achieve maximum efficiency of global value chains, companies can unite their divisions in a cyber-physical system network[52]. Take Nutella Corporation, whose global value chain was described in section 1.3. For this corporation, it means that nuts arriving at a warehouse in Turkey and palm oil extracted in Malaysia will appear in the system in real time; automatic systems will assess the need for one or another ingredient and send them to factories located on different continents closer to the final producer. In factories, autonomous conveyors will accept ingredients and produce the final product. Similar schemes will work with more complicated production as well. Thus, the involvement of humans in logistics and production will be minimal because only cyber-physical systems will be able to achieve a necessary level of coherence.

[51] The model is based on the three-sector theory suggested by Alan Fischer, Colin Clark and Jean Fourastie in the first half of the twentieth century. According to this model, along with economic development, industry moves to a higher level, from primary to secondary, and then to a tertiary sector. Later on, a quaternary sector describing the knowledge economy was added to the sector analysis.

[52] A cyber-physical system is a system with a high-level integration of physical and digital processes, including a large number of autonomous machines in production and transport interacting with each other and the world.

Robots cooperating with humans

At the current level of technology, we will still see robots working together with humans for some time. But most factories establish separate zones where industrial robots work and humans are not allowed. There are separate buffer zones where produce is transferred from the world of machines to the world of humans in order to accomplish corrective or creative tasks.

Some factories develop using the cooperation model and implement cobots[53] — robots made for cooperative work with a human. They are programmed in such a way that they cannot do any harm to a person working nearby. Eventually robots take part in physical tasks, while humans do corrective work on the same conveyer.

Autonomous factories

From a mid-term perspective, the majority of routine tasks on industrial conveyors will eventually go to robots. It will allow us to create fully autonomous factories where physical parametres (temperature, illumination, chemical composition of air, etc.) will not be limited to narrow limits suitable for humans to function.

Robots can work at speeds unavailable to a human, and machine-machine communication protocols allow them to reach a final coherence of actions and maintain a single rhythm. New materials allow autonomous systems to create various complex constructive elements from one raw material. This kind of production is able to revolutionize even agriculture. For example, the automatization of farms in the Netherlands enabled the amount of potato crops collected from one hectare to double, while water consumption decreased by 90% and chemical fertilizer usage became rare[54]. This allows us to place highly effective autonomous farms close to a megapolis.

Иллюстрация: Steve Jurvetson, Flickr.com CC BY 2.0

TESLA FACTORY: A MACHINE CREATING MACHINES

In June 2016, Elon Musk published a new Tesla Master Plan[55]. In addition to the development of electric cars and solar panels for clean energy generation, the company believes it is necessary to create a closed cycle in which machines will be created exclusively by machines.

In subsequent interviews[56] Elon Musk said that a version 0.5 factory had been launched but it's only at a beginning stage. By version 3.0 “this factory will not look like any other, it will be an alien dreadnaught. You cannot invite a human to a conveyor, otherwise you will have to be limited by human speed”. According to Tesla, the introduction of a fully automized factory will allow for an increase in car production twenty-fold.

[53] Co-bot, from English “collaborative robot”. More information: Meet the cobots: humans and robots together on the factory floor, Financial Times

[54] This Tiny Country Feeds the World, National Geographic

[55] Tesla Master Plan, Part Deux

[56] Elon Musk: Tesla's factory will be an 'alien dreadnought' by 2018, Business Insider

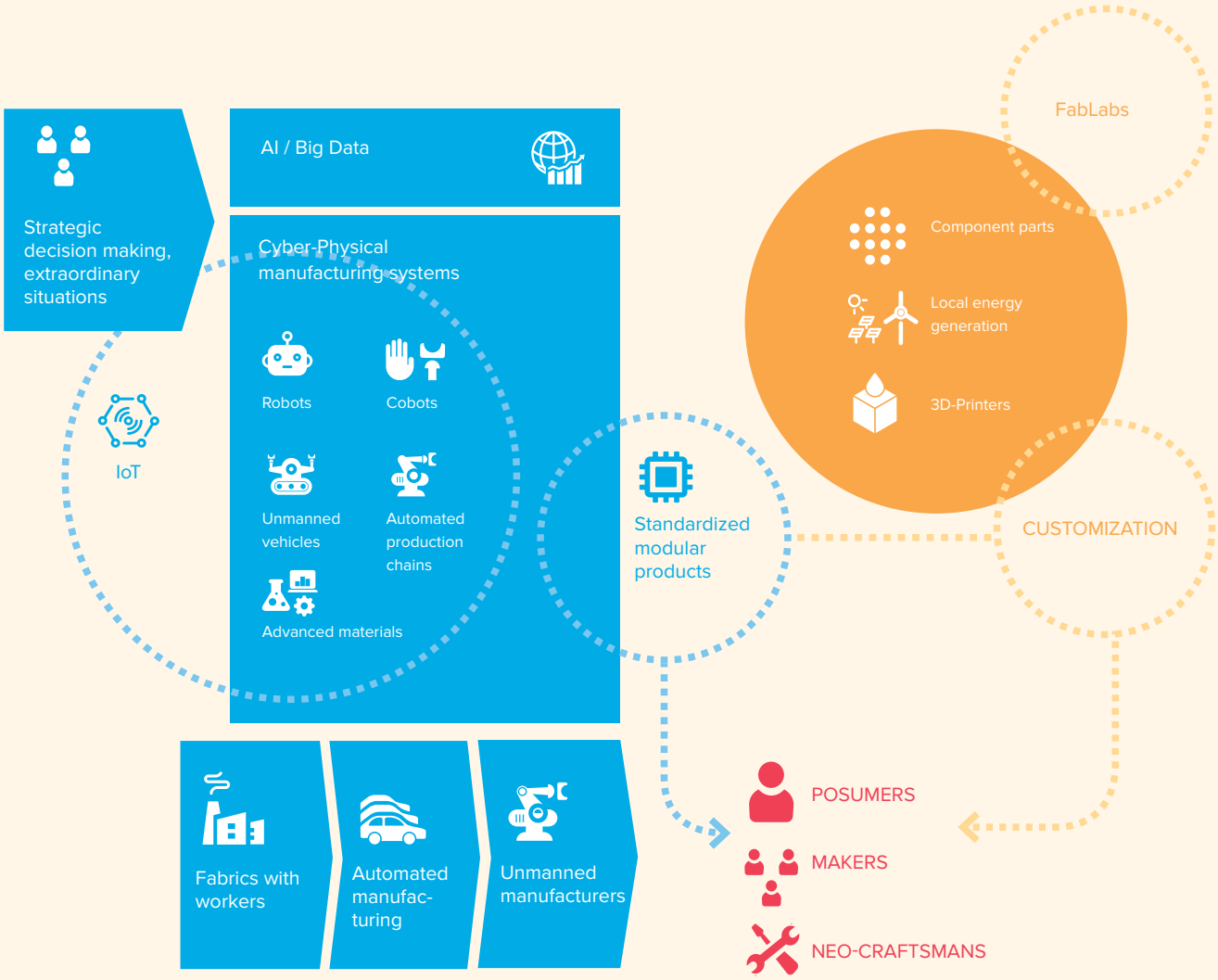


Diagram 25: Manufacturing sector

A human at a factory

A human will step out from a conveyor and will rise several levels up in terms of task complexity. Robotization will affect not only tasks done by ordinary workers, but taskmaster work will be automized as well. Monitoring and making low-level decisions will be the responsibility of artificial intelligence systems controlling the Internet of things and operating large amounts of data in real time.

Humans are to control activity of complex systems, make strategic decisions, supervise implementation of innovation and intervene in case of emergency. Mostly it will be teamwork because a single person cannot deal with the whole complexity of a system and is not able to have the whole spectrum of necessary knowledge and skills. Such teams will assemble for emerging tasks, so the skill of quickly finding of a common language will be important, as well as uniting different ways of looking at complex systems.

In this scenario, most interventions in factory work will be implemented without direct physical contact, but rather through the remote control of specialized robots. Future factories will work at a high caliber of performance and there will be a high level of production per employee.

Creative production

In spite of this, the production sector will not become absolutely unmanned.

Firstly, the demand for customization of standardized products will grow. Secondly, thanks to technological progress, there will be a possibility for full-fledged local production. This is primarily an additive production technology where contemporary 3D-printers work. This technology is complemented by the development of local possibilities for electricity generation and the availability of components.

Currently a new class of consumers is emerging, which is called prosumers[57]: they participate in the production of unique or customized products, the creation of which would be too expensive or entirely impossible within the framework of mass production. One of the emerging elements of a network society is communities of makers — amateur engineers who collect equipment for themselves or their network.

In a world where all products are standardized and available, the demand for unique things created by particular masters[58] will grow, from ceramics and jewellery to clothing and furniture.

Integration of production and service

We should also note the trend of uniting production and the services sector and creating a common product experience. A report by the Organization for Economic Co-operation and Development titled “The next production revolution"[59] suggests the term “manu-services” — it describes the production of a good accompanied by unique services. This makes it possible to establish a long-term relationship between a producer and a consumer: more often consumers do not simply buy a product but also subscribe to services which accompany it.

[57] A word prosumer is made by uniting English words producer and consumer. It defines a person who takes an active part in the production of goods and services which he or she consumes himself or herself. More information — Ritzer G. (2015). Prosumer capitalism. The Sociological Quarterly, 56(3), 413-445.

[58] Handmade 2.0, The New York Times Magazine

[59] Enabling the Next Industrial Revolution, OECD

2.3 Changes in the services sector

The automation of mass services

As for various mass services (healthcare, education, entertainment or finance), human activity is swiftly replaced by software and hardware systems based on artificial intelligence and the Internet of things. This also affects working with clients (front-office) and inner work (back-office). Inner work in these sectors often includes routine intellectual operations — for example, analysing and processing questionnaires and other data. The current pace of digitalization and the development of artificial intelligence allows us to fully automize this activity and in a number of cases to significantly improve performance.

A computer can successfully assess applications for a loan, check homework or monitor dynamics of health indicators. For example, since 2013, artificial intelligence IBM Watson has been successful at diagnosing cancer. The programme succeeds in detecting cancer with 90% accuracy, whereas a doctor's accuracy is only 50%[60].

Working with a client requires less and less direct physical contact. Currently in many countries, you can open a bank account and make all operations without any physical contact with staff. For now, it is still possible to choose whether you communicate with a real human or with software, but the swift development of artificial intelligence systems is erasing this line.

Even now there are cases where digital assistants manage to fully mimic a human — for example, a teacher's assistant. In the future, digital assistants will be able to offer an even higher level of service because they will have permanent access to a large amount of data that is inaccessible to humans.

[60] IBM's Watson is better at diagnosing cancer than human doctors, WIRED

[61] A professor built an AI teaching assistant for his courses, Business Insider

GEORGIA INSTITUTE OF TECHNOLOGY PROFESSOR ASHOK GOEL runs a popular course about artificial intelligence. In addition to 50 students attending the course full-time, nearly 200 students take part in it online. During a whole semester, an assistant named Jill Watson helped the professor to answer students' questions. It was only close to the end of the term that some students started to doubt whether this was a human and not artificial intelligence. The main reason for the students' doubt in the assistant's "humanity" was the extremely high speed of response and readiness to help at any time.
The digital assistant continues to help professor Goel but now it uses a new alias so that students do not to know for sure if they are communicating with a human or a machine.

Unmanned logistics

The modern global economy relies on well-built logistics, in which millions of people are engaged. Now this sphere is undergoing enormous changes. Digitalization allows for the tracking of cargo anywhere on the planet and the coordinating of all transportation with minimum involvement of humans in planning freight traffic.

Major changes are expected in long-haul trucking. Driver labour costs are an important part of the budget and risks related to human factors are enormous. At the same time, the vast majority of the route lies on a highway, in conditions with which artificial intelligence systems can already cope. Unlike a human, a computer does not get tired and can effectively work both day and night.

Currently, various systems of drone trucks are already being tested on the roads. In the mid-term perspective, humans will not be totally excluded from controlling machines, but the degree of their participation will decrease significantly.

A Californian company called Starsky Robotics developed a system which provides the autonomous movement of trucks on a highway and remote control by a human in case of deviation from the road[62]. In this scenario, "the driver" is at a desk in the office and looks after several cars, taking control if necessary.

In Europe, there has been successful testing of cargo caravans[63], in which humans control only one car with autonomous trucks following them. Autopilot can keep a very short distance during the entire duration of transportation. Apart from saving on drivers' salaries, this method of transportation reduces air resistance and cuts costs as well. All these systems imply a dramatic increase in productivity, which means that one person can control cargo in amounts exceeding current figures several times.

Unmanned cargo transportation is only the beginning of the logistic sector's automation. One may expect the majority of cargo logistics to be automatized: products will be sorted at robotized warehouses and will be delivered to the final customer by drones.

In parallel with the cargo sector, autopilot will be introduced to taxi and car sharing businesses. The implementation of mobile platforms has already dramatically changed the passenger transportation market, having removed operators and made the occupation of a taxi driver available to every owner of a car suitable for safe passenger transportation.

Now Uber, Lyft and other similar companies are already testing driverless taxis on the streets of ordinary cities[64]. The introduction of unmanned logistics meets obstacles in the form of law regulations, which demand that humans participate at certain stages. These limitations are most likely to disappear first in the cargo sector, and then in passenger transportation.

Global digital entertainment

We live in an era of global entertainment. Millions of people worldwide watch the same TV series and movies produced with the increased involvement of digital technology.

Video games will remain one of the entertainment industry's[65], main drivers officially recognized as sport[66]. Virtual reality will remain a niche hobby for a while. In order to provide access to it, special centres will be created.

We are to expect a swift development of games and applications based on the technology of augmented reality[67]. The digitalization of the entertainment industry implies that one product developed by a small team reaches millions of consumers worldwide. For example, Valve, which created and now supports the world's biggest game platform STEAM and develops the popular computer games Half-life, Counter-Strike, and Dota 2, has only about 360 employees[68]. At the same time, hundreds of thousands of people play Dota 2 on STEAM worldwide every day[69], and there are up to 9 million people every second on the platform.

Human-oriented service

In the face of increasing digitalization and automation, the demand for services from which clients have real contact with a person will grow. An automated coffee machine can make good coffee but it will not replace a good barista who can keep a conversation going.

In the future, more services oriented on the replenishment of human contact in the automatized world will appear. In some places, technology usage will be purposefully limited in order to shift focus to communication between people[70].

Human services will integrate with digital applications to increase the availability and effectiveness of services. Thanks to the synergy of mass services such as Airbnb and the particular individual offerings of final house-owners, a consumer gets an experience comparable or superior to the one a client would get using the services of hotel businesses.

[62] This Driverless Truck Startup Is Putting Human Drivers to Work, Fortunee
[63] European Truck Platooning
[64] Uber launches first self-driving taxi fleet in US, Financial Times
[65] The Pulse of Gaming, Accenture
[66] Video Games May Be a Part of the 2024 Olympics, Fortune
[67] Why Virtual Reality Developers Think AR is Going to Be Bigger Than VR, Digital Trends
[68] Valve denies wrongdoing in skin gambling, PC Gamer
[69] An ongoing analysis of Steam's concurrent players.
[70] Some cafes are banning wi-fi to encourage conversation, BBC

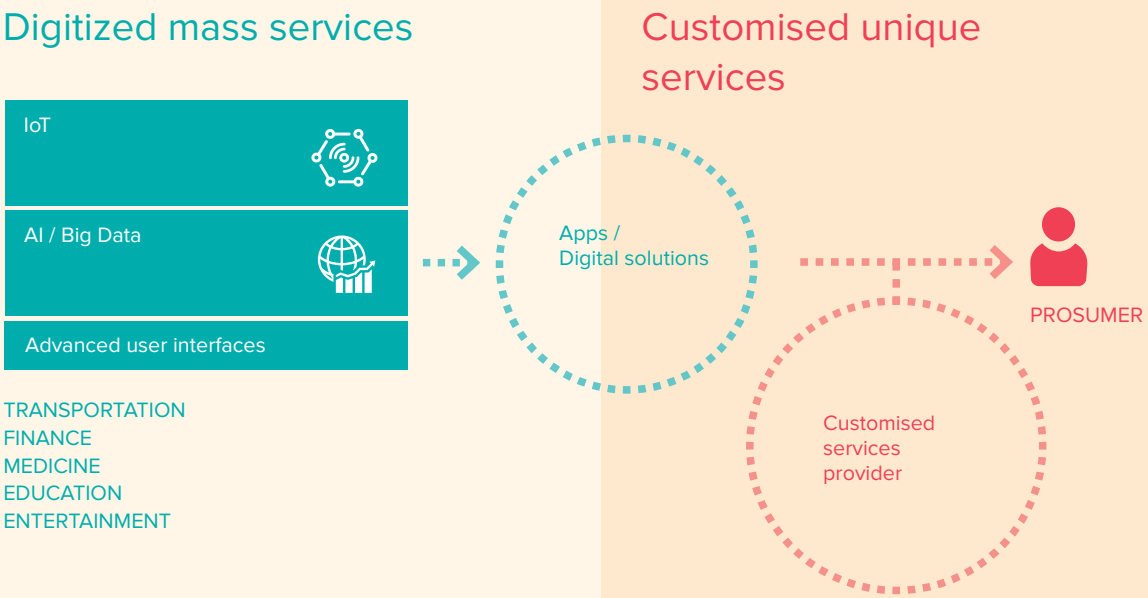


Diagram 26: Services

2.4 Changes in the knowledge economy sector

Growth of complexity

Together with the development of computer technology, automation and the replacement of human labour with machines take place in the sphere of intellectual work as well. However, in the sphere of the knowledge economy, the key trend changing the workplace landscape will not be the replacement of humans by computers, but the growth of the complexity of tasks.

Together with the development of computer technology, automation and the replacement of human labour with machines take place in the sphere of intellectual work as well. However, in the sphere of the knowledge economy, the key trend changing the workplace landscape will not be the replacement of humans by computers, but the growth of the complexity of tasks.

Operational analysis of huge volumes of information and structuring of big data requires a special approach: people working in the knowledge economy sector will need to work with hybrid super-systems which will include teams of people and artificial intelligence-based systems.

Hybrid Intelligence

Scientists used to make an effort to obtain new information, but now we are already in the age of overabundance of information and information overload[72]. A human can no longer succeed in filtering and analyzing all the information, and thanks to digitalization and globalization, volumes of available information will increase dramatically.

[71] Fraser, A. G., & Dunstan, F. D. (2010). On the impossibility of being expert. BMJ, 341, c6815.

