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FUTURE CHANGES IN THE LABOR MARKET

Introduction

Metamorphosis is an irreversible process that changes the form or nature of a thing or person into a completely different one. In this respect, digital technology is bringing about a social metamorphosis. Information and communication processes are increasingly playing a critical role in contemporary society. Computers are affecting human life in a great deal in that they are essential in all dimensions of life. An ever-increasing numbers of thing are run by computers and massive amount of multimedia materials circulate through the Internet, especially via smartphones.

In relatively short time, information and communication technology (ICT) has spread worldwide from defense to space and large industry applications, business, hospitals, education and entertainment. New technologies have thoroughly penetrated into our everyday life, affecting not only science and business, but also leisure and interpersonal relationships. They are now part of the daily reality.

The difference between contemporary and past times lies in that, nowadays, reality encompasses the physical and the virtual, as well as living individuals and artificial agents. Electronic devices and software are currently used to buy goods in digital marketplaces, read electronic documents, books and newspaper, consult digital encyclopedias and database, send and receive messages, play games alone or with other players, receive assistance by doctors and caregivers, and so on.

One of the most notable impacts the computer has had is in the field of communication, which has made a great leap forward thanks to the advances of networking and internet

technologies. Today, one can connect with friends and family around the world, as well as being able to deal with businesses anywhere and anytime. Conferences and seminars are now made through the help of computer and educational activity and are also supported by powerful e-learning platforms. Even the entertainment world has greatly benefited by computer and fast connection; games, music, movies and social personal relationships have taken conspicuous advantages by the digital universe.

The Internet acts as a cost-effective channel for businesses to connect with their employees, customers and suppliers. Unlike any other medium of communication, it facilitates the flow of information among relevant and concerned people at mass level with minimum spending. As such, e-Business has confidently become a critical component of organizational strategy.

From its creation by Tim Berners-Lee in late 1989, the Internet has evolved through main four stages[1], namely the Web of documents (Web 1.0), the Web of people (Web 2.0), the Web of data (Web 3.0), and, now, the Web of things (Web 4.0). The main comparative differences between Web 1.0, Web 2.0, Web 3.0, and Web 4.0 are showed below in the table 1.

Table 1. The very few characteristics of the Web stages.

Web 1.0	Web 2.0	Web 3.0	Web 4.0
1996-2004	2002-2016	2006+	2014+
Read Only	Read and Write Web	Executable Web	Interoperating Web
Links	People participation and Interaction	Understanding contents	Full connections
Websites	Social networks	Semantic web	Internet of things
One Directional	Bi-Directional	Multi-user Virtual environment	Multi-layer real-virtual environment
Static content	Dynamic content	Intelligent analysis	Intelligent actions

Nowadays, the Internet continues to grow exponentially and massive quantities of data are more and more available[2]. Recently, Artificial Intelligence solutions and Big Data tools are introducing new opportunities to overcome the limitations of the traditional web-based applications[3].

Digital technology has determined profound socio-economic transformations in the contemporary society and digital revolution represents its peculiar essence. In fact, both the

[1] Choudhury, N. (2014). *4.0 Department of Computer Science and Engineering. Sikkim Manipal Institute of Technology*. International Journal of Computer Science and Information Technologies, Vol. 5 (6), p. 8096-8099.

[2] Hewson, C., & Stewart, D. W. (2016). *Internet research methods*. John Wiley & Sons, Ltd.

[3] Fan, W., & Bifet, A. (2013). Mining big data: current status, and forecast to the future. *ACM sIGKDD Explorations Newsletter*, *14*(2), 1-5; Wu, X., Zhu, X., Wu, G. Q., & Ding, W. (2014). Data mining with big data. *ieee transactions on knowledge and data engineering*, *26*(1), 97-107.

globalization and the passage from a production-based to a service-based economy appears strictly related to the growths of new digital technologies. They are responsible for the collapse of many intermediation barriers in accessing data, retrieving information, and delivering services. This is noticeable if one compares the labor world before the computer revolution of the 1980s and the spread of the Internet in the middle 1990s.

Many permanent and radical changes have been experimented in the last twenty five years which have transformed work organization, management processes, personnel policies, as well as the workplace design.

Luckily, the prediction of a world depersonalized, dominated by wicked and threatening machines remains, at least for now, dystopias sprout from the mind of science-fiction authors. Nobody can distrust the positive value of new technologies. Crowds of researchers and technicians are everyday engaged to exploit the digital technology trying to enhance people's quality of life.

