Engineering

HIGHLY PREPARED EXPERTS FOR INDUSTRY 4.0

Anca Georgiana COSTACHE (STOCHIȚOIU) [1]
Dan Mihai BARLIBA [2]
Violeta - Carmen ZALESCHI (NEGREA) [3]
Gabriela Beatrice COTET [4]
Costel Emil COTET [5]

ABSTRACT:
OVER THE LAST FEW YEARS THERE HAVE BEEN GRADUAL CHANGES TOWARDS THE NEW TECHNOLOGY, BUT FROM NOW ON, THERE IS ALREADY A DIFFERENCE IN THE PACE AT WHICH THINGHS NEED TO CHANGE. PROGRESS AWAITS NO ONE, AND EVERYTHING THAT IS NEW MUST BE ABSORBED AS FAST AS POSSIBLE. MOST OF THE DISCUSSIONS ON THE 4.0 INDUSTRY HAVE AS THEIR MAIN CONCERN THE LACK OF SPECIALISTS IN THE FIELD, THE LACK OF SPECIALISATIONS THAT CAN SUSTAIN NEW TECHNOLOGY OR THE LACK OF NEW SPECIALISATIONS REQUIRED BY THIS ONE. UNFORTUNATELY, TECHNICAL OR INDUSTRIAL SPECIALIZATIONS ARE NOT THE ONLY NECESSITIES THAT WILL COME IN HAND WHEN DEALING WITH THE CHANGE TOWARDS NEW. THE LACK OF SOFT SKILLS WILL BE FELT AS COMMUNICATION AND COLLABORATION AMONG VARIOUS INTERESTED COUNTRIES SHOULD BECOME BETTER. GREAT ORGANISATIONS ARE ALREADY BEGINNING TO REALISE THAT THERE IS A LACK OF SOFT SKILLS AT THEIR CURRENT EMPLOYEES OR AT THE PEOPLE TO COME TO JOB INTERVIEWS. HOW DO WE PREPARE EMPLOYEES FOR THE NEW TECHNOLOGY REGARDING EXPERT SKILLS AS WELL AS SOFT SKILLS?

KEY WORDS: SOFT SKILLS, 4.0 INDUSTRY, NEW TECHNOLOGY, SPECIALIZED SKILLS

INTRODUCTION

Many observers estimate that the world is at the start of a new Industrial Revolution, which is considered the Fourth Revolution and is called ”Industry 4.0”. Connecting a lot of products to the Internet, presence of sensors, wireless communications expansion, robot and intelligent machine development, real-time data analysis have the potential to turn the way the production is done. Connecting the physical world to the virtual world in cyber-physical systems will have a disruptive impact on technologies, manufacturing processes and people.

Industry 4.0 is a significant transformation of all industrial production by unifying digital technologies and the Internet with conventional industry. The views are divided with regard to the use of the terms of revolution or evolution.

[1] PhD Student, University POLITEHNICA of Bucharest, Romania, stochitoiu_anca_georgiana@yahoo.com
[2] PhD , University POLITEHNICA of Bucharest, Romania, mail
[3] PhD Student, University POLITEHNICA of Bucharest, Romania, vio_negrea@yahoo.com
[4] Lecturer PhD, University POLITEHNICA of Bucharest, Romania, beatricenica@gmail.com
[5] Professor PhD, University POLITEHNICA of Bucharest, Romania, costelemilcotet@gmail.com

In Europe, the concept was launched and supported by Germany through government programs and top companies like Siemens or Bosch. In America, the move is called ”*Smart Manufacturing*” more often, China is talking about ”*Made in China 2025*” and Japan is promoting ”*Innovation 25*”. All aim to develop an industry that launches products faster, increase flexibility as well as resource efficiency through digitization.

If we think that over the past 15 years the product variety has doubled while the life cycle has been reduced by 25%, it is quite easy to imagine that the development and manufacturing process is growing and requires new models and technological solutions could meet the needs of customers. From this point of view it can be stated that Industry 4.0 has emerged as a necessity for the efficiency of production processes. Technological exponential advances, manifested by processing power, memory capacity and the multitude of developed applications have made industry evolve to this level.

From an economic point of view, Industry 4.0 is a chance to re-launch, re-technologize Production and evolve business models for services and products.