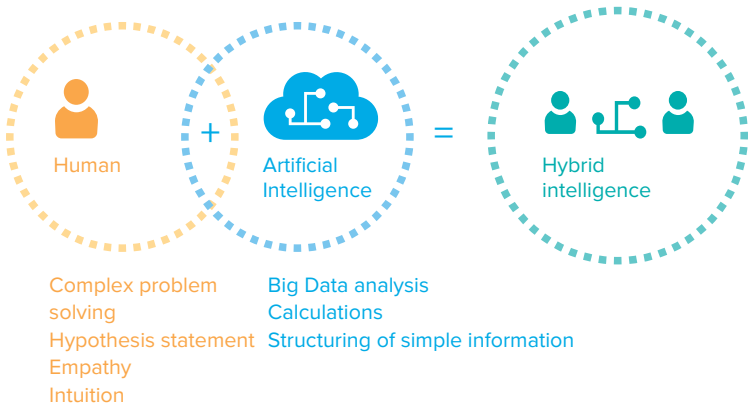
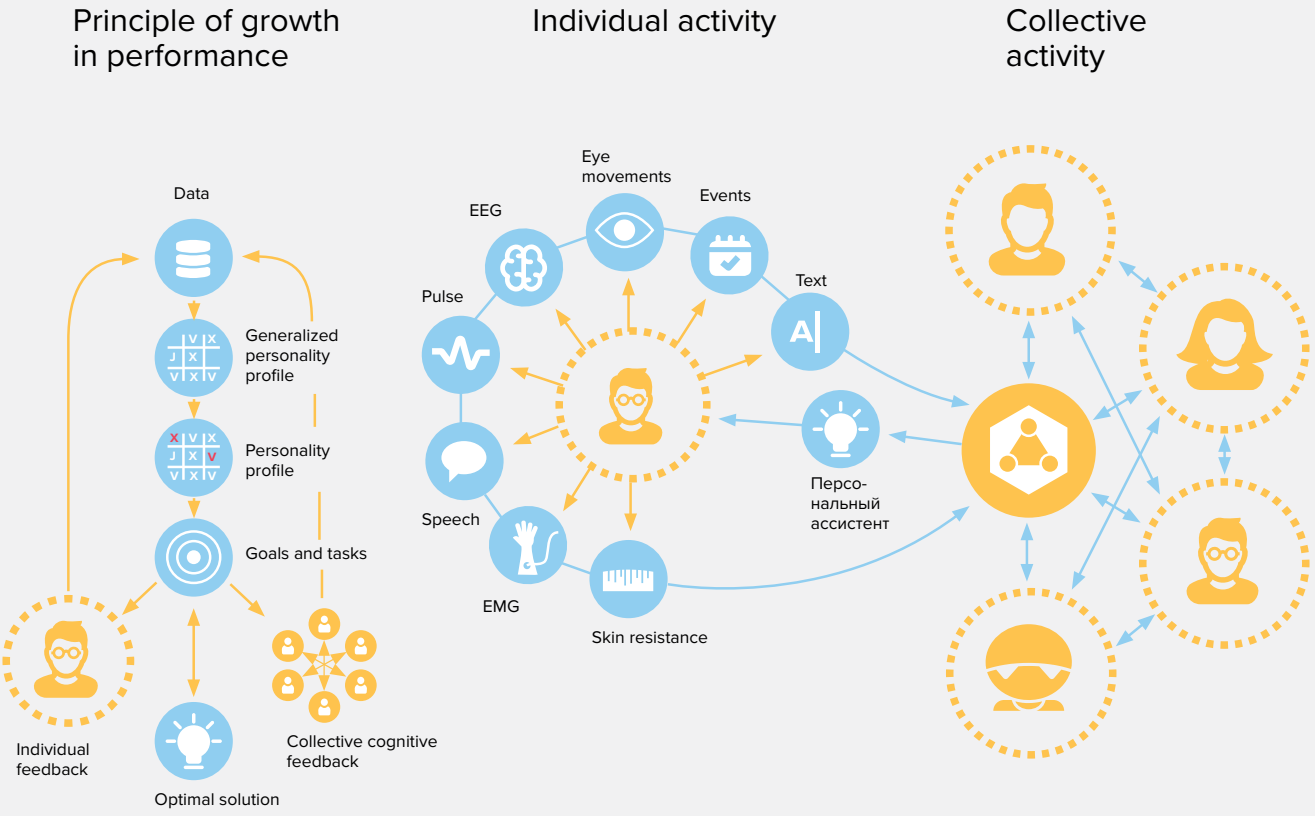


Diagram 27: Hybrid intelligence

Источник: Рабочая группа Нейронета

Diagram 28: Collective hybrid intelligence



Source: "Virtual Collaborative Assistant". Speech to National Technological Initiative project office (2017). Timour Shchoukine, NakedMinds Project Laboratory

For example, thanks to the development of electronic translators, language is becoming a small obstacle to scientific interaction. In the close foreseeable future, the role of hybrid intelligence will grow[73]: we'll be able to use virtual assistants for primary data processing and gradually teach them to accomplish more and more difficult tasks.

IN 2010, CARDIOLOGIST ALAN FRASER AND MEDICAL STATISTICS PROFESSOR FRANK DUNSTAN published an article "On the impossibility of being expert"[71]. Having analyzed statistics of scientific publications on medical topics, they came to a disappointing conclusion: to keep abreast of all published research, a specialist has to read 30-40 articles a week, which is simply impossible.

Teamwork

Currently, leading scientific projects (for instance, CERN or Human Brain Project) are implemented through the partnership between scientific organizations from dozens of countries. The Internet makes the results of experiments available to all participants of the project.

The Internet makes the results of experiments available to all participants of the project.

Due to a growing complexity of tasks, intellectual work will be more often done in teams, members of which will complement each other's skills and knowledge[74]. We should expect an extension of various systems of amplified collaboration environments[75] and virtual collaborative assistants. A significant breakthrough will happen with the extension of the NeuroNet — interaction between people through a direct transition of brain signals through neuro-interfaces.

[72] Ruff, J. (2002). Information overload: Causes, symptoms and solutions. Harvard Graduate School of Education, 1-13.

[73] Kamar, E. (2016) Directions in Hybrid Intelligence, Proceedings of the Twenty-Fifth International Joint Conference on Artificial Intelligence

[74] Science works best when it is open, World Economic Forum

[75] Leigh, Jason, et al. "Amplified collaboration environments." VizGrid Symposium. 2002. Stevens, R., Papka, M. E., & Disz, T. (2003). Prototyping the workspaces of the future. IEEE Internet Computing, 7(4), 51.

Open Science

Contemporary projects of the citizen science and wiki-platforms currently unite millions of users. Special software and social protocols create a digital environment for the optimum usage of “crowd wisdom"[76]. Citizen science implies a full discovery of raw data and everyone's involvement in primary data analysis, including amateur scientists.

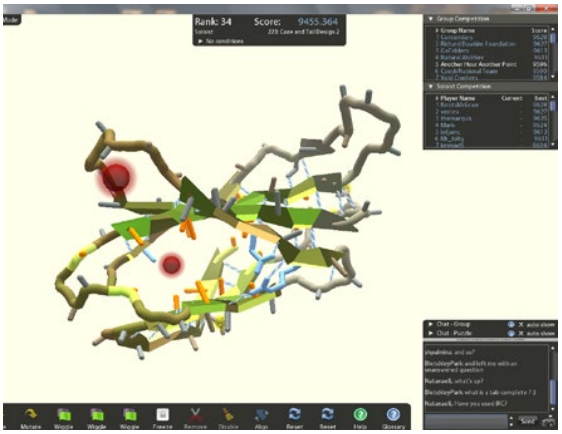
Such projects as Fold It, Polymath, Galaxy Zoo or Higgs Hunters already allow ordinary people to take part in advanced scientific work. At a later stage, this activity will be coordinated by artificial intelligence systems providing the optimum distribution of tasks between participants and liberating them from the simplest ones.

New management skills

In the network society, horizontal management systems will play an increasingly greater role. Extension of hybrid collective intelligence will cause a further transformation of management skills.

On a local level, professional community managers and facilitators will work to identify the real needs and opportunities of communities — after that, the data will accumulate on a regional level.

Over time we may expect an emergence of technical and social protocols of agreement of interests on a global level.



Animation Research Labs, University of Washington — CC BY-SA 3.0

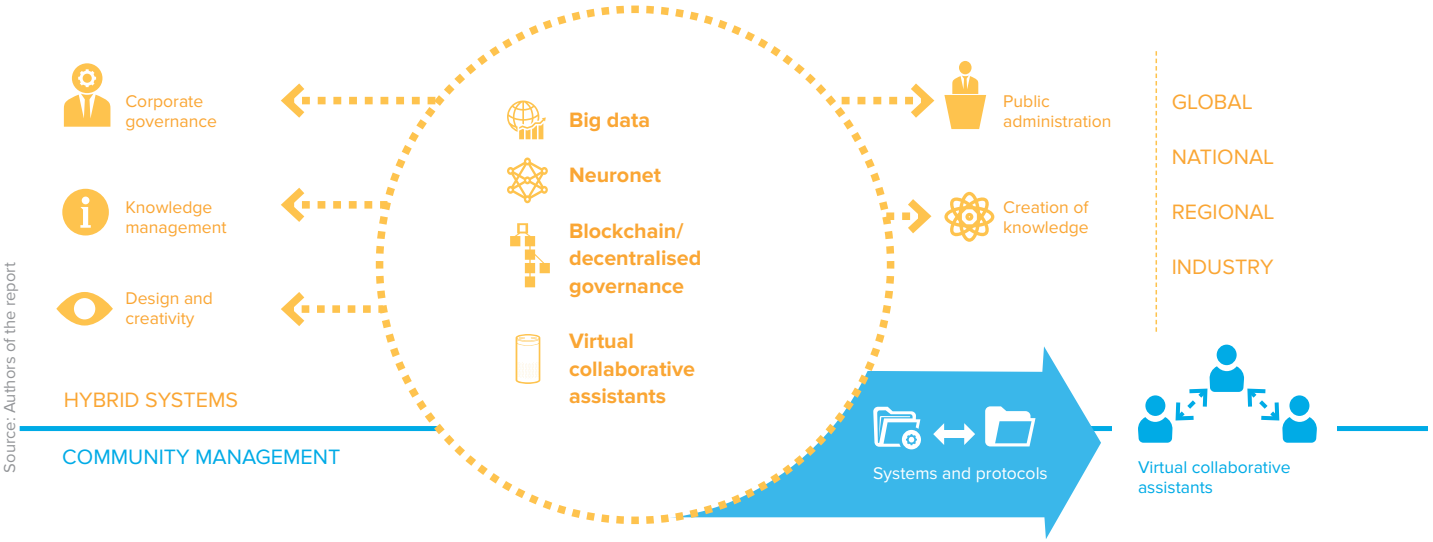
WASHINGTON UNIVERSITY'S GAME CALLED FOLD IT allows people to play protein folding and to suggest an optimal structure for the chosen protein. Players of different ages succeed with the task, score points, compete with each other and enjoy themselves . Scientists analyze the best solutions and obtain data. Searching for this information was an extremely time-consuming task. In 2011, players helped to decode a structure of ape virus causing AIDS. Scientists had been working on that task unsuccessfully for 13 years[78].

[76] Kittur, A., & Kraut, R. E. (2008, November). Harnessing the wisdom of crowds in wikipedia: quality through coordination. In Proceedings of the 2008 ACM conference on Computer supported cooperative work (pp. 37-46). ACM.

[77] Gamers Unravel the Secret Life of Protein, WIRED

[78] Foldit Gamers Solve Riddle of HIV Enzyme within 3 Weeks, Scientific American

Diagram 29: Knowledge economy



Source: Authors of the report

3. Changes in jobs

In the first two chapters of this report we have described the main trends that create the brand complex new world and suggested exactly how they will influence various sectors of the economy. Now we can consider the way these changes directly affect the workplace and then move on to the analysis of specific skills that will be in demand in the new economy.

3.1 Workers leaving mass production

Based on the results of the analysis of changes in various sectors of the economy, we can suggest how the demand for human labour will be changing.

Industry, service sector and knowledge economy will achieve the highest level of efficiency in the production of standardized products. New technologies and globalizing markets will allow the production of mass consumption products, involving a relatively small number of workers. Based on the expert sessions held, we assume that human labour will be in the highest demand in the production of customized products (see Diagram 29).

In the industry, the reduction of workers engaged in mass production will be incomparable with the increase of jobs, related to the creation and maintenance of customized products. Thereupon, many workers will have to seek employment opportunities in other sectors of the economy — in the service sector or in the knowledge economy.

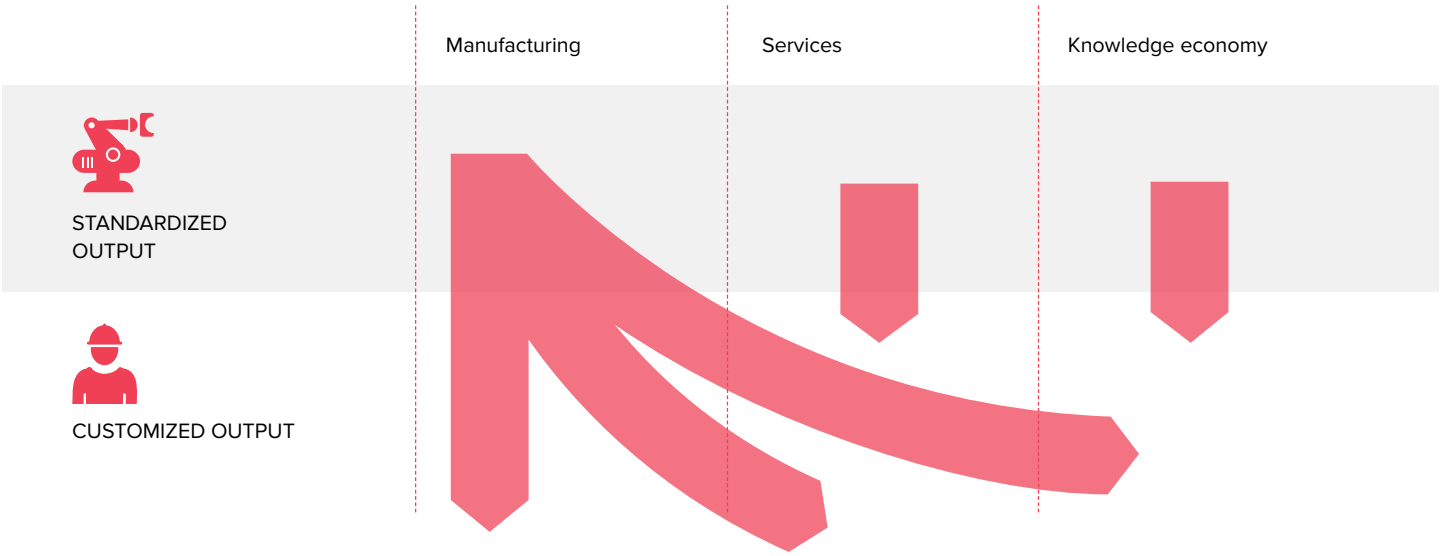


Diagram 30: Workers switching to new types of activity

Source: Authors of the report

3.2 Transformation of workplaces

Current changes in all sectors of the economy will affect the situation with jobs. We suggest considering three types of possible consequences.

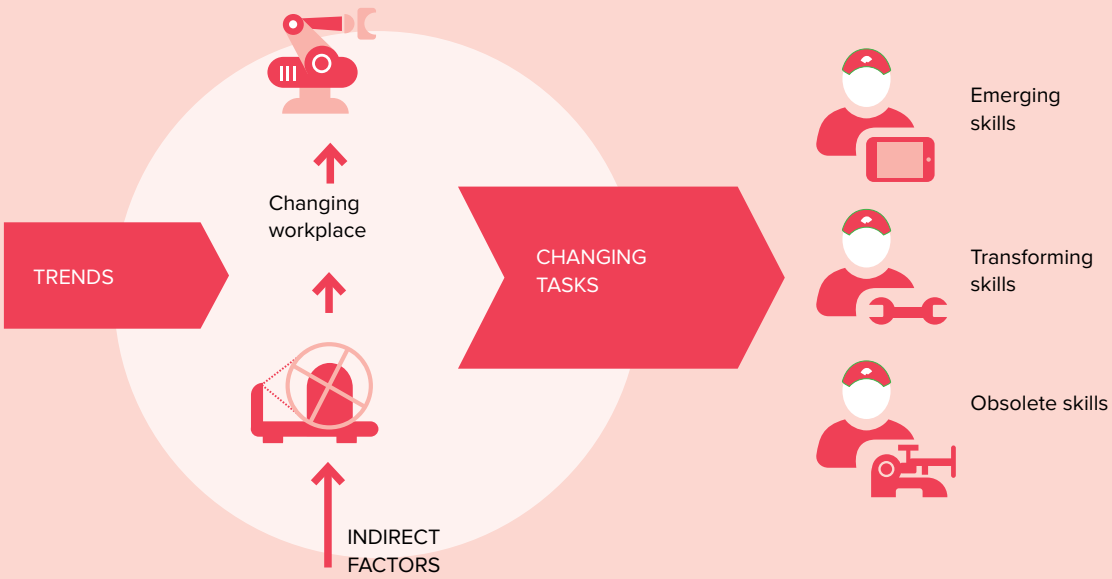
1) New work tasks give rise to new skills and new professions.

Electronic computing devices began to spread in the middle of the last century, personal computers — a little later, in the 70s. A new field of activity, software development, has emerged. In this area many skills and professions that had not existed before the rise of PC, emerged.

Electronic computing devices began to spread in the middle of the last century, personal computers — a little later, in the 70s. A new field of activity, software development, has emerged. In this area many skills and professions that had not existed before the rise of PC, emerged.

2) Change in the work tasks leads to the transformation/evolution of existing skills and occupations while preserving jobs.

We expect that the trends will seriously transform the professions that are familiar to us. In the recent past, many professions, related to typing and editing of the text have been transformed due to the transition from typewriters to personal computers (note that the profession of a proofreader, for example, has not disappeared, only its technical framework has changed). Now we can assume, for example, that most engineers will have to master the skills of working with augmented reality and be ready to perform creative tasks, delegating routine operations to computers.



Source: Authors of the report

Diagram 31: Changes in jobs

3) The disappearance of work tasks leads to a reduction in the need for skills necessary for their implementation, and to the disappearance of entire professions.

In some fields, automation leads to the disappearance of work tasks and the gradual disappearance of entire professions. For example, as the technologies of the unmanned motor car construction develop, we can expect the disappearance of the profession of taxi drivers and truckers.

However, the skills that have previously been in demand and common, rarely disappear completely. Often they are preserved, with the number of their carriers decreasing. This way, today the skill of riding or taking care of horses is in demand mainly in the field of sports, while the profession of groom, without disappearing completely, has long ceased to be widespread.

Diagram 31 reflects the estimated degree of influence of the trends on the appearance, transformation and disappearance of jobs.