Nevertheless, new technologies not only offer revolutionary solutions that make available to everybody skills that, in the past were not of all, but also pose some serious problems. For example, they made possible the relocation of services and production processes, the replacement of workers with robots and there are large corporations such as McDonald's and Wal-Mart that for years are using the threat of "automated workers" to keep wages low and suppress union growth within their stores. In addition, the amplification of operational capabilities acquired through digital devices and software brings other serious problems.

The digital technology, particularly through the Web, allows to access immense volumes of information and facilitates data processing and exchanging, but, at the same time, has generated a gap between those who can take advantage of the technology and those who, for various reasons, are excluded by it or cannot use it fully. This economic and social inequality is known as *digital divide* or sometimes *digital exclusion*, and regards the access to, use of, and impact of ICT on individuals and geographic areas. The digital divide is a political-economic issue since it is closely connected with the investments for building the network infrastructure needed to deliver services that are vital for business competitiveness and the quality of life. In addition to these investments, an effort is needed for removing the cultural blocks that prevent people to use new technologies.

It is well known that we are living in a rapidly changing society and changes are affecting our lifestyles, our ways of thinking, feeling and acting as well as our knowledge and skills. To cope with the continuous changes, knowledge is stored in digital systems, in theory, open to all, whilst educational programs are implemented to improve the people skills and learning at distance. But, paradoxically, all this is also causing the precariousness of people's skills and the dropping of the knowledge value.

The negative changes in the contemporary society are brilliantly depicted by Scott Adams an American cartoonist, creator of the Dilbert comic strip (1988) which takes the name from its main character, Dilbert, an engineer crushed by rusted gears of a large company that develops and markets software that doesn't work or works poorly.

Our contemporary society resembles more to the Adam's representation, where chaos, superficiality, stupidity, inefficiency dominate, than to the Baumanian metaphor of the *liquid society*[4].

Bauman advocates for the idea of *liquid modernity* and argues that the modern society changed from a society of producers into a society of consumers that is continuously changing and, because of this, is became a liquid society. Bauman's philosophical view contrasts with the actual situation on the contemporary society, except that new technologies really foster continuous changes[5]. Furthermore, in the last few years, consumerism is not the most relevant issue as the recent economic crisis is demonstrating.

Digital technology has been deemed to have a central role in the global political economy since they are estimated to be one of the most important lever which can the rise worldwide economy and production. Some researchers and activists argue that the digital technology can be used to create new models of civic engagement. This is the case of the *Internet of Things* (IoT) the paradigm that enables interconnections among devices anytime and anywhere on the planet, extending the advantages of the Internet to all aspects of daily life[6]. In fact, IoT allows users to get device-related information and control their devices through Web browsers. The conventional Web allows to search for information, exchange email, and engage relationships in social networking, whilst the IoT expand these capabilities including interactions with a wide spectrum of electronic devices and equipment that are around us.

Principal future issues

The principal issues in the labor market of the future envisaged by researchers and experts concern population ageing and the massive spread of digital technology in every productive sector.

It is expected that the number of people aged 60 years and older will triple between 2000 and 2050 (United Nations, 2002), while the potential support ratio will decrease to 4. In other words, by 2050 there will only be 4 people of working age between 15-65 years available to support one pensioner (Figure 1).

[4] Bauman, Z., & Donskis, L. (2016). *Liquid Evil*. John Wiley & Sons.
[5] Priban, J. (2016). *Liquid society and its law*. Routledge.
[6] Jain, K. (2015). *Internet of Things (IoT) and its impact on data science*, blog post, 15 April. Available: https://www.analyticsvidhya.com/blog/2015/04/internet-of-things-impact-data-science/ ; last accessed on 11.11.2017; Lee, I. (Ed) (2017). *The Internet of Things in the Modern Business Environment*, IGI-Global.