Political and social aims to re-industrialize Europe for sustainable development after two decades in which production has been shifted to Asia and only one in 10 EU-wide companies have made it into manufacturing. The European Commission has developed a "European Industrial Renaissance" plan. In 2014, value added in production accounted for only 14.5% at EU level and the growth target is projected to be 20% by 2020.

SKILLS AND JOB ANALYSIS FOR INDUSTRY 4.0

The training of specialists in the framework of Industry 4.0 is of tremendous importance for the society as a whole. Priority should be provided in this respect to the transition of experience (generically speaking) from one generation to another; new skills cannot be promoted and developed on an empty space, but on the contrary, they could continue and raise at higher levels to the already existing expertise both from theoretical and pragmatic points of view. Through organized school activities and informal actions, the already accumulated experience during the last decades with regard to automatic profile of industries, AI ways and means, digitization, cybernetics etc. could and should be taken into account and developed from new perspectives.

A second matter envisages the exchange of experience about the evolution under the auspices of Industry4.0. Here we have in mind multiple levels: local, regional, global with a great plurality of actors such as: communities governing bodies, Governments, governmental structures (agencies, centers and authorities), NGO’s, academic and scientific entities (schools, Universities, research centers, think-tanks), intergovernmental agencies, regional, sub regional and national organizations (e.g. UN System, European Union etc.), media, financial and banking institutions.

Concrete and valuable experience should follow in double way, having a great role in sharing new ideas, scenarios and priorities on short, medium and long term. Industry 4.0 and, on a much broader level, the Fourth Revolution of this century (the first one of the Third Millennium) does not represent a task limited to a single local community, a single nation, a single geographical region, but has to concern the mankind and the world as a whole. It is therefore a universal worldwide matter.

Thirdly, interdisciplinary approach represents a *sine qua non* (an indispensable and essential) condition which could guarantee the future of the Industry 4.0. This is why, besides the contacts among experts from the same scientific or technological branch, collaboration among specialists belonging to various, but complementary fields is needed on the basis of some matters of mutual interests, discussed and evaluated from different professional perspectives.

Looking at the technology history from the point of view of adapting to consumer requirements, we can divide it in the next four stages:

1. The period before the first industrial revolution (that of craft production) is characterized by the fact that each product was designed and made for a particular customer (footwear, clothes, horse harnesses etc.).
2. The industrial revolution of the 18th and 19th centuries has led to an increase both in productivity and volume of production by product variants, which led to the transition to a new paradigm at the beginning of the 20th century: that of production (introduced by Ford in the Ford T model).

At this stage, a limited number of products are manufactured, which are made in a very large number (mass), assuming there will be enough customers for them. Year 1955 is considered to be characteristic of mass production, as the year with the highest production volume for a particular product alternative. Starting this year, turning, the variety of products grows and the number of similar products starts to drop.

1980 is the year of transition to a new stage, that of mass customization in which the customer selects the desired product from a list of options before it is made (classic example is that of choosing the passenger car configuration based on a list of variants and then putting it into production).

The fourth technological stage is that of personalized production that begins in the first decade of the 21st century. During this time, product options are chosen by the customer, purchased from the manufacturer and then made with advanced processing systems. An essential role in the leap in technological innovation that has been applied on an industrial scale: faster prototyping technologies, called Additive Manufacturing, cloud manufacturing, augmented reality, simulation etc.

The great Industrial Revolution depends on small technological revolutions in various areas such as:

- Applying information and communications technology to digitize information and integrate systems into conception, development, manufacturing and use of products.
- New software technologies for modeling, simulation, virtualization and digital manufacturing.
- Developing cyber-physical systems to monitor and control physical processes.
- The evolution of 3D printers and additive manufacturing to simplify manufacturing.
- Decision support for human operators, the emergence of intelligent tools and assistance using augmented reality. New forms of human-machine interaction. Many of these technologies have been available for a few years, and others are not yet ready for use on a broad scale.

<u>Benefits of Industry 4.0:</u>

TIME: Every employee becomes more efficient while working in an optimized process. Engineers spend 31% of working hours searching for information which can be used for activities that produce value.

COST: Provides accurate data in the right context and format to make information-based decisions. Incorrect or partial information and erroneous decisions taken on them cost about 25% of the company's income.

FLEXIBILITY: Creates flexible systems ready for change and for new opportunities. Only 36% of companies are prepared to optimize processes based on data analysis.

INTEGRATION: Digital manufacturing involves the simultaneous development of the product and the production process. Companies reduce 80% time with production interruptions if they use digital validation.