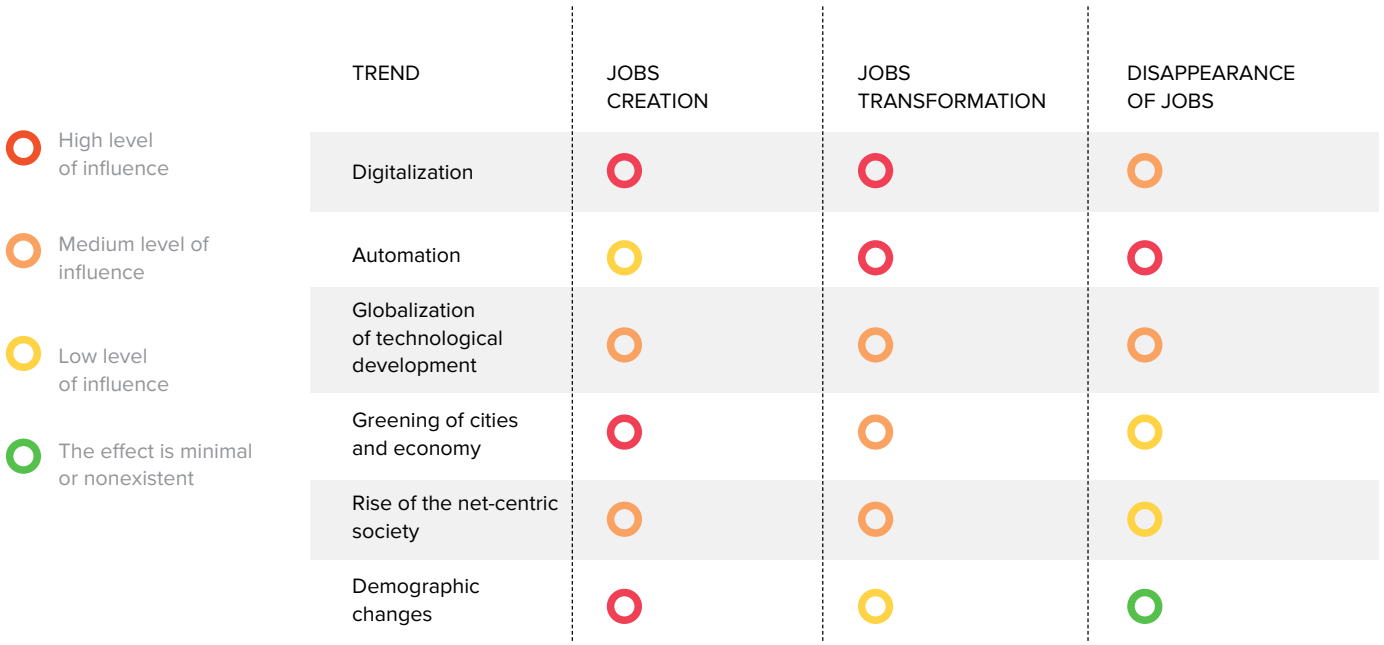


Diagram 32: The influence of the trends on jobs

Source: Authors of the report

3.3 Automation patterns

Changes in jobs in each sector of the economy and even in each individual profession will occur in different ways. Nevertheless, there are general trends that are typical for automation process. Some of them started developing long ago, others are arising only now when automation begins to spread to cognitive tasks.

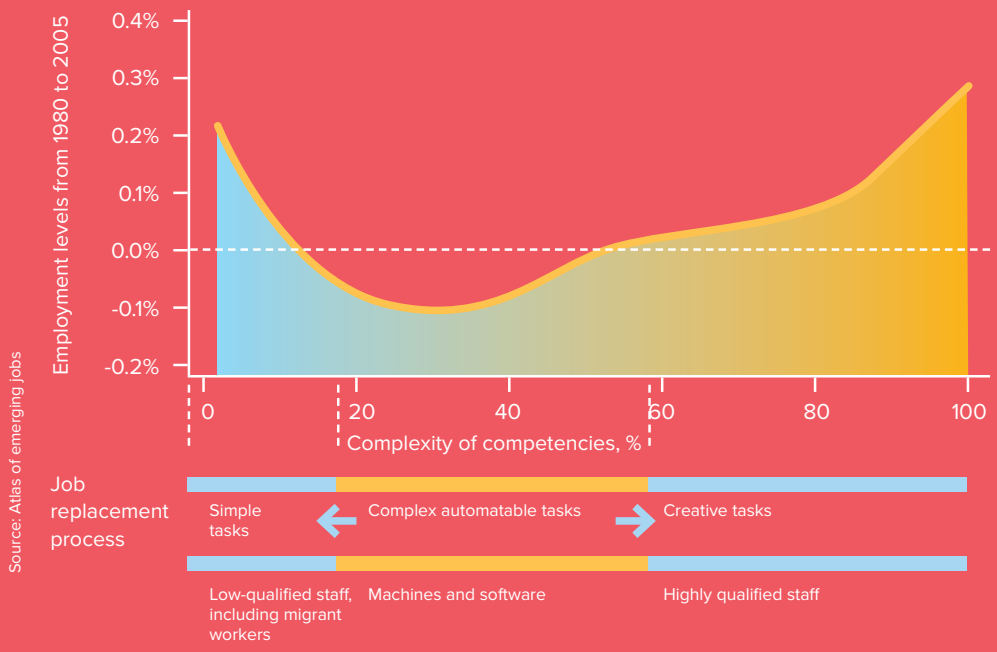
Automation of tasks of an average level of complexity

Automation primarily affects the tasks of the average level of complexity. This pattern was demonstrated by the American economist David Autor. In his works[79] he analyzed the changes in employment in the USA industry, depending on the skills of workers.

From the obtained graph (Diagram 32, this diagram is often called the “Autor curve"), one can see that from 1980 to 2005, employment declined among workers of medium qualification, and the highest growth was observed among highly skilled workers. This was primarily due to the wide spreading of automated solutions for tasks of an average level of complexity, since an economically similar approach is the most appropriate one. The tasks of a low level of complexity are often unprofitable to automate because of the low cost of human labour. The tasks of high level of complexity are difficult to fully automate, since they imply numerous non-routine tasks.

Thereby, automation mostly affects jobs, for which the average level of qualification is required. The average level of skills still includes many template components but the skills themselves are well-paid enough to pay back the costs of introducing automated solutions.

[79] Autor, D., & Dorn, D. (2013). The growth of low-skill service jobs and the polarization of the US labor market. The American Economic Review, 103(5), 1553-1597. Autor, D. H., Levy, F., & Murnane, R. J. (2003). The skill content of recent technological change: An empirical exploration. The Quarterly journal of economics, 118(4), 1279-1333.



Source: Atlas of emerging jobs

Diagram 33. The Autor curve — the reduction of demand for medium-complexity problems.

Areas of activity and levels of complexity[80]

The Autor curve gives a good idea of the level of skills that will be in demand in the market but it does not describe the specific changes taking place in the economy due to the automation of cognitive tasks. In order to reflect these changes, it is necessary to pick out some basic areas of human activity.

The most fundamental models of the taxonomy of human activity were developed for the analysis of pedagogical goals in the course of primary education. At this stage, a person gets acquainted with the widest possible range of possible tasks, and pedagogical taxonomies cover the whole range of potential work activities. The classical typology of pedagogical goals was suggested by Benjamin Bloom in 1956[81]; then his students specified it in 2001[82].

The invention of instruments of labour increased humans opportunities in the performance of psychomotor tasks. With the rise of machines, some of these tasks have been fully implemented without human intervention. With the distribution of autonomous robots, most psychomotor tasks that do not affect other areas will be performed entirely without human intervention.

However, psychomotor tasks often imply intervention in other areas. Many tasks in the service sector have not only a physical, but also an emotional and cognitive component. For example,

[80] This section is based on the idea proposed by Charles Fadel (Center for curriculum redesign) in the interview with Global Education Futures.
[81] Bloom, B.S., (Ed.). 1956. Taxonomy of educational objectives: The classification of educational goals: Handbook I, cognitive domain. New York: Longman.
[82] Anderson, L. W. & Krathwohl, D. R. (2001). A taxonomy for learning, teaching, and assessing. New York: Longman.

Bloom's specified taxonomy distinguishes three areas of activity:

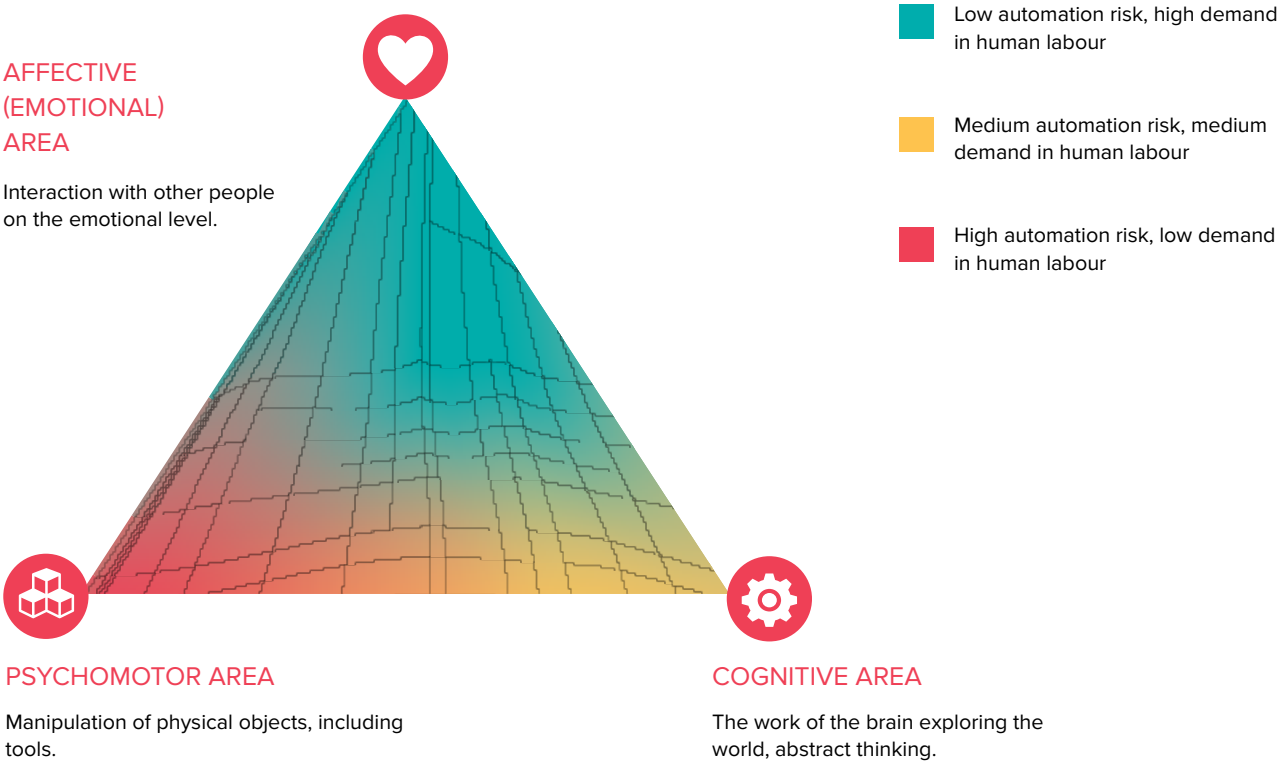


Diagram 34: Influence of tasks on the areas of activity

Source: Authors of the report

a good masseur is not under the threat of being forced out of the profession by a robot since people seek not only physical effects but also psychological contact.

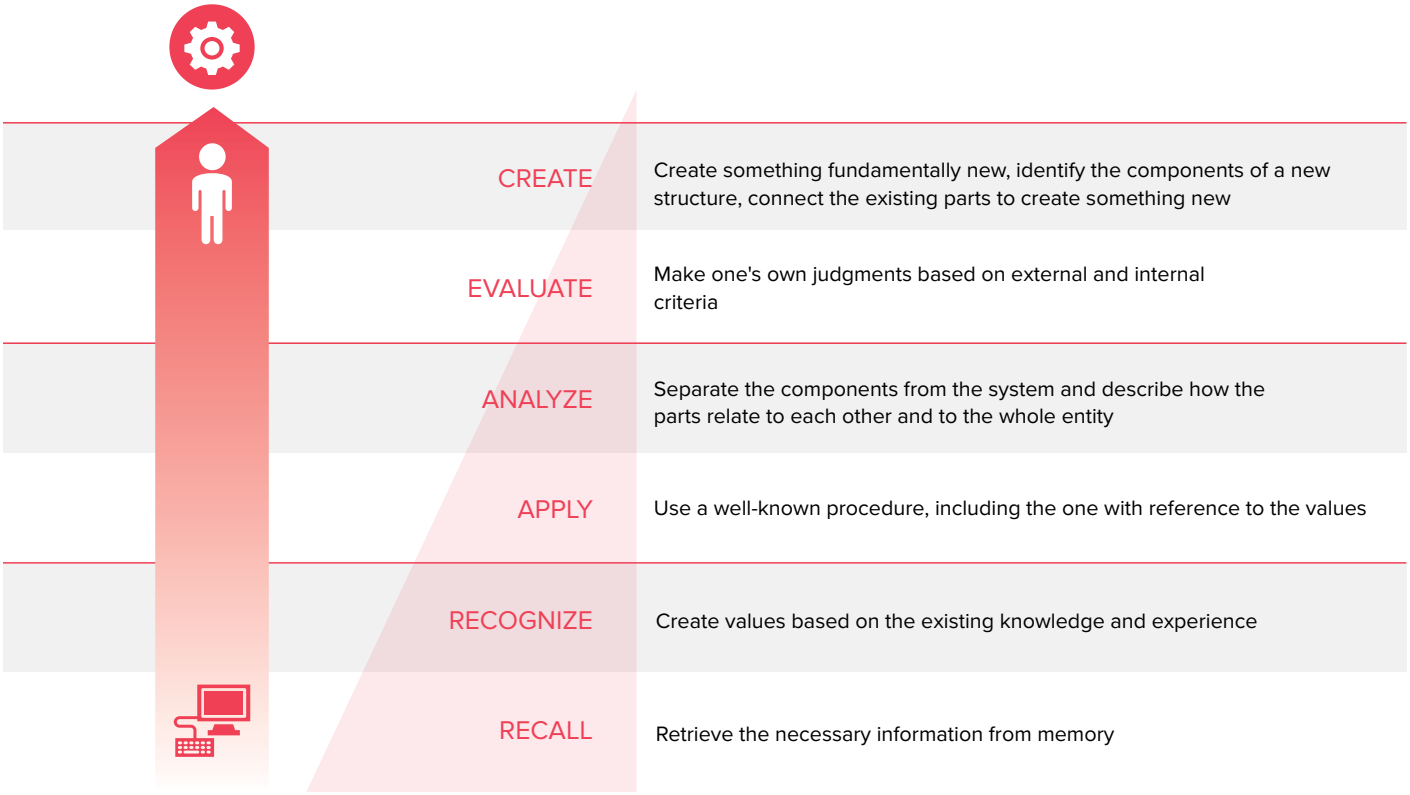
In the affective field the progress of technology is still minimal. This is where the significant part of the tasks, which a person will perform in the workplace, will be concentrated. In the increasingly automated and digitized world, the demand for human contact will grow: it is necessary that the service or product is accompanied by attention to feelings, emotions, personality (Diagram 33).

Writing, arithmetic, and calculating machines have long been used to enhance human abilities in the cognitive field. Now the development of computer technologies, and especially the emergence of neural learning networks, makes us reconsider the range of tasks that only a human can cope with. Not all tasks will be within the capacity of computers but many of the cognitive tasks that people used to do in the past will pass into the competence of machines.

Bloom's taxonomy distinguishes six levels of cognitive processes. Computer systems are already significantly ahead of humans in cognitive tasks of the first level ("recall of information").

Neural networks are now coping well with generalization of experience and the analysis of new information. At all workplaces, employees will inevitably face the need to increase the level of cognitive tasks they solve.

More and more work will be associated with the ability to come up with new solutions or make one's own judgments without relying on pre-defined parameters. This applies to both purely cognitive and mixed tasks, where psychomotor functions are supplemented with cognitive and emotional functions. (Figure 34).



Source: The authors of the report based on Bloom's taxonomy in the version of Anderson, L. W. & Krathwohl, D. R. (2001). A taxonomy for learning, teaching, and assessing

Diagram 35: Levels of complexity of cognitive tasks in Bloom's taxonomy

3.4 New sectors of employment

New jobs will emerge in all sectors of the economy in those activities where a personalized approach is required to create a product or a service, where tasks are related to higher cognitive levels (the ability to analyze, synthesize, make independent judgments, create new things) or require emotional involvement.

But we are talking about not only new jobs in the existing economy but also about the emergence of new areas of activity. Many of them will be focused on the realization of humans' creative potential, and not only on commercial success in the customary logic of the market economy.

We suggest considering a number of new sectors of employment, in which the space for human activity is most likely to emerge in the foreseeable future.

>> Creative economy

Creative economy implies that the main factor of production is human imagination and the ability to create something new — music, videos, scripts, a game plot. A significant part of this work will be based on the use of new technologies, in particular, technologies for digital processing of sound and images, technologies of augmented and virtual realities.

>> Cyber economics

By cyber economics we mean an industry based on the creation of values within the digital world-for example, e-sports, video blogging, the provision of services in online mass games. Over the recent years, e-sport[83] has grown into a professional sport that attracts hundreds of teams and hundreds of millions of viewers around the world. Today virtual reality can offer real employment to cyber sports-

Diagram 36: New areas of employment

men[84] or waiters in the virtual world of Second Life[85]. More and more people are becoming video bloggers[86].

It is important to distinguish between the growth of cyber economics itself and the opportunities for employment in this sector.

>> Human-oriented services

In response to the growth of robotization, digitization and the transition of a significant part of communication to a virtual environment, the need for human contact and interaction with a person is increasing. An example of that can be original hairdressers or coffee shops, where a person receives not only the service or the product itself but also the accompanying communication. The same sector includes various educational centres, where personal participation of a teacher-mentor plays a significant role.

In addition, we should expect employment growth in the services aimed at the elderly. We can talk about it, firstly, due to the demographic changes that we have described in the first chapter, and secondly, due to this demographic group being more focused on interpersonal contact than others.

>> New technological sector

New types of work activity are arising in the field of introduction and maintenance of new technologies. We are talking about working in new medicine, robotics, biotechnologies, neuro technologies and working on teaching the artificial intelligence systems. In most cases this refers to start-ups or small teams of developers who are happy to experiment with technology and create new products. For example, small companies developing new methods for recognizing the genome regularly achieve success and receive attention and funding from the major players in the industry[87].