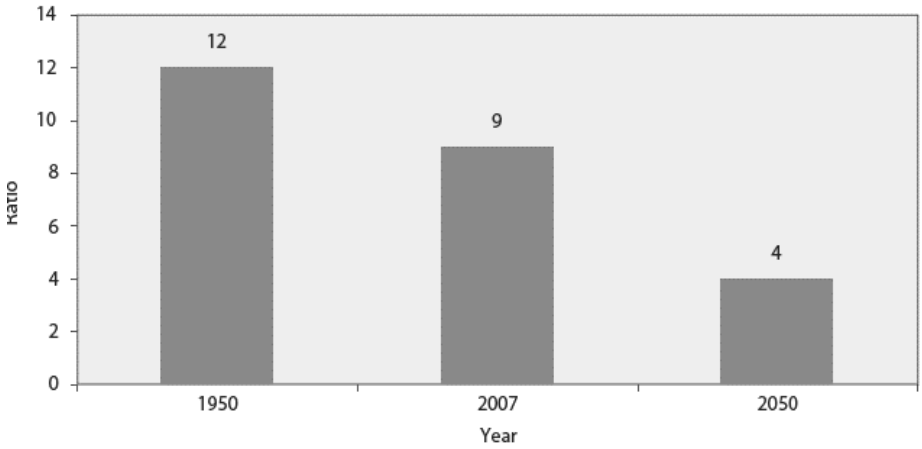

Figure 1. Potential support ratio (PSR): world, 1950-2050 (source United Nations, 2002).

There is unanimous consensus that both ageing population growth and advances in digital technology will radically change the labor market, although differences of opinion exist as to the actual dimension of that change. For example, it is a widely shared opinion that Artificial Intelligence (AI) and robotics will drastically decrease the number of jobs but that technology will also create new work opportunities.

Despite the evident differences in interpreting future trends, including that for a post-work world, experts are broadly persuaded that to prevent the negative impacts of an ageing population and the spread of digital technology, that can be both qualitative and quantitative, it is necessary to invest in education. The basic idea is that, in a world in which people live longer and where routine work - either physical or intellectual - will be progressively automated, continuous learning is the only way to ensure a job not only for blue but also for white collar workers. In fact, owing to increases in the retirement age and a booming digital economy people must constantly update their skills.

Furthermore, in the next few years, we have to take into account that demand will also decrease for many traditional, highly-paid professionals like lawyers, accountants, academics, middle managers, and journalists too[7].

Accordingly, new skills will be needed to tackle the social changes that are being brought by technological advances, and concerted efforts will need to be made to imagine and design the professional skills that will be required, and to define the new professions and specialized jobs of the future.

However, we are still at the turning point and it has been observed that, up to now, labor markets have coped with the transformations by adopting a strategy whereby:

[7] Vivarelli, M. (2013). Technology, employment and skills: an interpretative framework. *Eurasian Business Review*, *3*(1), pp. 66-89; Piva, M., & Vivarelli, M. (2013). The impact of technological change on employment and skills. In Morone, P. (Ed.). *Knowledge, Innovation and Internationalisation: Essays in Honour of Cesare Imbriani*, pp. 155-170; Franklin, B. (2014). The Future of Journalism: In an age of digital media and economic uncertainty. *Journalism Studies*, *15*(5), pp. 481-499.

> […] workers needing jobs have little option but to accept dismally low wages. Bosses shrug and use people to do jobs that could, if necessary, be done by machines. Big retailers and delivery firms feel less pressure to turn their warehouses over to robots when there are long queues of people willing to move boxes around for low pay. Law offices put off plans to invest in sophisticated document scanning and analysis technology because legal assistants are a dime a dozen[8].

In the current transitional period, many talented people, especially among the young, struggle to find jobs matching their advanced skills. Mainstream attitudes continue to dominate public and large private organizations alike. Nowadays, innovation is a buzzword, but not all enterprises are jumping on the innovation bandwagon[9].

On the other hand, there are many workers aged from 55-60 years whose job is at risk, since they are "too young" to retire but "too old" to be motivated to upgrade their skills and start a completely different job.

The digital revolution

Today's ongoing changes in national labor markets are embedded in a worldwide process that encompasses global transformations at a social and cultural level. In fact, digital technological advances have signaled the end of the Third Industrial Revolution and the beginning of a new revolution whose speed, scope, and impact have no historical precedent. The continuous progress of technology is evident in every field, since digital technologies encompass economics, politics, and human interactions all around the world.

In the last few years, software has become decisive in determining the value of many traditional goods, such as vehicles and household appliances. Its role is now essential for the automatic measurement and control of devices, as well as for facilitating technical design or project management.

In the past, technological advances changed the nature of jobs and led to great social unrest. The so-called Luddite movement, that started in Nottingham around 1811, is a well-known example of popular reaction to the new conditions resulting from the first industrial revolution[10]. Will the great advancements in digital technology provoke similar social effects in the near future?