As a matter of fact, there are certain specific advantages, mainly related to the professional background of young people who will be sooner or later involved in all processes of Industry 4.0. This background envisages on one hand, the level of knowledge and updated information and on the other hand, the level of competences and abilities. There is a relevant and useful point, for instance, the openness of younger generation, particularly of graduates of the secondary and higher education institutions, towards the basic issues of IT, communication systems, virtual environment, new software technologies etc.

At the same time, one should stress the fact regarding the knowledge of certain foreign languages (mainly English-for those who don't have it as a native language, but also French, German, Italian or Spanish), with an emphasis on the technological and scientific language (area of words and expression). It is obvious that those languages represent am useful door to a solid specialization in accordance with the values, realities and trends of Industry 4.0.

The Digital Factory will allow optimization of all phases in the product life cycle. Virtual simulations of design and functionality, developed parallel to the manufacturing planning lead to a much faster market launch, significant cost reduction and higher quality. Everything will be driven by data analysis. The Digital Factory integrates Product Lifecycle Management, Digital Manufacturing, Manufacturing Execution System and IoT components that communicate feedback from on-going manufacturing processes or from in-service products.

In terms of inherent disadvantages and short-comings we have to underline various aspects, among them:

- The need for professional re-orientation, a matter which requires a certain degree of mobility, of capacity of changing, in due time, the environment (in its broad sense, including social one). Such a process of re-orientation seems to be more difficult and complex on the level of those people being more than 40 years old; anyway "difficult,, does not mean "impossible".
- The need for new categories of professions/kinds of activity, which have to overcome the previous ones, very familiar for the given reasons and which must cover the full range of competencies that will come up with advancing to the Industry 4.0.
- The particular need for high-level specialists in fields like: IT, Artificial Intelligence, robotic etc.

Each of the above-mentioned requirements depends on the content and orientation of training process of various degrees, mainly on higher education process, which is the closest to the future jobs understanding.

Jobs in Industry 4.0

The future of specialists will be seriously influenced by Industry 4.0. Surely the skills required in the factories of the future will be other than the present ones. Many of today's activities, serving production machines, precision positioning, assembly, quality inspection will be done by robots. They are not only more effective, but they also communicate perfectly with decision and control systems.

The labor market will change, but it is hard to predict if there will be more or fewer jobs overall. Robots are still at the beginning and cannot replace people in all their activities. On the other hand, the rate of return on investment in a fully automated factory is not attractive nowadays. All forecasts are based on historical data, but exponential technologies are completely new, so the effect of large-scale evolution and use is hard to be predicted. The

risk is to have massive unemployment for certain categories of population and the lack of staff with digital skills.

Disturbing changes in business models will have a profound impact on the labor market landscape in years to come. The rapid pace of change will translate into distortions of current business models that will lead to a permanent need for new skill sets. At the same time, this will require joint efforts for adaptation. Expert Klaus Schwab voiced concern that organizations may not face the adaptation process. Governments may also, from their position, not be able to hire or regulate new technologies to make the most of their benefits. The transfer of power will generate important safety concerns, inequality may increase and society may be fragmented.

When compared to previous industrial revolutions, this fourth wave of change evolves rather at an exponential than linear level. In addition, it brings massive changes almost every industry sector in each country. The extent and depth of these changes predict the complete transformation of production systems, management and governance. The revolution can amplify the phenomenon of social inequality, especially through its potential to disrupt the labor market equilibrium.

As a consequence, some analysts are of the opinion that talent in the future, more than capital, will become an essential factor in the production process. This will bring an ascendance of a more and more segregated labor market into categories such as "few skills / little money" and "multiple specializations / more money" and this will in turn lead to an increase of social tensions. Technology is, therefore, one of the main reasons why revenues have stagnated or even diminished for most of the population in countries having high income sources. The demand for super-qualified personnel increased, while employees with a basic level of education diminished. The result is a labor market with a strong demand at both ends, but with middle-goal goals.

Job training for a successful career path

The field of informatics and mathematics was expected to record a strong focus on data analysis, as well as on the development of software and applications. Not only the IT & C industry will grow, but also a wide range of sectors, including:

- The system of financial and investment services.
- Entertainment and Information.
- Mobility and professional services.
- Computational power and Big Data analyzes as an important driver for generating new jobs, all as a result of digital transformation globally.