>> Taking care of the environment

Gradual introduction of the value of environmental friendliness in production and in the urban environment creates new opportunities for employment. If, for example, the goal is not just planting of sapling but the real restoration of the ecosystem, then this will require long-term attention. Perhaps, this very sector will allow providing jobs to people of working professions that are unlikely to find themselves in the creative economy and at the same time are not ready to move into the service sector.

This division is rather conditional, since some types of jobs arise at the intersection of several areas. All these sectors to some extent use new technologies or imply a creative approach to solving problems.

By proposing such a division, we want to show the versatility of emerging sectors and do not seek to offer a rigid model for classifying the new economy.

[83] Rosell Llorens, M. (2017). eSport Gaming: The Rise of a New Sports Practice. Sport, Ethics and Philosophy, 1-13.
[84] The rise of the professional cyber athlete. The New Yorker.
[85] Virtual Recruiting for Real-World Jobs, NPR
[86] How video blogging is changing the media industry. Deutsche Welle
[87] Illumina Accelerator Welcomes its Fifth Cycle of Startups. illumina

4. The problem of transition

Having examined key technological and social trends, we have noticed that the future economic structure will differ significantly from the current one. The industrial economy is already coming to an end but the post-industrial society has not yet emerged. Mankind is in the transition phase. Some people meet what is happening happily, others, with caution, seeing numerous challenges in the changes.
In this chapter we suggest considering one of the most critical problems of the transition, which is potential technological unemployment.

4.1 Disappearing jobs

In the past, most of the automation in production was due to the surgical introduction of specialized robots designed to perform specific tasks (they work on conveyors and perform monotonous work that does not involve making any decisions).

Slightly more complex machines are able to analyze the environment while performing the formulated task, to interact with each other and to adapt their behaviour in a changing environment. For example, Kiva's self-administered robots help Amazon automate the work of warehouses in the USA[88].

Modern industrial robots and cobots are complex systems that can be reprogrammed to perform a wide range of tasks. Robots supplemented with artificial intelligence will be capable of self-learning, which significantly increases their potential efficiency.

Economic incentives point to simple conclusions: if hiring an employee is more expensive than installing a robot, then companies will give up human labour. Technological development provides a gradual reduction in the cost of industrial robots and enables them to successfully compete with people in an increasing number of tasks.

In the automotive industry of the USA, introducing robots is more cost-effective than employing people. According to Boston Consulting Group estimates[89], In the automotive industry of the USA, introducing robots is more cost-effective than employing people. According to Boston Consulting Group estimates

ROBOTS AT AMAZON'S WAREHOUSES

In 2012, Amazon corporation spent 775 million dollars to purchase the company Kiva Robots (in 2015, it was renamed Amazon Robotic), which developed autonomous robots to perform storage operations. By December 2015, there were 30,000 Kiva robots working at Amazon's 13 warehouses. According to Amazon, automation has reduced order processing time from 90 to 13 minutes.

Фото: designboom.com

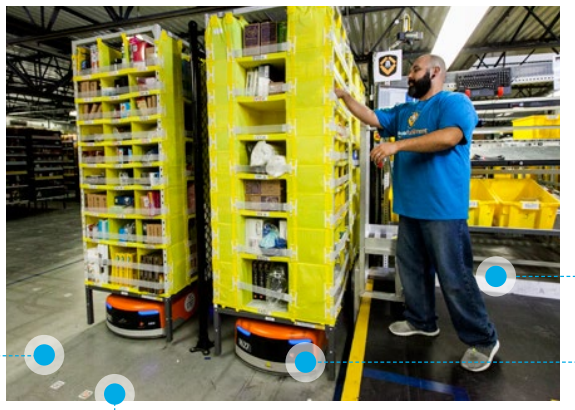
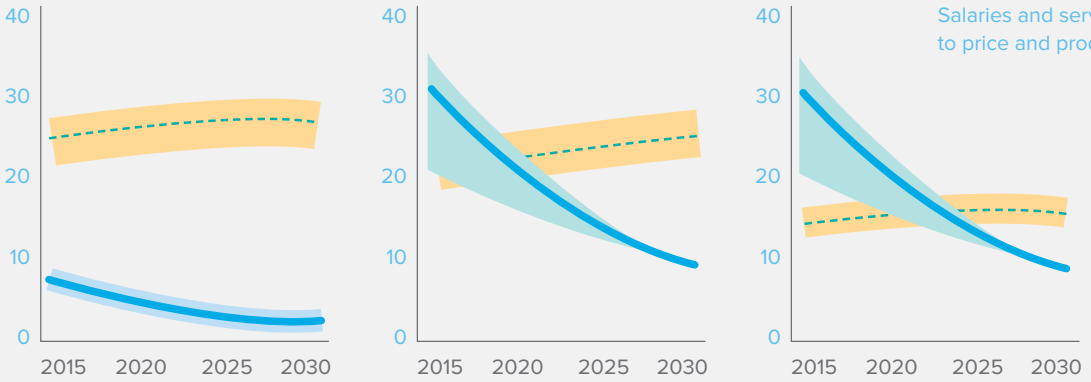


Diagram 37: The effectiveness of robots.

Salaries of workers in relevant production
Cost of robot maintenance

AUTOMOTIVE	ELECTRICAL EQUIPMENT	FURNITURE
10 320	3 328	23

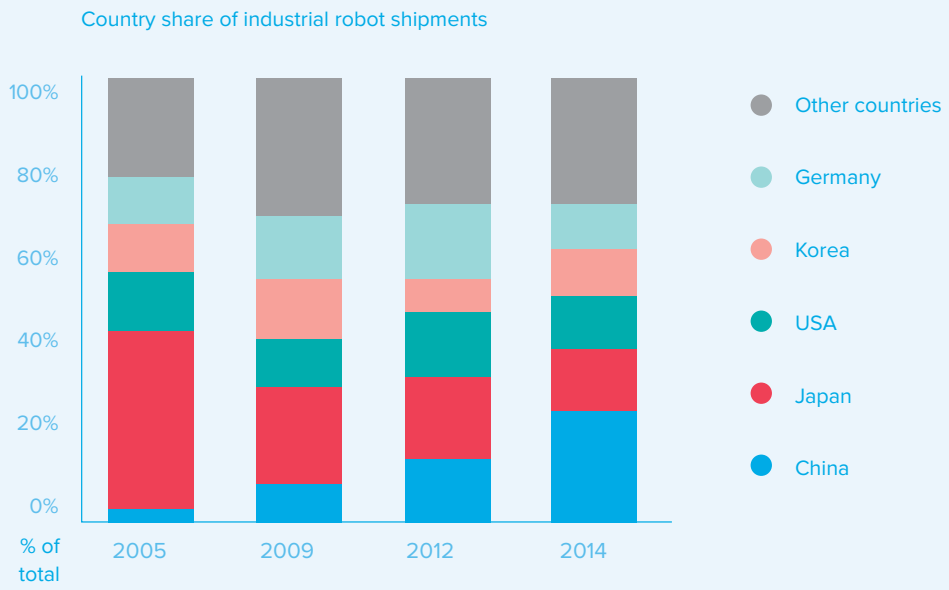
Количество промышленных роботов, поставленных в 2013 году



Source: BCG: How Robots Will Redefine Competitiveness

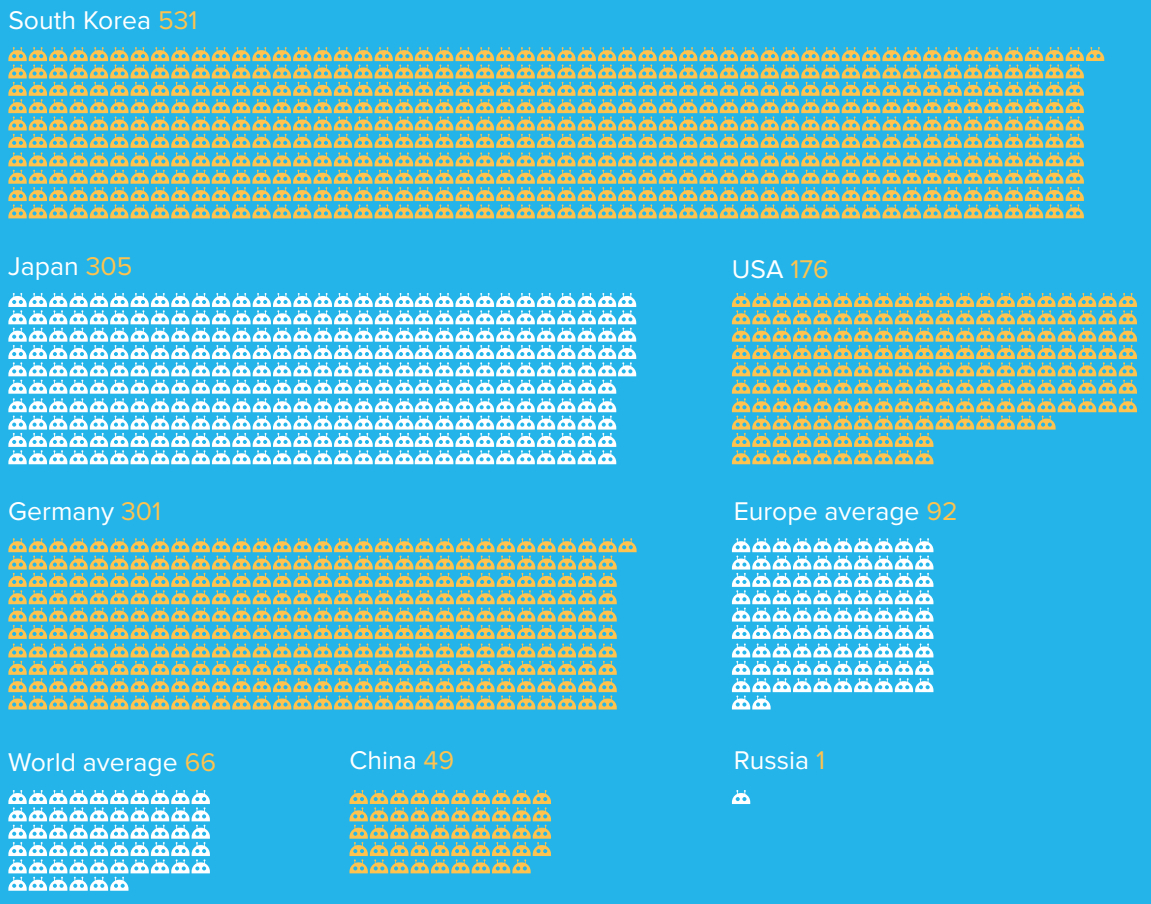
[88] Amazon's $775 million deal for robotics company Kiva is starting to look really smart, Business Insider
[89] How Robots Will Redefine Competitiveness, Boston Consulting Group

Diagram 38: Industrial robot supplies



Source: Oxford University and CitiGroup Technology at work 2.0 report, based on the data of IFR World Robotics, Citi Research.

Diagram 39: "Density" of industrial robots per 10 000 workers



Source: IFR World Robotics 2016

The high level of wages in OECD countries makes the introduction of robots particularly effective, while many other countries continue to focus on cheap human labour. Countries postponing robotization put their economies at high risk, since the cost of maintaining robots will inevitably decline with time and workers of conveyor lines will not be ready for such competition.

The report "Technology at work v2.0", published by Citigroup and Oxford University in January 2016, provides an analysis of automation risks for developing countries, based on the Frey and Osborne methodology and World Bank statistics[90]. The share of employment located in the "risk zone" of automation in most developing countries exceeds 60%, while in Bangladesh, China and Ethiopia it is over 70%.

Unlike many other countries that have built their economies using cheap labour, China is actively robotizing its industry. In 2014, it became the leader in the number of industrial robots being introduced (Diagram 35), and since then has continued increasing its pace.

In 2015, China installed more than 68,000 new robots, which is almost two times higher than the indicators of Japan, the USA or the combined indicators of all European countries[91]. However, China is still lagging far behind the leading countries in the "density" of the introduction of robots: in 2015, there were 39 robots per 10,000 workers, while in Japan and Germany about 300 robots corresponded to the same number of workers, and in Korea there were 531 robots (diagram 37). Given the rising cost of labour, China will rapidly increase the pace of introduction of industrial robots, thereby setting free a significant amount of labour[92].

Digital unemployment

Digitalization does not have such a strong direct impact on the disappearance of jobs, but it will also affect the reduction in the need for workers engaged in certain areas. Changes in the service sector, which have been described in detail in section 2.3 of our report, will lead to a reduction in the number of people engaged in working with customers and processing data in back offices.

However, there are two important characteristics of the new economy that have a serious impact on the unemployment rate[93].

Firstly, in the global digital economy, there are one or more leaders working in each niche, leaving no room for local companies (no one will download the "local" application if you can immediately install a "large" popular programme). At the same time, there is no connection between employment and the place of sale of digital goods.

Secondly, the digital economy implies an extremely high effect of economies of scale. The manufacturer's marginal cost for the production of an additional copy of the programme are close to zero, one just needs to provide access to the download page. This allows companies to achieve tremendous sales with a minimum number of people working on the creation and distribution of a digital product. In the recalculation of capitalization per employee, digital companies significantly outperform companies operating in the traditional industry[94]. The example of Instagram demonstrates that in the new global digital economy, one employee can be producing a product worth 77 million dollars.

In addition to the direct savings from human labour in the production of a digital product, the product delivery method to the final customer also changes. Sales of tangible products provided a large number of intermediaries with work, from logistics managers to sellers and promoters. The digital economy enables the manufacturer to build a direct connection with consumers. This applies not only to production but also to the services sector, as well as to the knowledge economy. "Uberisation" of the economy makes it possible to let go of operators, intermediaries and coordinators in virtually every area of activity[95].

GLOBAL ECONOMIES OF SCALE

In April 2012, Facebook purchased Instagram for 1 billion dollars. The Instagram application enables its users to easily improve a photo taken on a mobile phone and share it with one's followers. At the time of purchase, the company employed only 13 people. The application was downloaded by over 30 million users. Thus, every Instagram employee on average provided services to over 2 million users and earned about 77 million dollars[96].

[90] World Bank Development Report 2016, based on Frey and Osborne (2013)
[91] World Robotics 2016 Industrial Robots, International Federation of Robotics
[92] China's robot revolution, Financial Times.
[93] Jones, R., & Mendelson, H. (2011). Information goods vs. industrial goods: Cost structure and competition. Management Science, 57(1), 164-176.
[94] Facebook IPO Shows (Once Again) Tech Companies' Crazy Value Per Worker, The Atlantic
[95] Schneider, H. (2017). Uber: Innovation in Society. Springer.
[96] Instagram Is Now Worth $77 Million Per Employee, The Atlantic

4.2 Estimating the effects of automation

Existing estimates

A detailed methodology for the analysis of automation risks was presented in 2013 by Benedikt Frey and Michael Osborne of Oxford University in their article “The Future Of Employment: How Susceptible Are Jobs To Computerisation?[97]. The study was based on the classification of professions used in the electronic system O*NET, developed by the U.S. Department of Labour.

This system contains detailed information on 903 different professions, including a detailed description of various skills required for the successful performance of professional tasks. Based on expert opinions, Frey and Osborn evaluated the risk of automation of specific skills and built a mathematical model, enabling us to assess the probability of automation of every profession. With all the limitations of the methodology, this study remains the most cited work on this topic. It has formed the basis of many other studies in this field.

According to Frey and Osborne, about 47% of jobs in the economy of the USA fall in the risk zone. This implies that in the near future, people working in these professional fields might be replaced by a robot or a computer.

Using the same methodology for OECD countries, the World Bank has determined that in these countries about 57% of jobs are in the risk zone[98].

Some of the professions that will be automated are associated with the execution of routine physical tasks; for example, with the work of operators and mechanics of milling and planing machines. But with automation, human labour will be inefficient not only in the industrial sector, but in all sectors of the economy connected with the implementation of standardized operations.

In developed countries, the vast majority of professions where the probability of automation is estimated to be above 90% are associated with performing routine cognitive tasks. Such professions include clerks employed in various fields (accounting, insurance, and the financial sector). In the field of analysis of loan applications, artificial intelligence systems take one hour to do the work, which was previously estimated at 60,000 working hours[99].

A completely different methodology was suggested by researchers from the Centre for European Economic Research[100] (Zentrum für Europäische Wirtschaftsforschung). From their point of view, many professions and jobs that are at risk of automation will not be completely replaced by robots and computers.

In the methodology used, they divided the skills at each workplace in more detail and concluded that, although computers and robots can perform a significant part of the tasks, almost every profession has skills that cannot be automated. The estimation of these researchers is more modest: unlike their colleagues from Oxford, they foretell that only 9% of jobs in OECD countries can be fully automated.

The lowest estimate of the influence of robotization on jobs was given by the Centre for Economic Policy Research[101] This study analyzed the impact of the rate of introduction of robots on the level of employment in 1990-2007, as well as the level of salaries in various districts of the United States.

Researchers found out that the introduction of one industrial robot per 1,000 workers increases unemployment by only 0.37%. This means that even with optimistic estimates of the introduction of robots, job losses will account for not more than 1.76% up until 2025. However, the authors indicate that this effect will be distributed unevenly, and some regions that have a high proportion of those employed in industrial production will experience a serious increase in unemployment.

[97] Frey, C. B., & Osborne, M. A. (2017). The future of employment: how susceptible are jobs to computerisation?. Technological Forecasting and Social Change, 114, 254-280. Chicago

[98] World Bank Group. (2016) World Development Report 2016: Digital Dividends

[99] Экспертное интервью

[100] Arntz, M., Gregory, T., & Zierahn, U. (2016). The risk of automation for jobs in OECD countries: A comparative analysis. OECD Social, Employment, and Migration Working Papers, (189).

[101] Acemoglu, D. and Restrepo P. (2017). Robots and jobs: Evidence from the US.

Limitations of the methodologies

It is important to note that the most recent of these studies focuses only on one aspect of automation: on the introduction of robots. However, in the USA, the proportion of workers employed in routine physical labour in factories is not very high. When considering the consequences of automation, it is necessary to take into account other areas in which employment will decline. Citigroup's analysis does not touch upon the entire economy but predicts a 30% reduction in the number of bank workers in the USA by 2025[102], while in the trade sector, up to 80% of people in warehouses and up to 63% of those engaged in direct sales are threatened by layoffs[103].

According to McKinsey Global Institute research[104], there is the greatest potential for automation in professions related not only to routine physical labour (78%), but also to analysis and data collection (69% and 64%). The further development of driverless vehicles will have a serious impact on the labour market[105]. According to estimates of the White House Council of Economic Advisers, the introduction of self-driving vehicles in the USA will affect from 2.2 up to 3.1 million jobs[106].