Many experts are persuaded that the risk of this is not so great, since the selfsame technologies could be used to better orchestrate the impact of digitization, turning negative ef-

[8] Avent, R. (2016). A world without work is coming – it could be utopia or it could be hell, The Guardian, 19.11.2016. Available at: https://www.theguardian.com/commentisfree/2016/sep/19/world-without-work-utopia-hell-human-labour-obsolete; last accessed on 11.19.2017.

[9] Bekkers, V. J. J. M., Tummers, L. G., & Voorberg, W. H. (2013). From public innovation to social innovation in the public sector: A literature review of relevant drivers and barriers. *Rotterdam: Erasmus University Rotterdam*. Available at: http://www.lipse.org/userfiles/uploads/From%20public%20innovation%20to%20social%20innovation%20in%20the%20public%20sector.pdf; last accessed 6.12.2017; Pellegrino, G. (2016). Barriers to innovation in young and mature firms. *Journal of Evolutionary Economics*, pp. 1-26; Coad, A., Pellegrino, G., & Savona, M. (2016). Barriers to innovation and firm productivity. *Economics of Innovation and New Technology*, *25*(3), pp. 321-334.

[10] Jones, S. E. (2013). Against technology: From the Luddites to neo-Luddism. Routledge.

fects into positive ones. However, analogies are evident between the radical changes generated by the first manufactured production of goods and the current digital revolution[11]. In fact, nowadays, advances in AI and robotics allow for the replacement of human beings in relation to a growing list of tasks, including those requiring a high degree of skills or knowledge-based competencies. For example, self-driving technology may eliminate the need for human drivers, whilst intelligent programs will definitely replace call center operators [12]. In the coming years a new generation of robots will act as mobility aids for the elderly[13] and, further down the line, even provide companionship for them too[14].

As a consequence, an increasing number of people and organizations are warning of the extreme effects of the digital revolution[15]. The World Economic Forum's Future of Jobs Report (2016)[16] argues that transformations currently affecting global industries are expected to have significant but contradictory effects on jobs: new jobs will be created whilst other jobs, currently popular, will be lost or displaced.

Across the countries covered by the report, it has been estimated that disruptive labor market changes will cause a net loss of more than 5.1 million jobs over the period 2015–2020, with a total loss of 7.1 million jobs, two-thirds of which are concentrated in routine white-collar office functions, compared to a total gain of 2 million jobs in computing, mathematical, architectural, and engineering fields. White collar workers employed in office and administrative fields will be the most exposed to layoffs, since their re-skilling could be considered an unprofitable investment by employers.

To understand the risk of redundancy for staff working in office and administrative functions, we must consider the evolution of computer programming. Over the last two decades, many electronic programs have stopped being tools only for specialists and have become consumer goods. Powerful and sophisticated environments now facilitate the development and customization of computer applications. With a moderate amount of effort, anyone can now create electronic forms and spreadsheets for all kinds of purposes, as well as manage questionnaires, analyze texts, and archive documents.

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[11] Elliott, S. W. (2014). Anticipating a Luddite revival. *Issues in Science and Technology*, *30*(3), pp. 27-36.

[12] The Economist (2016). The end of the line, The Economist 2.16.2016; Available at: https://www.economist.com/news/international/21690041-call-centres-have-created-millions-good-jobs-emerging-world-technology-threatens?fsrc=scn/ln_ec/the_end_of_the_line; last accessed on 11.09.2017.

[13] Takahara, S., & Jeong, S. (2014). Prototype design of robotic mobility aid to assist elderly's standing-sitting, walking, and wheelchair driving in daily life. In *Control, Automation and Systems (ICCAS), 2014, 14th International Conference*, pp. 470-473.

[14] Piatt, J., Nagata, S., Šabanović, S., Cheng, W. L., Bennett, C., Hee Rin Lee, M. S., & Hakken, D. (2017). Companionship with a robot? Therapists' perspectives on socially assistive robots as therapeutic interventions in community mental health for older adults. *American Journal of Recreation Therapy*, *15*(4), pp. 29-39.