The future looks good for those who want indeed to become data analysts or sales representatives. That's because of all the malfunctioning generated, the competition for genuine talents in IT, math, architecture, engineering and other strategic areas will become fierce. Employers will have to prioritize how they secure their valuable human resources.

The world is changing: from smartphones to video games or gadgets which we are witnessing, transforming the world into an incredible place. The same happens with professional skills. The qualities that we are now implementing at work are not necessarily the same we will need in the future.

Fortunately, a report done by the World Economic Forum, generically called ”*The Future of Jobs*”, makes a forecast of how the labor market will look more than 15 years old. The information comes from dialogues with certain heads of human resources and strategy managers from some of the most renowned multinationals. But before we find out what are the skills that everyone will need in 2020, let's first understand what the change factors are:

- Extreme longevity - people live longer.

- The rise of smart devices and systems can potentiate and even expand our own skills; automation at work brings the end of repetitive jobs.
- A Computerized World - The multitude of sensors and processing make the world a programmable system. Information gives us the ability to see things on a scale that has not been possible so far.
- New Media - New media and communication tools require media literacy that goes beyond the usual text; Visual communication becomes the new common language.
- Super structured organization - Social technologies generate new forms of production and place great emphasis on creation; Social tools allow organizations to work at oversize levels.
- Global Connectivity - Diversity and adaptability are at the heart of things; Europe and the United States no longer have the monopoly of job creation, innovation or political power.

Which abilities will suffer the most significant changes? In our view, these change leaders will metamorphose the way we live and how we operate. Some jobs will disappear, while others will appear and become commonplace. One thing is certain: the future of the workforce will have to align its skills set in order to keep up with the change.

Tabel 1. Top 10 skills 2015 vs. 2020

	In 2015	In 2020
1.	Complex problem solving	Complex problem solving
2.	Coordinating with others	Critical thinking
3.	People management	Creativity
4.	Critical thinking	People management
5.	Negotiation	Coordinating with others
6.	Quality control	Emotional intelligence
7.	Service orientation	Judgment and decision-making
8.	Judgment and decision-making	Service orientation
9.	Active listening	Negotiation
10.	Creativity	Cognitive flexibility

Creativity will make the biggest jump in the rankings of skills, becoming one of the three most sought-after qualities by employers. With a great deal of products and services, new technologies and working methods, employers of the future will have to exploit more and more creativity to implement the most of these changes.

On the other hand, negotiation and flexibility, two skills that are now leading in the ranking, will gradually lose their relevance. Computers using large data sets are starting to make decisions in our place. By the same pattern, active listening also loses ground and runs the risk of not taking place in the top 10. Emotional intelligence, which so far has not accumulated too many points, will also go up in the rankings to an attribute that everyone needs.

Another report, this time provided by the Institute for the Future (IFTF), identified some of the key skills needed in the coming years. They are as follows:

- The ability to mix correlates things to give rise to new ideas and proposals.
- Social Intelligence - the ability to relate to people and build functional ties. Influence and the creation of relationships will derive from the ability to ask the right questions and not necessarily always have the best answers.

- Computational Thinking - refers to being analytical, a very important quality in a focused environment around the notion of information. The ability to translate large amounts of data into really useful information is now more than ever an essential quality.
- Inter disciplinary - Companies will look for people having new skills, trained agility who have general views, know how to listen, synthesize ideas and make connections.
- Cognitive load management - the ability to effectively filter and focus on what is really important.

Of course, all of the abilities above mentioned do not only function independently. They also need to be accompanied by technical skills or professional certifications to help the individual entity remain relevant in the competitive labor market environment.

Advantages of Romania in Industry 4.0 perspective

There are significant development opportunities for Romania in the context of Industry 4.0. The direction in which the industry goes is very clear. Data management and security will be key issues requiring adequate and lasting solutions. To achieve the true Industry 4.0 potential, companies need to plan digital transformation, producers must today on-the-go search for and build the best talents with digital skills and develop a clear plan on how the digital factory will look and companies need to fully understand the importance and urgency of digitization, both success and bankruptcy will happen at very high speeds.