All existing automation assessment methodologies are based on extrapolating data from previous years to the future (for example, data on employment, on the types of tasks performed or on the effect of automation during the past years). This does not take into account possible disruptive changes, which can lead to a revision of the entire employment market. Many changes in the labour market can be of an avalanche-like nature, which is due to the delayed effect of introducing technology in the presence of legislative restrictions.

In the medium term, lifting the ban on the use of driverless vehicles will simultaneously endanger a large number of people employed in various sectors of the economy. The emergence of driverless vehicles is changing not only the automotive and transport industries, but also the real estate market (due to changes in demand for parking spaces), as well as insurance, legal aid and police markets[107]. This makes it difficult to assess possible changes in the labour market.

As a result, foresight sessions involving experts are often a more effective tool for predicting the future[108]. In our report we combine these approaches, relying on both the results of expert sessions and on the materials of published empirical studies and forecasts.

[102] Citi GPS (2016) Digital Disruption, How FinTech is Forcing Banking to a Tipping Point

[103] Oxford University, CitiGroup (2017). Technology at work v3.0: Automating e-Commerce from Click to Pick to Door

[104] McKinsey Global Institute(2017). A future that works: Automation, employment, and productivity

[105] Self-Driving Trucks Will Kill Jobs, But Make Roads Safer, WIRED

[106] White House (2016). Artificial Intelligence, Automation, and the Economy. Executive office of the President.

[107] Benedict Evans blog (2017) Cars and second order consequences

[108] Rapid Forsight Method: The New Tool for Collective Vision Design, Global Education Futures. Loveridge Denis. 2008. Foresight: The Art and Science of Anticipating the Future. Routledge Miemis Venessa, Smart John and Brigis Alvis. 2012. Open Foresight. Journal of Futures Studies, September 2012, 17(1): 91-98

READ MORE:

Frey, C. B., & Osborne, M. A. (2013). **The future of employment: how susceptible are jobs to computerisation?**. Oxford Martin School.
Citi GPS (2016). **Digital Disruption, How FinTech is Forcing Banking to a Tipping Point.**
Citi GPS & University of Oxford (2016). **Technology at work 2.0, The Future Is Not What It Used to Be.**
Agency for Strategic Initiatives (ASI) and the Moscow School of Management SKOLKOVO (2014) **"The Atlas of New Professions"**.

4.3 Redundant people

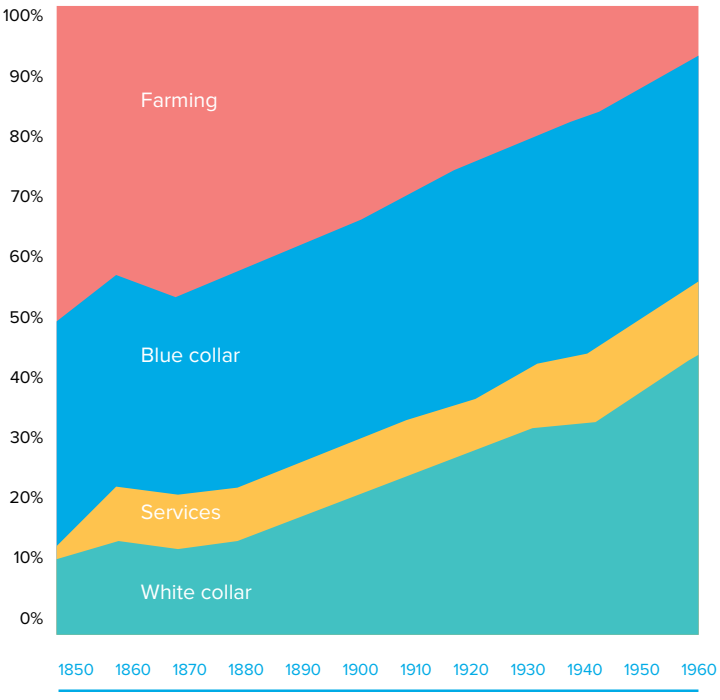
In the long term, the labour market will reach equilibrium, and job cuts will be compensated by the emergence of new employment opportunities. However, according to John Maynard Keynes, "*a long-term perspective is a bad adviser in current affairs. In the long run, we are all dead.*"[109]. Without proactive actions by all stakeholders involved in shaping the economy of the future, in the medium term we can find ourselves in a situation of global labour market failure and large-scale structural unemployment.

In the 20th century, countries carried out the transition from an agrarian society to an industrial one in different ways. In a number of countries (in particular, in the Soviet Union and China), industrialization was accompanied by tremendous social upheavals. Taking into account the trends of accelerating changes and globalization, it can be assumed that the forthcoming transition to a post-industrial economic structure in the 21st century will occur faster than the similar transformations in the last century. But it will also be more global, since transnational corporations that automate their production and services simultaneously affect both workers and consumers around the world.

In the medium term, this can lead to a global failure in the labour market, where market mechanisms cannot quickly adapt a huge amount of released labour. The risk of structural unemployment is high: unemployed people will not be able to find a job, since the skills they possess will not be in demand in the market.

[109] J.M. Keynes. A Tract on Monetary Reform (1923) Ch. 3;

Diagram 40: Changes in employment during industrialization in the USA



IN THE 20TH CENTURY, industrialization changed the labour market. During the past 100 years, the share of employment in agriculture in the USA declined from 50% to 5%. Similar changes occurred in many countries of the world. Millions of people had to find a new job.
Current changes are similar in scale but occur in a more coherent and complex world.

Source: IPUMS-USA, University of Minnesota

Transition mitigation strategies

Nowadays, there is no country that has officially adopted a strategy for adapting to the forthcoming changes. Three types of actions can be observed that are, in one way or another, applied or discussed to mitigate the impending shock.

>> Stimulation to create new kinds of jobs

In the modern economy it is very difficult to create conditions that are assured to lead to the creation of jobs in the long term. Companies can support jobs as long as there are subsidies, but then abandon them in favour of more effective solutions as soon as the subsidy ends. A possible solution will be supporting economic fields in which human actions are almost impossible to replace with a robot or a neural system. This may require a change in the approach to the very concept of the workplace, in which instead of working, the person will be engaged in the realization of their creative potential, which fits into the trend of the network society.

>> Legislative slowdown in the spread of technology

This strategy does not always imply the adoption of new laws against technology, but many existing laws can be used for braking the automation processes. For example, laws that completely prohibit operating driverless vehicles, hinder the development of driverless taxis and trucks and for some time protect drivers from losing their jobs.

An unwillingness to switch to the distributed registries based on blockchain technology opens the possibility for employing workers of various registration services. Such actions may delay the introduction of new technology, but without a parallel adaptation process this will only intensify the impending shock.

>> Unconditional basic income, universal basic income (UBI)

Nowadays, the idea of an unconditional basic income (a regular payment of a certain amount to all members of society, allowing them to meet basic needs) is gaining popularity. This measure is supposed to free people from the fear of losing their jobs.

Experiments on the implementation of UBI are carried out by various countries, cities and public organizations. The largest experiment is taking place in Finland, where starting from 1 January 2017, 2,000 unemployed people have received a basic income of 560 euros[110]. This income is approximately equal to unemployment benefits, but it does not require any action to register at the labour exchange and it is retained if a person finds a job.

Some of the most influential businessmen — Elon Musk, Mark Zuckerberg and Richard Branson — advocate for the introduction of unconditional basic income[111] Apart from criticism that such approach does not motivate UBI beneficiaries to find work, there is also a more complex problem that will be faced by countries when implementing it.

Albert Wenger[112], the author of "World after Capital", notes that people perceive work as a religion, because it gives meaning to their lives. If you remove a job and offer unconditional income in return, the result can be ambiguous. Many people may lose the sense of meaning in their own lives.

Structural unemployment

Even with the application of certain strategies aimed at smoothing down the consequences of automation, we expect high structural unemployment in the medium term. Structural unemployment occurs with the sharp release of a significant number of skilled workers, whose skills are no longer in demand in the economy. The state, employers and public institutions did not cope with the organization of the retraining system, and, even more importantly, they could not offer them a new motivation to restore an active life position[113]. As recent local examples of structural unemployment, we can cite the "Rust Belt" in the USA or a surge in unemployment in the countries of Eastern Europe in the transition from planned to market economy.

[110] Is Finland's basic universal income a solution to automation, fewer jobs and lower wages? The Guardian.

[111] Richard Branson backs universal basic income joining Mark Zuckerberg and Elon Musk, Independent

[112] Wenger, A. (2016), World After Capital

[113] Job retraining classes are offered to Rust Belt workers, but many don't want them. Public Radio International

"THE RUST BELT" (eng. Rust Belt) — the region of the United States, which until the 1970s was saturated with factories of American heavy industry, in particular, steel and automobile production. The territory belonging to the "Rust Belt" was formerly called the "Industrial Belt" or "Steel Belt". It begins with the states of New York and Pennsylvania, captures the entire state of Ohio and extends further to Michigan, Indiana and Illinois. Since the 1970s, employment in heavy industry in the United States began to decline rapidly. It was partially due to the emergence of cheap labour in other countries, but automation of production has also played an important role[114]. By 1996, the number of people employed in heavy industry in the region decreased by a third[115]. A large number of abandoned factories and entire districts appeared.

A global "Rust Belt"?

The current situation in the world economy may begin to develop under the scenario that led to the emergence of the Rust Belt in the USA, but this time the consequences can affect many countries at once. The world has become so global that a market failure will no longer be limited to one region but will affect the entire global economy. Modern market economy implies a constant performance race. Further reduction in the cost of robots, autopilots and artificial intelligence systems will make them more cost-effective.

The ready-made automation packages are starting to appear in the market, and global corporations will introduce these packages in their sectors. This will lead to an avalanche-like change in the labour market, where dismissal can simultaneously affect entire plants or large office complexes.

Certainly, new complex tasks will arise, for which new employees will be needed. But if you are building a linear career in a predictable industry for all of your life (from the truck driver to the clerk in the office), it is extremely difficult to adapt to a complex new world where work is arranged in a completely different way.

[114] Technology and Steel Industry Competitiveness: Chapter 4. The Domestic Steel Industries Competitiveness Problems. Washington, D.C: Congress of the United States, Office of Technology Assessment, 1980, pp. 115-151. Retrieved December 27, 2015.

[115] Kahn, Matthew E. "The silver lining of rust belt manufacturing decline." Journal of Urban Economics 46, no. 3 (1999): 360–376.

"Useless class", or "redundant people"

By virtue of additional stimulating measures, it is possible to ensure a situation in which the speed of creating jobs in new fields of the economy will be comparable to the speed of reduction of irrelevant working positions. However, the majority of vacancies will require skills that are difficult to expect from professionals who are exempt from performing routine tasks.

The historian, the author of the worldwide bestseller "Sapiens. A Brief History of Humankind" Yuval Noah Harari, has called this phenomenon the emergence of a "useless class"[116] . In Russia, this phenomenon was called "redundant people" (by analogy with the novel by F.M Dostoevsky).

These "new unemployed" have education of a certain level, they have already established themselves in a profession that was in demand by the economy and society. But due to structural changes in the economy, their skills are no longer needed, and opening vacancies require knowledge and skills that "new unemployed" do not possess.

But the most important thing is that people dismissed from jobs that are focused on performing routine tasks do not possess key skills for the "new reality", which are adaptability and anti-fragility[117]. The education system, parents, and society prepared them for doing the usual work and progressing in a linear career, but suddenly they find themselves in a situation where they need not just new skills, but literally a new attitude towards life.

The problem that arises with the disappearance of entire professions from the labour market will consist not only of the loss of a source of income, but also in the loss of life guidelines[118].

A scary future?

Many people somehow feel the problems that await them in a brand complex new world. They are the main catalyst of populist sentiment in modern politics. In the slogan "Let's make America great again!", we can clearly hear a desire to hide from the future in a beautiful past[119].

A significant part of the world's population does not see themselves in the future, which awaits us with the further development of the current social, technological and economic structure. According to the IPSOS survey, most residents of the largest countries believe that their countries are moving in

the wrong direction[120]. To reduce the growing fear of the future, it is necessary to offer a positive picture of the world that awaits us — a world in which people participating in this transition would like to live.

And there is a need for different tools to support this transformation — such as programs of mass re-education to prepare people who are losing their jobs for new economy and for the complex new world.

[116] The meaning of life in a world without work, The Guardian.
[117] Taleb, N. N. (2012). Antifragile: how to live in a world we don't understand (Vol. 3). London: Allen Lane.
[118] The meaning of life in a world without work, The Guardian.
[119] A survey taken before the election shows how Trump supporters' outlook on the future propelled him to victory, Business Insider. Frey, C. B., Berger, T., & Chen, C. (2017). Political Machinery: Automation Anxiety and the 2016 US Presidential Election
[120] IPSOS (2016). Majority across 25 countries say their country is on the wrong track

4.4 A new understanding of work

The evolution of attitudes towards work

We are used to the perception of work as an activity, for which a person receives money (salary) in return[121]. Most countries now adhere to a market economy, in which everyone chooses a job based on market demand. It is intended that, due to the laws of supply and demand, equilibrium wages encourage every single member of society to engage in activities that will benefit the entire community, the country, and ultimately the entire planet[122].
But it is worth remembering that the very idea of mass wage labour arose only in the era of industrialization, which began in Western Europe in the 17th century. The final dominance of the existing approach to work has only been recently consolidated, with the collapse of communist regimes that adhere to the planned economy.

In the Middle Ages, there was a completely different idea of work and daily labour. Labour is given to a human as a punishment for original sin, as work must be done with dignity, since it is also where human destiny lies. It was assumed that an employee could not freely change profession, because it was given to them from above. Everyone should work diligently in their place to provide food for themselves and their family[123].

In ancient Rome, work was intended for slaves, while a free man was engaged only in what brought him pleasure, which was necessary for the management of society or for noble work for the benefit of his own family[124].

But if we go beyond the borders of Europe, we will discover that separate ideas about work developed in different cultures. For example, work could be determined by the fact that a person belongs to a particular varna (caste) or it could be not at all considered as a separate special activity. In order to picture an image of work in the world of the future, we must be ready to go beyond the familiar image of the industrial labour market[125].

[121] "Work — activity that you do regularly especially in order to earn money", Merriam Webster Dictionary
[122] Borjas, G. J. (2013). Labor economics. New York: McGraw-Hill. Chapter 4. Labor Market Equilibrium
[123] Tilgher, A. (1930). Homo faber: Work through the ages. New York: Harcourt Brace
[124] Maywood, A. G. (1982). Vocational education and the work ethic. Canadian Vocational Journal, 18(3), 7-12.
[125] Méda, D (2016). The future of work: The meaning and value of work in Europe. ILO Research Paper No. 18.

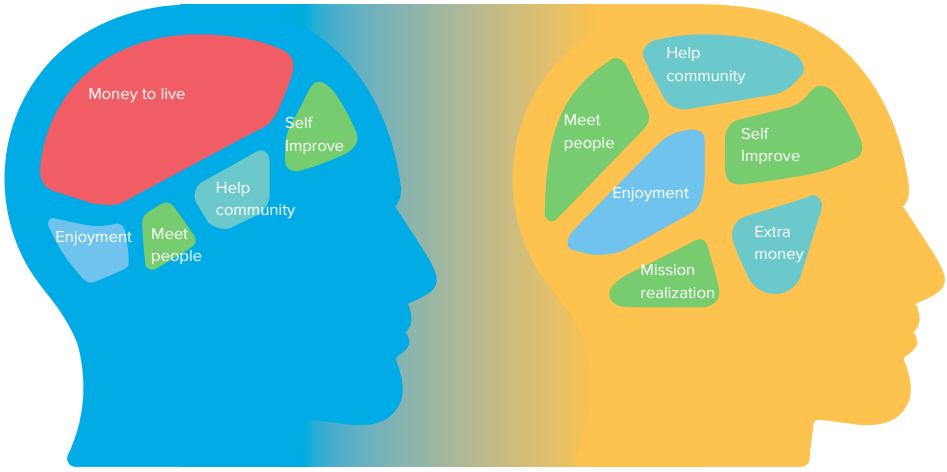


Diagram 41: Why do people work?

Source: The author of the report based on the illustration from kittysjones.wordpress.com

Calling instead of profession

In the brand complex new world, there will be no linear professions, meaning specializations that we learn in our youth, after which we simply do the same kind of work throughout life, slowly moving up the career ladder to the highest position on the conveyor. With the accelerating pace of technological and social change, a person will have to be retrained several times throughout their life and move to new areas of activity.

In this regard, more attention is paid to adaptation skills[126]. But if a person only adapts to the constantly changing labour market, they will find themselves in a situation of eternal stress.

In order to cope with the increasing complexity of the world, a person must have their own idea of the meaning of their activity. Then the work becomes only a manifestation of this meaning. We should not teach schoolchildren and re-educate adults for the "professions of the future" (note, constantly changing), but instead help them find their calling and teach them self-realization.

Changing attitude towards work becomes particularly relevant with the introduction of unconditional income. Now people perceive wages as an assessment of their social usefulness. State payments are associated with benefits for people, who for one reason or another cannot contribute to the social product.

Will society be able to accept the idea of paying money to members of society who are capable of working? And why will a person go to work then? If a person goes to work only in order to earn a means of subsistence, then they will not need this kind of work. Considering the fact that more and more people believe that there is no purpose in their work[127], we can assume that there will be serious changes in areas of activity.

As recently as in the '80s, the American architect and visionary Buckminster Fuller wrote about the need to reconsider labour due to the end of the industrial era[128]. He pointed out that an economy focused on the market employment of people will multiply jobs, creating unnecessary inspectors and supervisors.

By introducing a basic income (a handsome fellowship), we can abandon the need to provide a workplace for each person. But more importantly, we will create the opportunity to abandon a job that one does not enjoy.

According to Fuller, people can start to remember what they wanted to do before they were told that they should make a living. Having gotten rid of the need to constantly think about money to satisfy the basic needs, a person can treat work as a space for their own development, communicating with other people and realizing themselves (Diagram 41).

[126] Three tips for being flexible and adaptable. Management.Issues
[127] A growing number of people think their job is useless. World Economic Forum
[128] Fuller, R. B. (1982). Critical path. Macmillan.

Biospheric approach

Realization of one's own calling is impossible in isolation from other people and the whole biosphere. Humanity has to learn how to harmonize its desires in order to maintain technological, social and ecological balance in the world. Even if we manage to avoid global military conflicts, accidental or provoked technogenic disasters, we still face the most difficult task of harmonizing our standard of living with the capabilities of the planet.

It is now believed that the market economy serves as a mechanism to harmonize individual needs and opportunities for the inhabitants of the whole planet by virtue of the allocation of resources in the best way possible. Even if we do not take into account growing inequality[129], we must admit that this mechanism has not coped with the formulated task.

If mankind maintains current development rates, then in order to secure our consumption of resource we would need several planets[130].