[15] Bowers, C. A. (2014). The false promises of the digital revolution: how computers transform education, work, and international development in ways that are ecologically unsustainable. Peter Lang Publishing; McChesney, R. W. (2015). Rich media, poor democracy: Communication politics in dubious times. The New Press; Ford, M. (2015). The rise of the robots: Technology and the threat of mass unemployment. Oneworld Publications; Helbing, D., Frey, B. S., Gigerenzer, G., Hafen, E., Hagner, M., Hofstetter, Y., ... & Zwitter, A. (2017). Will Democracy Survive Big Data and Artificial Intelligence. Scientific American. February, 25. Available at: https://www.bsfrey.ch/articles/D_283_2017.pdf; last accessed on 11.08.2017.

[16] World Economic Forum. (2016). The future of jobs: Employment, skills and workforce strategy for the fourth industrial revolution, Geneva, Switzerland, World Economic Forum.

The migrant and robot threats

In the popular literature and press, migrants and robots share some similarities in that, it is argued, they substitute native workers and depress wages and, albeit for different reasons, both migrants and robots are considered to be a serious threat to the social order. Robots work for free but don't spend money since they don't demand and consume goods and services, thus they create an anomaly in the model whereby workers perpetuate the economic cycle. In contrast, migrants don't work but do demand and consume goods and services, thus they represent a burden on social welfare.

There is, however, a profound difference in how people perceive these two phenomena. Whilst in the former case the diffusion of robots in our daily lives is deemed to be unstoppable, people can be convinced that walls and anti-immigration legislation are effective remedies in the latter.

Despite these evident differences, however, the same approach is often used to tackle both issues.

Attempts are made to tackle these phenomena through old and renovated forms of protectionism and defense of the status quo, but walls and quotas and solutions inspired by *ad hoc* taxation measures can only be momentary palliatives that will demonstrate their inefficacy in the medium to long-term. On the other hand, efforts to encourage integration can also be useless and insignificant if they are not supported by adequate social projects and global social policies.

The incursion of robots and migrants into our social system represents a complex problem that requires innovative and flexible solutions designed at a global level. Social innovation is the key to transforming these issues into development opportunities and benefits for the community. For example, to tackle the migrant issue, one should also investigate whether immigration policies in receiving countries could foster development in sending countries[17]. Helping migrants to return to their home countries and creating productive activities there, especially in the field of education, can generate a virtuous circle that facilitates the growth of social capital in both sending and receiving countries.

Likewise, to contrast the negative effects of robots, one should invest in their development and diffusion, seeking innovative ideas that can decrease their cost. Furthermore, new green energy solutions should be developed to feed robots and machines, along with advanced solutions that focus on security. One should look at technology with a new mindset sustained by an attitude of social innovation.

In this regard, the *Global Information Technology Report 2016* highlights the ways in which the digital revolution is changing the nature of innovation, and indicates four key factors characterizing the digital revolution:

[17] Zimmermann, K. F. (2017). *Migration for Development: From Challenges to Opportunities* (no. 70). GLO Discussion Paper. Available at: https://www.econstor.eu/handle/10419/158004; last accessed on 11.04.2017.

- *Firms will face increasing pressure to continuously innovate*. Technology-enabled innovation unleashes new competitive pressures that call for yet more innovation by tech and non-tech firms alike.
- *Businesses and governments are missing out on a rapidly growing digital population*. Businesses and governments need to act now to adopt digital technologies that satisfy people's expectations. Governments should invest in innovative digital solutions to drive social impact.
- *A new economy is taking shape, requiring urgent innovations in governance and regulation*. Societies should elaborate policies in order to be able to anticipate the impact of emerging technologies and react quickly to changing circumstances.
- *The digital revolution is changing the nature of innovation*. New and near-costless types of innovation are spreading that require little or no R&D effort, for example the automation of existing processes, the implementation of blockchains for applications in strategic fields (such as healthcare, food traceability, document management, etc.), advertising-based "free services", as well as the prospect of more "uberized" activities in multiple sectors, including transport, banking, entertainment, and education.

It is notable that, owing to the spread of applications based on the Internet of Things (IoT), Big data, and crowdsourcing platforms, digital innovation are widely extending to the social sphere and, recently, the term Digital Social Innovation (DSI) is becoming more popular. Digital Social Innovation has been defined as

> […] a type of social and collaborative innovation in which final users and communities collaborate through digital platforms to produce solutions for a wide range of social needs and at a scale that was unimaginable before the rise of internet-enabled networking platforms[18].