There are many factors that place our country as an EU Member State in a very favorable position in the prospect of moving to Industry 4.0. Even if there are some voices claiming that we cannot make the leap from 2.0 to 4.0, Romania will significantly benefit and attract many investments. Here are 7 major advantages that Romania has:

- Strategy Industry 4.0 aims to bring production back to Europe, focusing on personalized production, high quality and manufacturing near the consumer market. Eastern European countries with their emerging market economies are the best destinations for investing in new production facilities.
- The car industry will be the one to engage most resources and make the most investments. Fortunately in the last 10 years, this industry has strongly developed. The number of automotive suppliers in Romania is steadily increasing. We have only two car makers, Dacia and Ford, but the supplier network is well-developed and diversified. Of the top 20 global automotive suppliers, 13 are today present in Romania with production facilities. According to ACAROM (Association of Automotive Manufactures of Romania-a professional body of companies involved in the automotive industry), the turnover of suppliers higher than the builder's.
- The speed of Internet connection in Romania is one of the highest in Europe. The Internet of Things will generate a huge amount of data and will require very high transfer and processing speeds.
- IT companies will have increased involvement, Industry 4.0 will attract new cyber-physical systems (CPS) or services: IT security, Big Data analysis, M2M solutions and Artificial Intelligence. The IT sector is well developed in Romania and can support investors' efforts in digital factories.
- The skills required for the digital factory can be found in Romania. There is a good production tradition and good technical universities all over the country, as evidenced by the numerous investments in automotive R & D centers.
- In the period 2016-2020 there are envisaged many programs with non-reimbursable R & D in Industry 4.0 technologies. They will support the development of Romanian companies and attract foreign investors.

- Germany is the main supporter of Industry 4.0 strategy and one of the largest investors in Romania. Many German companies already have state-of-the-art technology in our production facilities.

CONCLUSION

An important challenge for education and training systems is represented by their rapid adaptation to the spectacular technological developments of the last quarter of a century. Automation and information technologies radically changed the skills needs of the labor market, highlighting the enormous gap between the provision of training provided by the institutions and the demand for new skills tailored to the needs of this new Industrial Revolution. As early as 1970, Alvin Toffler drew attention to the impact of new information and communication technologies on individuals and society in general in his famous book:"*Future Shock*". More recently, but in the same direction, a plethora of global personalities presented arguments on how spectacular developments in technology revolutionize the nature of work, triggering an alarming signal about the need to adapt the organization and functioning of public institutions.

Sir Ken Robinson, in his book "*Creative Schools: The Grassroots Revolution That's Transforming Education* " emphasized the idea that new forms of work are characterized by innovation, creativity and in-depth specialization, which is why it is very important for governmental institutions dedicated to education and training to encourage skills-based approaches through effective capitalization of the skills / talents of each individual. Ray Kurzweil, an inventor, futurologist and artificial intelligence expert, stated in one of his public interventions that "the biological abilities of the human mind develop at a linear pace, while non-biological abilities of technology develop exponentially," which means, according to its projections and expectations, that by 2029 artificial intelligence will have similar skills to those of people. In 2011, a study elaborated by the Institute for the Future1 (a research group with more than 40 years of experience in anticipating and identifying emerging trends and discontinuities that transform markets and global society) outlines the main challenges ahead for 2020. Digital technologies can substitute workforce through capital. Productivity shows major increases, but not the same with wages. Moreover, due to increased accessibility to telecommunication services (voice and data), multinational companies have the opportunity to use a cheaper local workforce to carry out activities in a region of our planet where workers are much better paid. This generates social dumping and increased competition on the labor market, especially in developed countries, which can lead to the escalation of conflicts whit in society and the degradation of social protection systems.

In order to assist Member States in implementing education and training policies, the European Commission considers that public dialogue should be stimulated in the next period, that a new Education and Training Vocational Agenda be adopted as well as alternative models of local, national and global governance. Following consultation with the social partners and the main training providers, the Commission has established a list of key competences that are needed to increase employability in the labor market: mother tongue communication, foreign language communication, mathematical skills, basic skills In science and technology, digital competences, learning to learn, social and civic competences, the spirit of initiative and entrepreneurship, cultural awareness and expression.

REFERENCES

1. **Robinson, K. and Aronica, L**. (n.d.). *Creative schools*;
2. **Schwab, K.** (2017). *Fourth Industrial Revolution*. The Crown Publishing Group;
3. **Toffler, A.** (1970). *Future shock*. London: Pan Books;
4. World economic forum. (2017).*The Future of Jobs*. [online] Available at: http://reports.weforum.org/future-of-jobs-2016/ [Accessed 11 Jul. 2017].