Future work will imply collectively managing “Spaceship Earth"[131] or practicing the art of “cultivating the planet” (Planet Craft[132]). If earlier the key metaphor for the workplace was an engineer tuning the mechanism, then in a new way of life this image will be closer to the forester, supporting the ecosystem.

In this case, the activity itself will differ both in the way it is implemented and in the scale of its impact. Someone can choose to maintain balance on a small piece of land (returning flora to the dead city space or restoring the destroyed forest away from the city), while someone will take part in the regulation of global processes (controlling complex systems based on artificial intelligence).

But the ecosystemic (biospheric) approach implies the ability to see the importance of each party in this planetary orchestra and it will enable us to respect each other's work as well as the work of all elements of this complex system called planet Earth.

[129] Divided we Stand: Why Inequality Keeps Rising, OECD

[130] How many Earths do we need? BBC

[131] The term “Spaceship Earth” was used by various economists and public figures throughout the 20th century, describing the careful attitude that humanity must develop towards the planet and its limited resources. The term was popularized by Buckminster Fuller in his book “Operating Manual for Spaceship Earth” (1968).

[132] The term “planet craft” was suggested by the ecologist Stewart Brand in his book “Whole Earth Discipline: An Ecopragmatist Manifesto”. In his book, he suggests that ecologists move away from the “natural” positions and use the latest technologies to control the further development of the planet.

5. Skills of the 21st century

The key element of any strategy that ensures the transition of modern society to the postindustrial phase should be education oriented toward developing an ability to work in a complex new world and adapt to its requirements. We need to reconsider the existing approach to education where applied skills are put at the forefront.

5.1 “Long tail” of skills

Throughout history, mankind has mastered millions of different skills. The growing complexity of the world will be accompanied by a further increase in the diversity of existing skills and knowledge. Based on the trends that form this complex world of the future, all employees will need to receive:

1) Various “hard” skills and knowledge related to the change of technology and working contexts; and

2) “Soft skills” and general knowledge that can be applied across a range of professional, social, and personal contexts (including those related to the wave of technological transformation), such as:

Skills and knowledge that help to deal with fundamental volatility, uncertainty and ambiguity of the future, including collaboration, creativity, and entrepreneurial skills. This category also includes skills that generally increase personal resilience (e.g. health-inducing habits and the ability to cope with stress), as well as future awareness (the ability to understand and/or carry out a variety of future scenarios and create relevant individual and collective action strategies);

>> Skills and knowledge that help deal with the growing complexity of our civilization, including system and ecosystem thinking, problem-solving, and design and project thinking;

Skills and knowledge that help us live in the world overwhelmed with information and communication technology, including basic programming skills, information searching and processing, as well as analytical skills (e.g. knowledge mapping), information hygiene/media literacy, etc. These skills also cover the ability to direct and maintain attention, which will be required in the context of the information-intense world of the future;

>> Skills and knowledge that will focus on what machines cannot do, including empathy/emotional (or interpersonal) intelligence, bodily intelligence and naturalistic intelligence, as well as fostering the capacity of co-creation with others, and serving others with sincerity and dedication.

There is a danger of endless expansion of educational programmes because of the desire to embrace the most comprehensive spectrum of knowledge and skills. According to the study by the SKOLKOVO Moscow School of Management[133], most skills applied by specialists in their "complex" workplace refer to unique, specialist skills. They are used by one or several employees at a company or even across the entire industry.

At the same time, there is a small core of common skills that are used by a significant number of workers across the entire industry. The center of this core contains "basic skills" possessed by all working people, regardless of the area of employment (for example, the ability to read, count and write).

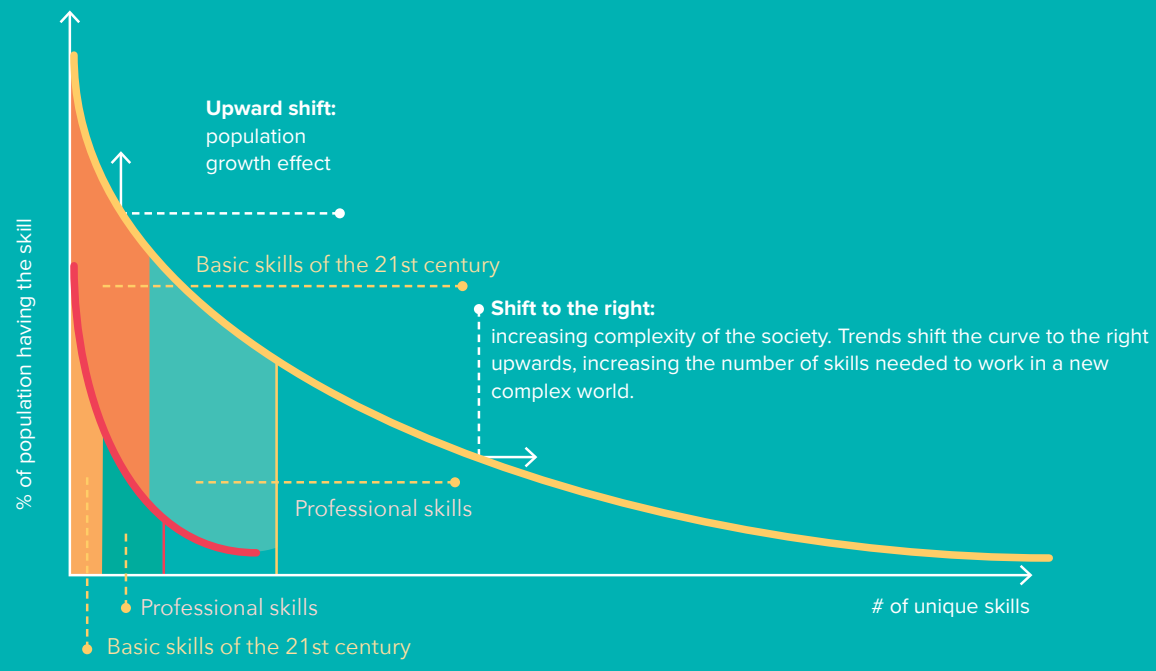
Furthermore, there is a shell for each specific type of activity — professional literacy. Thus, any of the hundreds of thousands of engineers employed in high-tech industries must have the skills of project management and work in computer-aided design systems (CAD).

However, basic and professional skills are followed by a "long tail" of hundreds or even thousands of specific skills that relate to the completion of specific tasks in certain conditions. Due to the growing complexity of the world, this "tail" is constantly growing, whereby the number of basic skills increases (but not that much) (Diagram 42).

We believe that major educational institutions should primarily focus on the development of basic skills with a subsequent addition of professional skills, whereas specialist skills can be left outside the main curriculum. These skills will constantly change, and you can acquire them both independently and via self-organizing small groups.

[133] The study hasn't been published yet; the materials have been provided for the preparation of the Report.

Diagram 42. "Long tail" of skills.



IN 2014, THE SKOLKOVO MOSCOW SCHOOL OF MANAGEMENT screened the professional skills of two thousand engineers working in leading companies in high-tech industries — aviation, shipbuilding, nuclear industry, and production of new materials. The screening was conducted based on the analysis of these employees' profiles on LinkedIn (for each category 400 profiles has been chosen).
The analysis revealed that for each of the activities, in general, engineers indicated 950-1500 skills.

Схема 43. Total number of skills, mentioned in LinkedIn profiles of engineers in different industries

INDUSTRY	NUMBER OF SKILLS
Mining and metallurgy	1458
Shipbuilding	1121
Advanced materials and composites	1023
Nuclear industry	957
Aerospace	946

Most of the skills (80%-90%) in each industry are represented by less that 1% of engineers. About 50% of them are unique and are mentioned just once in each sample. Only one third of all the skills are mentioned by majority of engineers.

5.2. Basic skills of the 21st century

The rapidly changing global landscape of employment and lifestyles changes the structure of demand for new individual and collective skills. In the 20th century, mass education used to cover the task of teaching people to read, count and write. Then specialized education, engineering technical schools or special courses were tasked with providing workers with skills required for a particular profession. The tasks performed changed little over time, and the education gained could suffice for most workers who would be honing their skills at the same machine day after day, and climbing up the career ladder step by step — from an ordinary employee to the foreman and the head of the production unit.

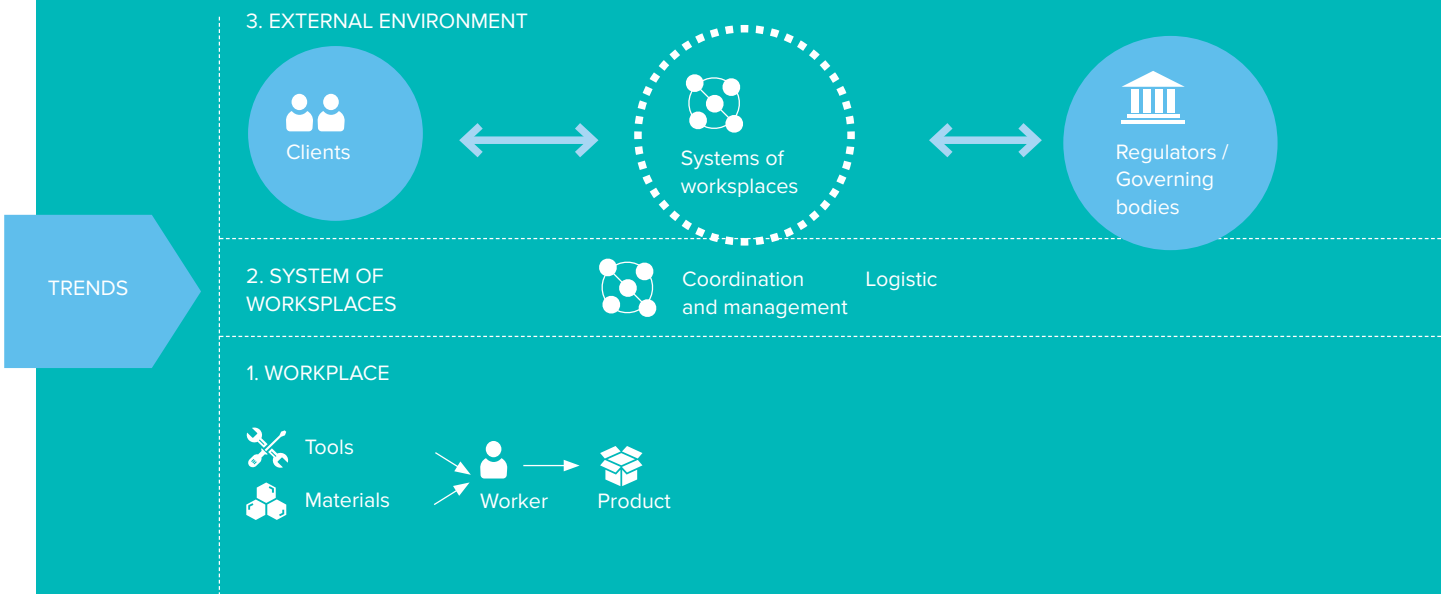
By the early 21st century, the vast majority of the world's population could read, write and count[134], but these skills are not enough to work in a complex new world. In the educational community, a new list of literacy called the 'Four Cs of 21st century learning', has been gaining popularity: critical thinking, communication, collaboration, and creativity[135].

In many countries there is a public debate about what skills should be included in a set of basic literacy of the 21st century. Impressive work in this dimension was done in the reports of the World Economic Forum[136], Center for Curriculum Redesign[137], Partnership for 21st Century Skills[138] and a number of other organizations.

Some countries are already carrying out full-scale reforms aimed at creating comprehensive education for the 21st century. In Europe, the pioneer is the government of Finland[139], in Asia, the pioneer is Singapore[140].

As part of our report, we want to complement the discussion on the skills needed in the 21st century by considering the changes in the structure of

Diagram 44: The influence of trends on the working environment.
The model is considered in more detail in Appendix 1



work that graduates will have to perform in a complex new world. When analysing the requirements that will be set for employees of the future, we propose to evaluate the changes not only at the level of a particular workplace, but also at the level of the system of workplaces (factory, office, etc.), and also at the level of interaction of the workplace system with the external environment (Scheme 43).

At the first stage of the analysis, we propose to outline a list of core competencies and basic skills that will be in demand in all types of human activity in the complex new world.

Basic skills of the 21st century

Attention management, concentration and awareness	These skills are necessary to cope with information overload and to deal with the complex technical systems
Emotional intelligence	The role of affective component of any job is rising. Understanding of one's own emotions, empathy and comparisons will allow to maintain personal balance in the complex world and to interact with others.
Digital literacy	The ability to work in the digital world (including AR and VR) will be as necessary as writing and reading skills are now.
Creativity	As more and more routine tasks will be automated the work done by humans will require the ability to come up with new solutions.
Ecological mindset	It is essential to understand the interconnectedness of the world, to perceive all actions with relations to the whole ecosystem, to sustain evolutionary processes
Cross-cultural skills	In any city, at any workplace the diversity of (sub-)cutures will be rising. The generation gap will add to this diversity.
(Self-) Study skills	In the fast changing world every person will have to keep learning throughout the life.

The list of basic literacies does not imply that education should be limited to these skills. We believe that in the 21st century, it is extremely important to move from a utilitarian industrial education to an integral educational paradigm. In the complex new world, education should be oriented not only around the transfer of knowledge and the development of skills, but also around the full support of the formation of man as a potent author of his life.

[134] According to UNESCO, in 2014, 85.3% of the world's population enjoyed a basic literacy rate. Among young people, this figure was 90.6% (50th Anniversary of International Literacy Day)
[135] "Four Cs" of 21st century learning: critical thinking, communication, collaboration, and creativity, developed by the American non-for-profit association Partnership for 21st Century Skills (P21) in 2002-2010. The association includes leading corporations, the US Department of Education, and public organizations.
[136] Reports of the World Economic Forum: Future of Jobs, The 10 Skills You Need To Thrive in The Fourth Industrial Revolution
[137] Center for Curriculum Redesign: Reports, books and other papers
[138] Модель Partnership for 21st Century Skills
[139] Finnish national board of education: Renewed core curricula
[140] Singapore Ministry of Education: Thinking Schools, Learning Nation

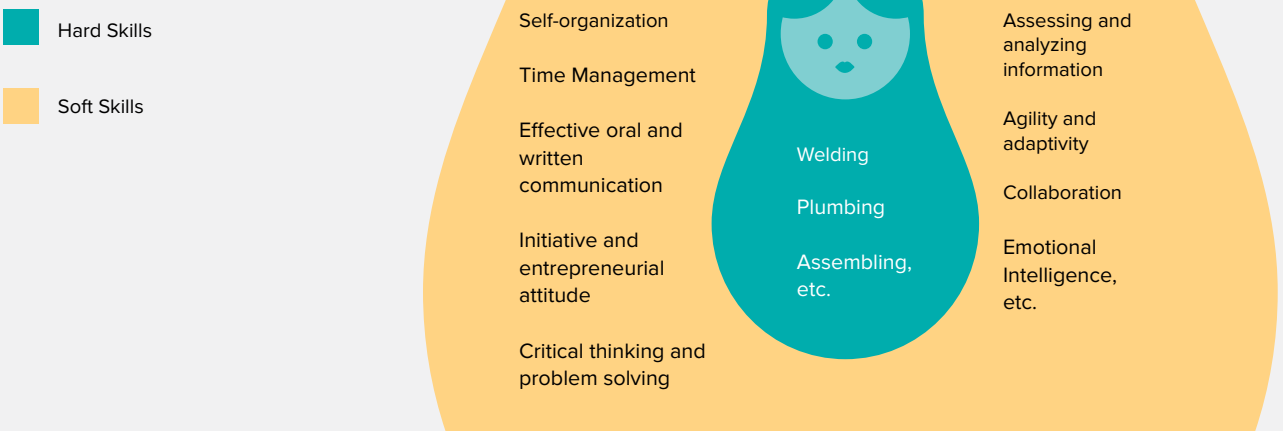
5.3 The new model of skills

'Hard' skills and 'soft' skills

The modern theory of management recognises the division of skills into hard skills and soft skills. Hard skills are understood as the ability to work with machinery and perform specific work, the result of which can be checked and measured. Soft skills include skills which are hard to track, test and demonstrate — for example, time management and the ability to interact effectively with people. Unlike hard skills with limited application, soft skills are applicable in broad contexts and are not limited to professional activities. In most existing educational programmes, the emphasis is made on hard skills, whereas various soft skills only complement the core programme.

The existing model for the majority of work professions can be represented in the form of a two-layered matryoshka doll. The hard skills would be at the core, and soft skills will accompany them on the outside (something that adds qualities and amplifies the first layer). It is assumed that hard skills are essentially a human activity. At the same time, soft skills shape that activity, adding more qualities.

Diagram 45. Simple skill model



Source: The work of the authors of the Report

The new model: existential and metacompetecies

Our ability to succeed in different contexts depends not only on soft and hard skills, but also primarily on the fundamental aspects of human personalities that determine how a person lives and acts. The properties of concern are usually considered intrinsic or acquirable at a very early age. However, the achievements of modern psychotherapy and practices related to the development of human potential indicate that even some fundamental properties (for example, a growth mindset[141] or optimism[142]) can be acquired or changed at any age.

More and more educational programmes pinpoint the significance of the development of foundational priorities in an individual. For example , in addition to typical knowledge and skills, the book 'Four-Dimensional Education'[143] encourages the consideration of such facets of education as the development of necessary character qualities and the capability of metalearning.

The term 'soft skills' developed with the need to distinguish them from other skills that are based on following standardised procedure and achieving a measurable goal (such as technical skills). This is an important step that has made it possible to pay attention to the social and emotional part of the educational process. However, now such categorization only limits the possibilities of educational process organization. To organize education, recognising changes that took place in the 21st century, we suggest using a four-layer skill model that includes the following levels:

(1) Context-specific skills (including, but not limited to, hard skills) are skills that are developed and applied in a specific context. These can be professional skills (programming in a specific language), physical skills (for example, driving a car) or social skills (for example, video blogging);

(2) Cross-contextual skills are those that can be applied in a larger domain of social or personal activities: the ability to read and write, time-management skills, teamwork skills, etc.;

(3) Meta-skills — are primarily different modes of operating objects in our mind or in the physical world, very close to what Gardner (1983) has called “multiple intelligences” or “intelligence modalities,” ranging from logical-mathematical to bodily-kinesthetic and interpersonal[144];

(4) Finally, at the most foundational level, there are **“existential” skills** that can be universally applied throughout the lifetime and in different living contexts of an individual. They include the ability to set goals and achieve them (willpower), self-awareness/self-reflection (meta-knowledge), the ability to learn/unlearn/re-learn (self-development).

The matryoshka of those skills will be assembled in a different way (see Scheme 43).