Indeed, across the world, digital technologies are being broadly used to tackle social challenges in several strategic sectors, such as healthcare, education, public participation, and the environment. Accordingly, digital technologies are profoundly reshaping the paradigm and scope of social innovation[19]. Computerization is affecting the economic, organizational, and social spheres, suggesting new business models and producing many positive changes in organizations. However, it has frequently gone beyond the mechanization of routine tasks[20], spreading into the socialization sphere and widely affecting the expression of personal experience, opinions, and emotions. In this regard, there are various unexpected

[18] Bria, F. (2014). *Digital Social Innovation. Interim Report.* A deliverable of the project "Digital Social Innovation". Brussels: European Commission, DG Connect; Bria, F. (2015). Growing a digital social innovation ecosystem for Europe. *Digital Social Innovation Final Report*. Available at: https://www.nesta.org.uk/sites/default/files/dsireport.pdf; last accessed on 8.28.2017.

[19] Bria, F. (2015). Growing a digital social innovation ecosystem for Europe. *Digital Social Innovation Final Report*. Available at: https://www.nesta.org.uk/sites/default/files/dsireport.pdf; last accessed on 8.28.2017.

[20] Loebbecke, C., & Picot, A. (2015). Reflections on societal and business model transformation arising from digitization and big data analytics: A research agenda. *The Journal of Strategic Information Systems*, *24*(3), pp. 149-157.

social collateral effects of digitalization, namely through the adoption of computer technology[21].

Over the last decades, digitization has certainly been the main driving force not only for innovation and change in productive sectors but also for profound social and cultural transformation. Nowadays, the key factors of innovative transformations are:

- IoT [22];
- Digital connectivity and social impact[23];
- Cloud computing[24];
- Big Data Analytics[25];
- Robotics[26];
- Multi-channel services[27].

Innovation (including digital social innovations) is a term that is difficult to define. It has recently become popular both in technical sciences and in the humanities in their broad sense. This is related to the fact that the increasing pressure of competitiveness in all spheres of social and economic life enforces the need to search for ever more innovative, creative solutions, products, services, and institutional reconstruction, to stimulate processes which are able to satisfy the increasingly evolving needs of the citizen-consumer, but also contribute to the economic and social development of countries.

The notion that the digital revolution represents an opportunity for innovators has been effectively argued by Brynjolfsson and McAfee:

How can we implement a "race with machines" strategy? The solution is organizational innovation: co-inventing new organizational structures, processes, and business models that leverage ever advancing technology and human skills. The stagnation of median wages and polarization of job growth is an opportunity for creative entrepreneurs. They can develop new business models that combine the swelling numbers of mid-skilled workers with ever cheaper technology to create value. There has never been a worse time to be competing with machines, but there has never been a better time to be a talented entrepreneur[28].

[21] Harigaya, T. (2017). *Effects of digitization on financial behaviors: Experimental evidence from the Philippines*. Semantic Scholar. Available at: https://pdfs.semanticscholar.org/1316/0107ab47963d79b809decbc3b3276fc0572c.pdf?_ga=2.3443568.1308685912.1566018693-579986055.1563366335; last accessed on 08.18.2019.

[22] Quinn, D., Chen, L., Mulvenna, M.D., & Bond, R. (2016). Exploring the relationship between online social network site usage and the impact on quality of life for older and younger users: An interaction analysis. *Journal of medical Internet research*, *18*(9), p.245.

[23] Subramanian, S., Nadarajan, R., Rao, S., & Sheen, S. (Eds.). (2016). Digital Connectivity–Social Impact: 51st Annual Convention of the Computer Society of India, CSI 2016, Coimbatore, India, December 8-9, 2016, Proceedings (Vol. 679). Springer.

[24] Rittinghouse, J.W., & Ransome, J.F. (2017). *Cloud computing: implementation, management, and security*. CRC press.

[25] Tsai, C. W., Lai, C.F., Chao, H.C., & Vasilakos, A.V. (2016). Big data analytics. In *Big data technologies and applications* (pp. 13-52). Springer, Cham.

[26] Siciliano, B., & Khatib, O. (Eds.). (2016). *Springer handbook of robotics*. Springer.

[27] Morandi, C., Rolando, A., & Di Vita, S. (2016). From Smart City to Smart Region: Digital Services for an Internet of Places. Springer.

[28] Brynjolfsson, E., & McAfee, A. (2012). Race against the machine: How the digital revolution is accelerating innovation, driving productivity, and irreversibly transforming employment and the economy. Brynjolfsson and McAfee.