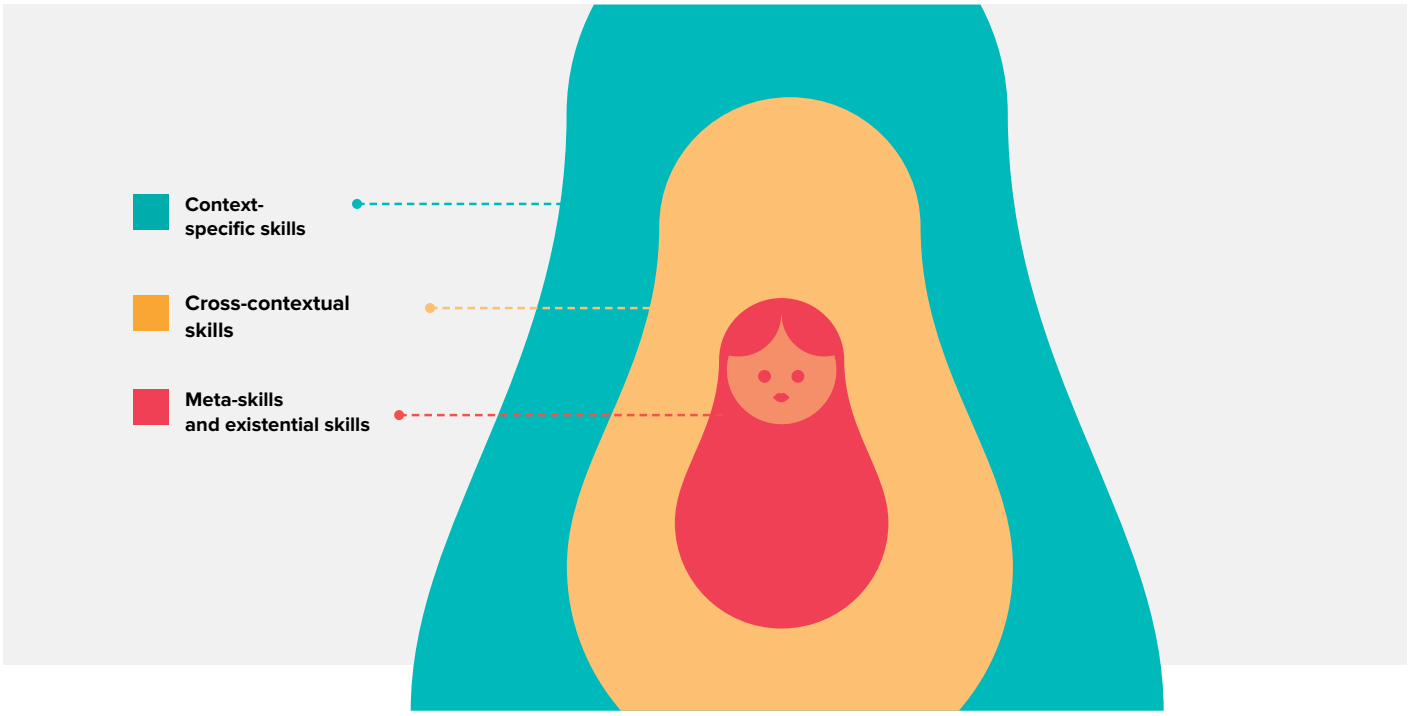
Existential skills will form the base since they determine the character of a person and the meta-skills that shape our ability to operate both in the external and inner worlds. The next layer will be cross-contextual skills, which are the base for any activity, and the context skills with most of the hard skills are on the outer layer since they can vary in accordance with the tasks performed.

[141] Dweck, C. S. (2006). Mindset: The new psychology of success. New York: Random House.

[142] Seligman, M. (1991). Learned Optimism: How to Change Your Mind and Your Life. New York: Knopf.

[143] The book “Four-Dimensional Education” is the result of the collective work of hundreds of teachers around the world who participated in foresight sessions and conferences held by the Center for Curriculum Redesign. In Russia it was published with the support of the SKOLKOVO Moscow School of Management.

[144] Gardner, H. (1983), Frames of Mind: The Theory of Multiple Intelligences, Basic Books



Source: The work of the authors of the Report

Diagram 46. New model of 21st century skills.

These skill layers also reflect the different life cycles of an individual (see Scheme 44). Context-specific skills (including hard skills in a professional context) can be learned and re-learned within short training cycles, and can quickly become outdated because of changes in context. Cross-contextual skills enjoy longer life cycles (years or even decades), but at the same time, they require longer periods to learn. Meta-skills, and in particular existential skills, have the longest life cycle; they are usually developed in the earlier stages of human life and rarely change afterwards. However, those individuals who are able to purposefully re-develop their existential skills are also able to change a variety of aspects of their life. This is why psychotherapy and spiritual practices often have a transformative influence on individuals, even those of a senior age.

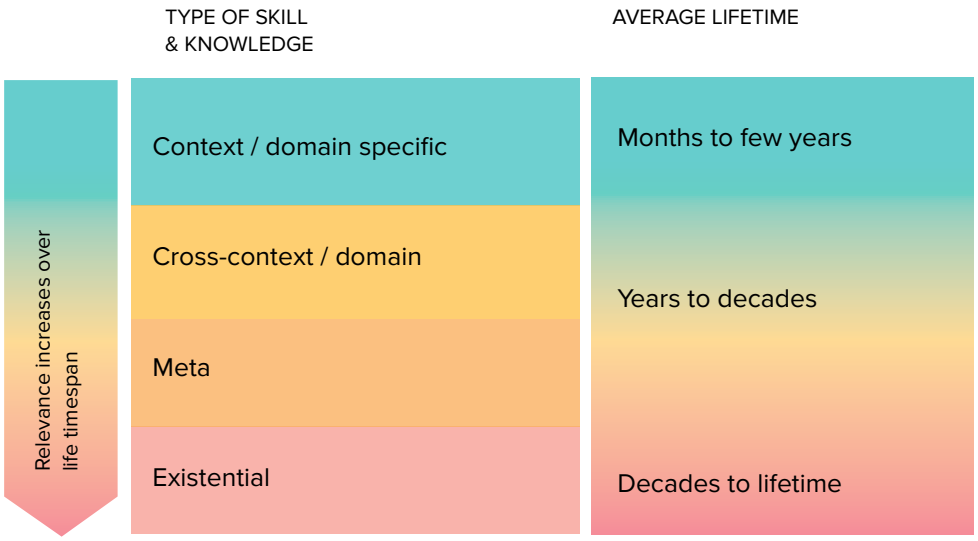


Diagram 47. The life cycle of skills

Source: Global Education Futures

6. Education for a new complex world

A new model of skills is impossible to introduce in a current educational system without changing the process of knowledge and skill transfer.

THIS CHAPTER IS BASED on the Report of Global Education Futures under the title "Educational Ecosystems for Public Transformation." (authors P.Luksha, A. Laszlo, J. Cubista, M. Popovich, I. Ninenko).
Since 2014, GEF has held a series of international forums and collective sessions on the formation of the image of education which is necessary to ensure positive social transformations. The events took place in the USA, Russia, Europe, Asia, Latin America, South Africa and New Zealand. The Report, which summarizes the results of this work, will be presented in autumn 2017.

6.1. Crisis of an industrial educational model

The change of a paradigm in vocational education

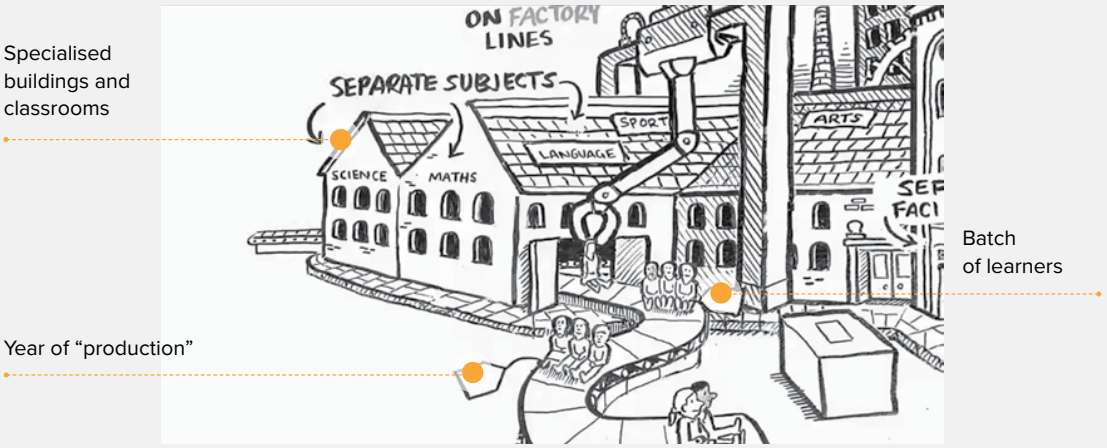
In almost every country in the world, the educational system is designed to prepare people for the conditions of the past: public obedience; work which does not normally require a creative approach; typical working processes; and a competitive working environment. A modern model of mass education emerged in the 19th century[145], where the main goal of education was preparing people for work in factories or government administration.

The whole educational system was built so that a student could grow accustomed to living in the rhythm of an industrial society: working week with a strict mundane schedule, the bell announcing the start and end for each class or academic day, and so on.

The educational process itself was based on the principle of an industrial conveyor belt where all students got the same pattern knowledge whilst progressing through a linear educational plan with only occasional freedom of choice. It was supposed that a skill-set required for work would remain quite static, and a worker would rarely attend vocational courses to acquire advanced skills and climb the career ladder. This educational model prepared people to complete routine tasks which were natural for the industrial epoch.

[145] This problem was discussed in greater detail in the works by Ken Robinson: "Creative schools"., Ted Talk "Changing Education Paradigms".

HERE IS AN EXPERT ON THE "INDUSTRIAL EDUCATION MODEL" British education expert Sir Ken Robinson from his book "Creative schools" [146]:
"Most of the developed countries did not have mass systems of public education much before the middle of the nineteenth century. These systems were developed in large part to meet the labor needs of the Industrial Revolution and they are organized on the principles of mass production. The standrads movement is allegedly focused on making these systems more efficient and accountable. The problem is that these systems are inherently unsuited to the wholly different circumstances of the twenty-first century."



Source: Illustration from the RSA Animate: Changing Education Paradigms based on talk by Sir Ken Robinson

The existing model proved its effectiveness in the 19th century and performed a range of crucial tasks in the 20th century: it successfully prepared billions of people to complete routine tasks which were natural for the industrial epoch, and promoted basic writing and reading skills among most people on the planet. But this system is inappropriate for educational tasks of the 21st century.

In a complex new world, there will be less grounded professions and more ad hoc roles that a person will assume while implementing collective and individual goals. The working environment will be changing on a constant basis. Education has encountered a situation where skills become outdated in some areas faster than a training process can be completed. This is why we need a decidedly new approach to the skills which are fundamental to the educational programme.

New educational goals

To solve the problem, it would not suffice to define a new set of literacies or update transferred knowledge. Economic and social transformation urges us to review the entire logic of the industrial educational model.

We can see the birth of a new educational paradigm which will facilitate the transition of society to a new social and economic way of life. This issue is discussed in greater detail in the Report by Global Education Futures under the title "Educational Ecosystems for Public Transformation." It considers the transition towards an integral education which would allow society to unlock the individual potential of each person and collective potential of humanity to the fullest extent.

In our Report we will not discuss in detail all facets of the new educational model, but we will put forward a few critical elements intrinsic to the image of an emerging educational ecosystem.

[146] Robinson, K., & Aronica, L. (2015). Creative schools. New York: Viking

THE REQUIRED SKILL OF THE FUTURE	WHAT DOES THE REQUIREMENT RELATE TO	CONFLICTING EDUCATIONAL PRACTICE	WHAT THE EDUCATIONAL PRACTICE SUPPORTS
Emotional intelligence, empathy	Necessity of co-operation with others, development of person-centred economy.	The tasks develop primarily cognitive skills. The emotional contact between teachers and students (and between students) becomes restricted.	The circle of "literacies" in the 19th century (reading, writing, counting) and scientific world picture. Controllability of school processes which arise as a result of intergenerational communi-
Media literacy, information hygiene	Problematic (often toxic) information environment.	Explicit ban on the use of new information technologies and devices in schools	Controllability of school processes: communication between students, lesson in progress, and so on.
Awareness, ability to manage attention		Lack of practical attention training for teachers and students	Reproduction of the work with attention in the 19th century (basically through the coercion of students) and prejudices
Ecological thinking	The need to combat ecological crises and create an eco-oriented civilization.	Limited contact with the biosphere (access to flora and fauna in school), use of terms such as "resource" in relation to the nature.	Controllability of school processes. Reproduction of nature images of the 19th century.
Creativity, ability to find unconventional solutions	High complexity, uncertainty and volatility of environment (VUCA).	Completion of standard tasks by a template within a prescribed time.	Obedience, compliance with the standard, restriction on creativity.
Co-operation, ability to solve unconventional tasks by way of co-operation		Individual completion of standard tasks, ranking and selection, explicit ban on reciprocal assistance.	Pursuit of personal development and success, controllability as a desire to meet school expectations (but not those of the classmates)
Ability to study which includes ability to choose personal learning strategies		Restriction or ban on setting personal goals in learning, pursuit of personal interests, independent research and experiments.	Obedience, compliance with the standard, controllability of school processes.

Diagram 48. Collision of the future skills and industrial education.

Source: P. Luksha

6.2 Elements of a new educational ecosystem

The industrial educational system consisted of standalone closed elements (school, technical college, university, etc.). They were interconnected, but offered a standardized educational programme. These days, education is turning into a sophisticated ecosystem with various educational elements ranging from large hubs to small centres. This may also include online courses and forums, mobile apps and devices, augmented reality application, mass games, and many other educational formats. The new ecosystem will appear evolutionarily, without abolishing the current one, but arising out of it. This will provide existing institutions with new roles and "ecological niches."

Schools, technical colleges and universities have good potential to become new educational hubs around which the ecosystem can centre itself.
>> They have **already existing special purpose spaces** appropriate for a wide **range of individual and collective educational activities** (classrooms, halls, yards), as well as special educational equipment (laboratories, sports equipment, etc.).
>> They have already become **a meeting place for different communities, groups and individuals**. They enjoy a wealth of knowledge and skills.
>> They are publicly recognized as a "safe harbor" or **container** which can accommodate different educational and social experiments.

In order to become an educational hub, schools and universities must step away from a traditional pattern.

In particular,
>> to be open to **students outside standard "cohorts"**, in other words, to the people of any age willing to engage in diverse lifelong learning;
>> to become quite flexible to provide educational **experiences of different durations** (from a brief one, limited to hours or minutes, to a very long one, extended to years), different intensity (from overly high, as in live role-playing games, to low, as in contemplative meditation), using different educational styles (co-operative and competitive, cognitive and emotional, participatory and observational, practice and theory-oriented, etc.);
>> to give opportunities **to many independent suppliers** who can add to the variety of the educational experience and create more sophisticated educational products through exchange and co-operation.

But the new system will not be limited to transforming existing institutions. It will represent a multidimensional space satisfying a wide spectrum of an individual's educational needs throughout their lifespan. From a learner's perspective, an educational system can be considered at least on two levels:
>> **locality/globality:** the educational process must relate to the local context, rely on a physical contact (for instance, city education, local project in schools), but at the same time it must rely on a world context, and be implemented via global co-operation (for example, with the help of global educational platforms);
>> **human/technology:** some educational experience can be acquired only through face-to-face interaction with a mentor, or in the community of practice; at the same time a significant part of education will be technology-based or have a full digital format.

Apart from schools and universities that gradually evolve to the "central nodes" which help navigate through the individual educational path and cultivate the environment for collective learning, one can name three spheres which will become an integral part of the educational ecosystem:
>> **global (online) educational platforms** which will become the main suppliers of knowledge and content;
>> **city educational formats** which will offer different educational services supporting the participants of lifelong learning;
>> **communities of practice** which will centre around groups of experts and start to rely on human interaction, co-creation, experience and technology transfer.

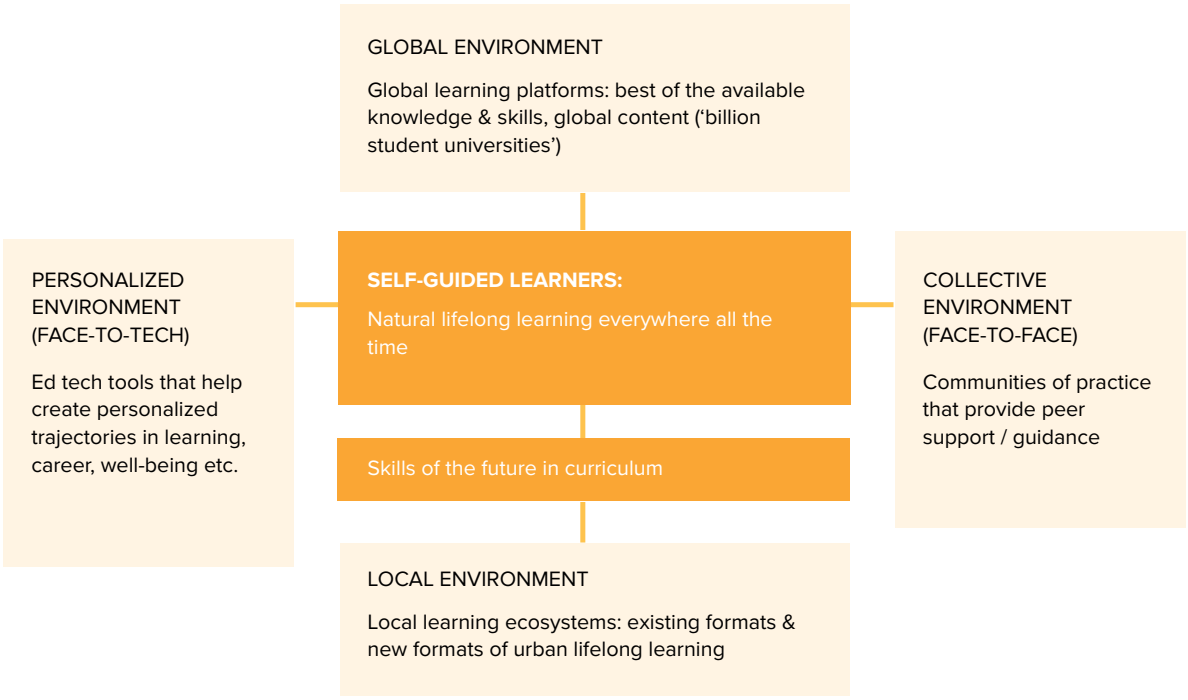


Diagram 49: Educational ecosystem: typology of environments

Global educational platforms

Global educational online platforms reduce the costs of full-time education and make education more accessible. At the moment, online learning exists in parallel to official full-time programmes, however more schools and universities are starting to create blended learning programmes where online and offline formats will organically complement each other[147].

Part of the knowledge-oriented learning programme will have adopted a purely digital online form over the next 15-20 years. This will allow teachers to shift the focus from knowledge transfer to other goals (for example, cross-disciplinary and metaskills, emotional development).

Educational platforms transform the very image of how knowledge is organized, by converting it from linear texts to multimedia form. One can expect the emergence of self-organized communities of knowledge (prototypes of arXiv, PLoS and Wikipedia). These platforms will connect fundamental knowledge with applied understanding, including through the development of comprehensive virtual models of real systems[148].

The development of mobile educational platforms will be the catalyst for the expansion of educational processes beyond the walls of schools and universities, and will help integrate education in various city sites and communities of practice.

City educational formats

City educational spaces will develop rapidly, thanks to the increased demand for new knowledge and skills for all students, from preschool to retirement age. Formal educational institutions cannot provide the required flexibility of educational formats. This will trigger the establishment of institutions of additional education including those targeting the development of creative and engineering skills, emotional and system intelligence.

[147] The Rise of Blended Learning, CUE

[148] Battulga B, Konishi T, Tamura Y, Moriguchi H. The Effectiveness of an Interactive 3-Dimensional Computer Graphics Model for Medical Education.

Lifelong learning takes place in a city environment and not only in schools and universities: in civil centers, fitness clubs, parks, during city excursions, etc. Local communities have started to self-organize and use cafes and other “third places” to acquire and disseminate skills and knowledge. The technologies of mobile learning and augmented reality will contribute to the conversion of many city spaces into educational ones.

All this leads to “overflow”, a growing shift from formal to informal, and from specialist to comprehensive education. As the city evolves into an educational space, more new instruments will support individual and collective education. Amongst the most important instruments are navigational ones, which link individual educational trajectories with educational opportunities in the learner's neighbourhood.

Communities, which are united by territory, profession, hobby and lifestyle, become educational sites around common interests and opportunities of the real world: sustainable farming, environmental protection, etc.

Communities of practice

A community of practice is a group of people who share common interests and support each other in improving and transferring skills in their area of interests. The term was suggested by cognitive anthropologist Jean Lave and educational theorist Etienne Wenger in their book “Situated Learning"[149]. Prior to mass education, skills were transferred through the very communities of practice. The admission to the communities was decided on an individual basis and only the chosen could become apprentices. These days, one can expect the promotion of this individual/collective regime of learning to admit everyone who is willing. Markets of educational opportunities will help connect the demand for practice-oriented education and acquisition of new skills with a flow of practical work inside the communities of practice. Given the universal access to theoretical information, there will be an ever-growing role of mentors who supervise their students in real projects.

[149] Lave, Jean; Wenger, Etienne (1991). Situated Learning: Legitimate Peripheral Participation. Cambridge: Cambridge University Press. ISBN 0-521-42374-0

Conclusion

In our report, we have tried to give an overview of the state of the labour market and vocational training around the world. It is hard to overestimate the challenges that industrial society is facing. We are witnessing simultaneous changes in the technological paradigm, governance models, social norms as well as large-scale demographic shifts. At the same time, ecology-associated planetary changes are starting to take place.

It is as if humanity is transitioning into a radically new form. The changes will hardly stop at the ones described in the review. Most likely, this is just the beginning of our journey and more dramatic events are awaiting us beyond this decade.

An outline of what is coming is emerging from the fog of uncertainty.

Despite being restrained by governments and society, automation will continue growing throughout the 21st century, quite possibly to a point when the whole global system of production and logistics can be maintained by only a few million highly skilled professionals.

Ousting humans from industrial production and knowledge production is bound to have systemic implications. Modern social contracts are based on the idea that every adult should be constantly working to provide for their family and children.

Part of the goods produced by adults is used to support the elderly in the form of pension contributions, the other part is used to provide for the disabled and perform social functions. The capitalist industrial system is a carefully honed machine within which labour markets, consumer markets, investments and government expenditure are trying to adapt to one another, and even slight modifications result in robust public debates.

In this sense, the cumulative effect of the trends that we have listed (reduction of available jobs by 50% over the next 20 years, emergence of “redundant” people, complete retraining of remaining staff in accordance with the requirements of digital economy, destruction of traditional future guarantee mechanisms, e.g. career guidance, long-term employment and adequate pension) can be evaluated as a revolution.

Transition towards a new model of society is not an issue by itself. Humanity has gone through such transitions at least twice: the first transition was from nomadic life to settled farming; the second transition was the mass migration to cities and engagement in industrial production.

From a historical point of view, the second transition took place very recently and resulted in multiple revolutions around the world, from a series of uprisings in France to communist revolutions in Russia and China, as well as two world wars that brought about an unprecedented number of deaths and redrew borders.

The main issue about the new transition is that it is happening too fast – not over a millennium like the agrarian one or over centuries like the industrial one but over merely a few decades. If we do not want the upheavals of the previous transitions to recur, we will have to assess our future and ask ourselves how we will be able to cope with what we are bound to face.

As Otto von Bismarck, the “Iron Chancellor” of Germany said, “If you can't beat them, lead them!” This is why governments of developed countries are beginning to search for ways to smoothen the transition towards a new “unemployed” society. As a first step, they are discussing the introduction of universal basic income for the majority of the population. Concurrently, they are conducting large-scale, long-term experiments in giving out money to the population “just because”.

However, there is still no response to the main question: what will the human of the future be occupied with, and what will their life be like? As for systems of education and vocational training and their regulators, they continue following old logic and preparing new generations for the swiftly disappearing world as if nothing has happened.

In some countries the situation is even more grave; not understanding how to deal with the approaching complex world, regulators of education systems are beginning to reverse the process and introduce detailed educational standards and unified national textbooks for all subjects. Such decisions may lead to years, if not decades, wasted by new generations on adapting to the real world, and enormous expenses for retraining graduates in order for them to meet employers' needs.

There is another major challenge that at least one third or even one half of the global population is facing.

Most of the trends we have listed (as well as associated transition) concern populations of developed economies, from European and North American countries to coastal cities of China and megacities of South America. These countries and regions will experience the transition towards a highly automated and network-centred society and will continue searching for new ways to include their population into the “complex new world”. However, a great number of other countries and economies (most of Africa and considerable parts of Asia and Latin America) simply remain on the other side of the fence: they do not possess skills needed for integrating in “the economy of the future”, and there may not be a role for them in the world of high-performance, automated production.

In other words, the globalization model according to which developing countries do the “dirty work” (sectors with a high share of manual labour or high levels of industrial pollution) and gradually become “cleaner” (as it happened in Japan at first, then in Korea, and is currently happening in China and Vietnam) is coming to an end.

Reindustrialization of technologically developed countries based on new developments (additive manufacturing, robotics, and renewable energy) in fact does not give underdeveloped economies a chance. The “complexity barrier” can create a more significant divide between countries, regions and social strata than all the ones we have experienced so far, such as a digital divide, global income inequality, or the North-South divide). At the moment, politicians and scientists do not dare start a serious discussion on this issue, yet we will be facing it in the coming decade.

We believe that the time for an ostrich-like attitude has passed. The only way to deal with the upcoming waves of changes is to acknowledge them and start actively engaging with them.

In this respect, there are three main areas in which government, business and community leaders should collaborate:

>> First of all, it is necessary to define a general outline of the future economy and society that will support desirable (non-catastrophic) scenarios of the development of mankind. To borrow the words of Buckminster Fuller, it is necessary to come up with a development option that would serve the interests of all humanity without destroying the planet.
Within these scenarios, new types of employment should be defined for people who would get released from the industrial economy (or would fail to enter it). Those could be the people-centred service economy, the creative economy (including new craftsmanship), as well as the economy of environmentalization and regeneration of natural ecosystems – in a word, all areas that rely on such human qualities as empathy, creativity, and the ability to feel and sustain life.

>> Secondly, there is a need for a large-scale discussion on transition in education from a “modular man” to a “complex man”, matching the challenges of a complex society. Naturally, a “complex man” needs to be described, shaped and assessed differently from a “modular man” of the industrial era, and these methods should be developed on the scale of global community, national and regional ecosystems. Education systems around the world are starting to be restructured according to the realities of the 21st century, and countries that delay the process are ruining their own future.

>> BThirdly, a new economy and new education require new governance systems that would reflect the challenges of the 21st century.
As early as the middle of the previous century, cyberneticist W.R. Ashby formulated his Law of Requisite Variety, according to which the internal complexity of a system must match the external complexity it confronts. A complex society requires complex control systems that on the one hand would work with big data and AI (i.e. data driven management), and on the other hand would make use of the huge potential of human networks and groups ("collective intellect”).
Small groups and lone leaders capable of managing a complex society are becoming obsolete. They are being replaced with distributed man-machine systems, permitting each member of society to be involved in management. The same principles will be applicable on the level of regions, industries, corporations and organizations, and this entails new rules of the game within economies and societies, new values, incentive systems, and elites. In order to avoid a war between old and new elites that, as we know, could bring about disasters of global scale, transition to new elites and handover of management rights shall be smoothed out by the creation of a new economy and new education system.

The question is not whether the transition towards a new society will take place. Let us reiterate: the transition has already started, and if there is no global disaster (e.g. global thermonuclear war), humanity will reach a fundamentally new state. The concern is how to make this transition less spontaneous and more deliberate and coordinated, as well as how to make it smooth out painful contradictions and prioritize global threats.

We should not be afraid of the new world; it can become the way out of an ancient labyrinth that humanity drove itself into centuries ago. Deep down, all of us understand the importance of being connected to nature, to life, and of feeling affection towards one another, but the industrial economy built around the world of machines has distorted this knowledge, distanced us from one another, and made us destroy the world in which we live.

Thanks to the new wave of economic transformation, automation and digitization, we are at a crossroads.

The nascent world can become a world of further enslavement of body and soul – digital enslavement this time around, when every move is controlled and where each one of us is inscribed in a "mega-machine" of global society. At the same time, we have a chance to remember what is truly important to us, to give back to machines what belongs to them, and to get back to nature and ourselves. This can happen, but only if we make this transition consciously, accepting and openly discussing the long-term implications of our choices, and developing new management principles and new ethics.

In this way, future skills can lead to the new world – a thriving global civilization of the 21st century.

Appendix 1

The influence of trends on the work environment

When analysing the tasks that workers face in the complex new world, it is important to consider changes not only at the level of a single workplace, but also at other levels of the work system. Within the framework of our analysis, we propose to consider three levels: the workplace level, workplace systems and the external environment (Diagram A 1.1).

The workplace level

At this level an employee works with basic elements of their workplace: the tools which help carry out activities, the material the product is made from, and the product itself. This description is best suited for the production sectors of economy, but these elements can also be projected on the economy of services or knowledge.

The level of workplace systems

Different workplaces form a system at the level of a workshop, project group, unit or enterprise. This level is characterized by interaction between workers themselves and jobs. Management and logistics are key elements at this level.

The external environment level

At this level, workplace systems interact with each other and with other external systems. The key external systems include regulators and consumer classes. Regulators are not only the usual public authorities, but also supranational structures of standardization and certification, as well as various branch associations and other structures. Social trends will influence the emergence of new consumer classes, which will generate not only demand for new products, but also create a new way of production organization.

Based on the results of expert meetings, we can assume the influence of certain trends on different levels of the work environment. At the individual workplace level, technological trends have the greatest impact. In the meantime, social trends play an important role at the external environment level. (Diagram A 1.2)

Diagram A 1.1: The influence of trends on different levels of the work environment

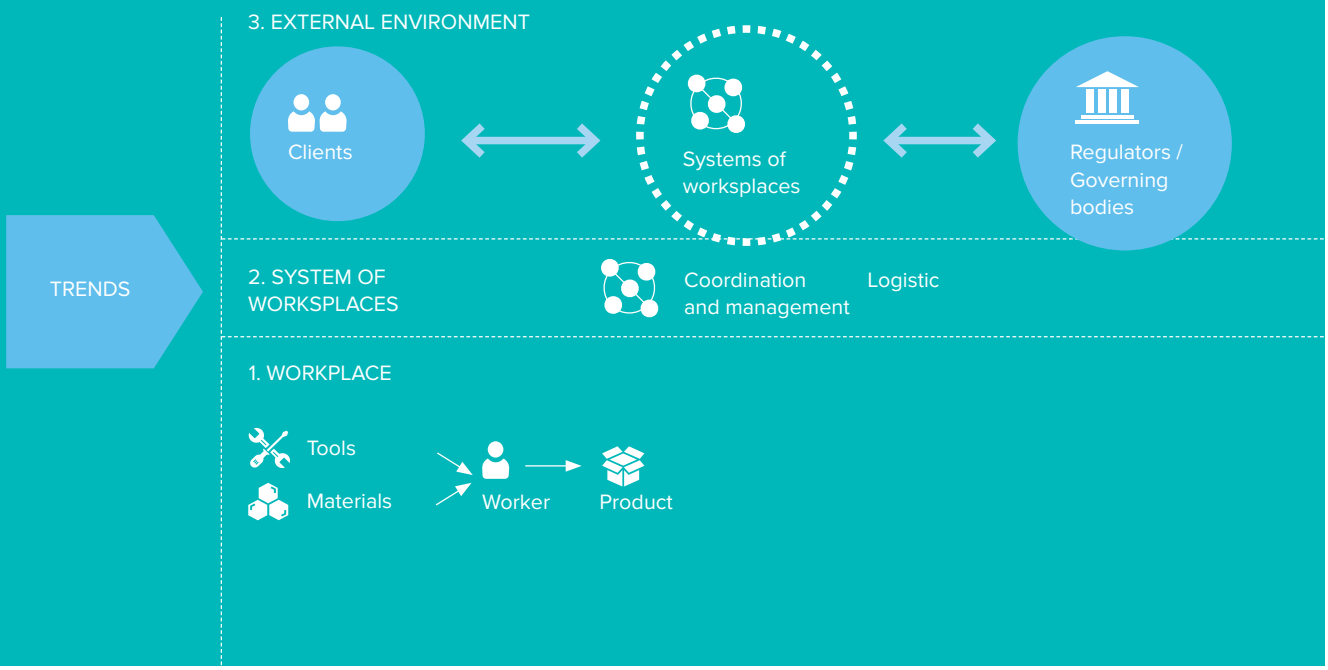


Diagram A 1.2: The influence of trends on the levels of the work environment.

TREND	WORKPLACE			SYSTEM OF WORKPLACES (e.g. fabric)		EXTERNAL ENVIRONMENT	
	Tool	Material	Product	Manage-ment	Logistic	Regulators / Governing bodies	Clients
Digitalization	High	Low	High	High	High	Medium	Medium
Automation	High	Low	High	High	High	Medium	Minimal
Globalization of technological development	Medium	Low	Medium	High	High	High	High
Greening of cities and economy	Medium	Medium	High	Low	Medium	High	High
Demographic changes	Low	Minimal	Low	Low	Minimal	Minimal	High
Rise of the net-centric society	Low	Minimal	Low	High	Medium	Medium	High

High level of influence
Medium level of influence
Low level of influence
The effect is minimal or nonexistent

Appendix 2

Recommendations for WorldSkills development

As a global movement which promotes the development of skills and improvement of training systems in 77 countries around the world, WorldSkills cannot stay out of the ongoing global transformations. Initially created as a system of competitions, these days WorldSkills represents a global hub which implements development projects in six main areas:

>> competitions;
>> education and training;
>> career management;
>> research;
>> communications;
>> international cooperation

Each of the mentioned blocks is subject to transformation for reasons including the processes described in this Report. Every National Skills Organisation is welcome to use the information in this Report at its own discretion when implementing development projects.

Below are the general recommendations for the WorldSkills movement which are based on the suggestions of project participants and foresight sessions held at various WorldSkills sites. This includes, in particular, the results of sessions on projecting the skills of the future in Kazan (Russia) in May 2015, in which WorldSkills technical and official delegates participated, as well as the EuroSkills 2016 Conference Programme in Gothenburg (Sweeden), WorldSkills Hi-Tech 2016 in Yekaterinburg (Russia), SkillsUSA 2017 in Louisville (USA), and the WorldSkills Russia National Competition Finale 2017 in Krasnodar (Russia). The suggestions expressed by experts during interviews with industry representatives, conducted as part of the preparation of this Report, have been taken into account for the purposes of these recommendations.

Due to the changes taking place in the economy and in society, the WorldSkills movement is advised to consider following suggestions:

>> articulate soft skills and metaskills within the standards for competitions and training;
>> carry out additional research on best practices in countries where soft skills are formed and evaluated both within hard skills, and separately;
>> identify areas for Future Skills competitions to encompass not only professions that are relevant and popular at the very moment, but in emerging specializations of new sectors of the economy with a focus on skills that are most in demand and needed in a changing world in the forthcoming 10-20 years;
>> allocate areas of Heritage competitions to hold such competitions in disappearing professions which are of historical value for the education of children and illustration of transformation laws of the labour market;
>> conduct “experiments” in new professions in partnership with technological companies, allow the accelerated introduction of new professions by the decision of a strategic or other relevant focus group, if this area corresponds with strategic priorities and developing trends of this particular industry;
>> To introduce a special experimental league which allows to broaden the age limits of competitions and training programmes to include younger (junior skills) and older ages ("expert competition");
>> promote the implementation of individual educational trajectories as well as the free transition between levels of professional mastery, and suprasubject areas, regardless of the basic level of training;
>> increase transparency and independence of the Skills Passport assessment and validation mechanisms, in co-operation with global companies and associations of employers;
>> enhance the attention paid to professions in new sectors of the economy including green economy, creative and knowledge economy, virtual economy and people-oriented services;
>> use best practices in online courses;
>> improve environmental awareness both by strengthening this component within a set of skills under evaluation and by improving the practices of competition organization.

>> In regards with the trends covered in this report it is also recommended to explore possibilities to strenghen the following components of the competition:

Teamwork — tasks with collaborative problem solving;
Uncertainty and adaptability — tasks to deal with new materials or technology, which require to jump into the working process;
Lean production — optimising resource allocation, waste minimization, utilisation strategies;
Interactions with client — tasks that require to communicate with client, to understand client's demands, to reach an agreement and to resolve conflicts;
Full manufacturing (or service) cycle — set of tasks that together model the full cycle of work;
Virtualisation of the workplace — tasks that require to use new interfaces, including remote participation;
Creativity — creative and non standardised tasks.

Authors:

E. Loshkareva, Official Delegate, Deputy Director General for Research and Development, WorldSkills Russia
P. Luksha, founder Global Education Futures, Professor of Practice at Moscow School of Management Skolkovo
I. Ninenko, researcher at Global Education Futures
I. Smagin, researcher at Moscow School of Management Skolkovo
D. Sudakov, head of the Atlas of Emerging Jobs project

Design: **D. Frolova**
Editor: **A. Dobryanskaya**

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