Changes in management

For a long time now, automation has been eliminating the need for humans to execute many onerous and repetitive tasks, leaving humans only to control them.

What is changing today is that smart sensors and advances in artificial intelligence are now allowing the control and optimization of these processes to be transferred to robots too. In a modern smart factory, robots can be programmed remotely, and their maintenance can be carried out by other machines[29]. In a 4.0 factory, the organization of work is radically changed, and entails collaboration between humans and machines[30]. In this context, what skills are needed for a human resources (HR) manager?

In the near future, the HR function should be reinvented and adapted to the new working environments. Personalized forms of motivation should be designed for new generations of workers who could work for more than one employer at the same time and carry out different jobs concurrently. Moreover, the HR function should be able to capitalize knowledge, innovation, and creativity, and to employ analytical tools for identifying talent trends and skills gaps in order to maximize available internal resources[31].

A few years ago, Hamel, one of the most influential management thinkers, wrote:

> Most of us grow up in a "post-industrial" society. We are now on the verge of a "post-managerial" society, perhaps even a "post-organizational" society. Before you object, let me assure you that this doesn't imply a future without managers. Just as the coming of the knowledge economy didn't wipe out heavy industry, a post-managerial economy won't produce a world free of executives and administrators. But it does imply a future in which the "work of management" is less and less the responsibility of "managers"[32].

Indeed, since the late nineties, new technologies have progressively changed the role of managers. The principal task of a manager has remained the same, namely to successfully guide the workforce towards its assigned objectives, but, in the past, they were also the communication line between company and workers. Now, new technologies are revolutionizing internal company communications. Business instant messaging tools have changed the way employees are able to communicate with each other, and top managers can send communications to all personnel by email.

[29] Schiffer, S., Wortmann, A., & Lakemeyer, G. (2010). Self-maintenance for autonomous robots controlled by readyLog. In *Proceedings of the 7th IARP Workshop on Technical Challenges for Dependable Robots in Human Environments*, pp. 101-107.

[30] Hermann, M., Pentek, T., & Otto, B. (2016, January). Design principles for industrie 4.0 scenarios. In *System Sciences (HICSS), 2016 49th Hawaii International Conference*, 3928-3937. Available at: http://www.snom.mb.tu-dortmund.de/cms/de/forschung/Arbeitsberichte/Design-Principles-for-Industrie-4_0-Scenarios.pdf; last accessed on 11.06.2017.

[31] World Economic Forum. (2016). The future of jobs: Employment, skills and workforce strategy for the fourth industrial revolution, Geneva, Switzerland, World Economic Forum.

[32] Hamel, G. (2008). The future of management. *Human Resource Management International Digest*, *16*(6).

From Bristow frustration to the Dilbert syndrome

Two comic strip characters, Bristow and Dilbert, can help us to better understand the changes in the labor world over the last forty years. Bristow represents an employee of the nineteen-sixties and seventies, whilst Dilbert is an employee of today.

Bristow is a mustachioed, round-faced, bowler-hatted buying clerk who works at the City conglomerate of Chester-Perry in London. He lives in a small bedsit in East Winchley and commutes to work by train. He invariably arrives late, although this never seems to worry him unduly. He is the archetypal downtrodden office worker. The author figures him waging daily battle against the frustrations of bureaucracy whilst chatting up the young women in the typing pool. He dreams of becoming a brain surgeon or a writer, and he is constantly striving to find a publisher for his epic book *Living Death in the Buying Department*, albeit without success. However, he is not discouraged.

Dilbert is a technically-minded single engineer employed in a large hi-tech company in Silicon Valley. The author depicts corporate culture as a freakish world of bureaucracy and technology in which company policies don't reward employees' skills and efforts, and where project management and quality assurance are merely bureaucratic tasks. The popularity of Dilbert amongst software engineers demonstrates its palpable correspondence to working in a hi-tech company today. The *Dilbert Syndrome* is a term that was coined some years ago and, in fact, the Dilbert stories have thrown up various suggestions on dynamics and the implications for organizations and individuals in transitional periods[33] .

Indeed, many researchers include Dilbert strips in their scientific publications since they present aspects that are not usually dealt with in academic papers. Figure 2 shows a strip that has been used in an article regarding the failures that occur when a project team neglects or mischaracterizes the needs of target users[34].

Figure 2. An engineer recommends user research (from Convertino & Frishberg, 2017).

[33] Feldman, D. C. (2000). The Dilbert syndrome: How employee cynicism about ineffective management is changing the nature of careers in organizations. *American Behavioral Scientist*, *43*(8), pp. 1286-1300.

[34] Convertino, G., & Frishberg, N. (2017). Why agile teams fail without UX research. *Communications of the ACM*, *60*(9), pp. 35-37.

The Dilbert stories are interesting in that they present an image of the hi-tech world with all its contradictions. Indeed, when we deal with future work, we have to take into account that, despite enormous technological leaps, human nature has remained essentially the same. This means that human factors will play a central part in any changes in the labor world.

A few key questions on future work

The literature is rich in analysis and predictions regarding the future of the labor market.

Experts in the fields of labor economics, politics, and technology are often asked to answer questions concerning the impact of automation, artificial intelligence, and robotics on the future of work. There are some key questions that are very relevant since they concern crucial and challenging issues; for example:

- What will the composition of the new working class be?
- Which jobs have a future in the digital era?
- How can we contrast the vulnerability of workers?

It is not easy to answer these questions. In many cases, experts' opinions are discordant, as illustrated in the case of a research conducted in 2014 by the Pew Research Center and Elon University's Imagining the Internet Center. Experts asked whether AI and robotics would create more jobs than they destroyed. The responses were evenly split: 48% of respondents envisioned a future where more jobs are lost than created, whilst 52% said more jobs would be created than lost[35].

More recently, a survey[36] revealed that the majority of Americans predict that robots and computers will do much of the work that is currently performed by humans within 50 years (Figure 3), even if most workers (80%) expect that their own job or profession will remain largely unchanged, and will still exist in their current form 50 years from now (Figure 4).

[35] Smith, A., & Anderson, J. (2014). AI, Robotics, and the Future of Jobs. *Pew Research Center*. Available at: http://www.pewinternet.org/2014/08/06/future-of-jobs/; last accessed on 11.10.2017.

[36] Smith, A. (2016). Public predictions for the future of workforce automation. *Pew Research Center*. Available at: http://www.pewinternet.org/2016/03/10/public-predictions-for-the-future-of-workforce-automation/; last accessed on 11.09.2017.

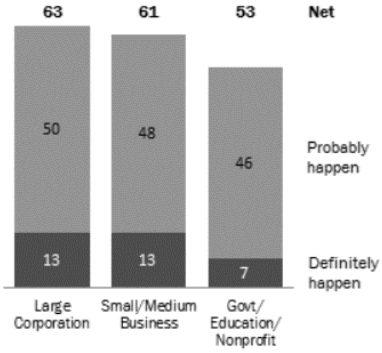

Figure 3. Percentage of workers in each group who say that robots and computers will do much of the work currently done by humans in 50 years (source: Pew Research Center, survey conducted June 10 – July 12, 2015).

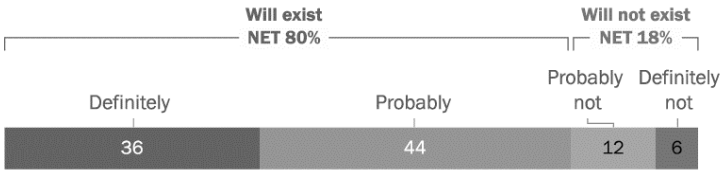

Figure 4. Percentage of workers who say that the job/profession they work in now will/will not exist in 50 years (source: Pew Research Center, survey conducted June 10 – July 12, 2015).

Another intriguing question concerns a post-work reality. Is a world without work really possible? Would it be a utopia or a dystopia?

Post-workists are a small group of writers, academics, and economists who theorize the end of work, and contest the mainstream notion of work[37]. They claim that paid labor does not always map onto social good since raising children and caring for the elderly or sick are essential types of jobs, and yet they are compensated poorly or not at all. In this regard, Hunnicutt argues that, in a post-work society, people might spend more time caring for their families and their neighbors, taking pride in their relationships rather than in their careers[38].

However, the key idea emerging from expert opinion is that education and learning are essential to help people stay employable in the labor force of the future. Experts also persuaded that education systems should be adapted to prepare individuals for the changing

[37] Aronowitz, S., Esposito, D., DiFazio, W., & Yard, M. (1998). The post-work manifesto. *Post-work. S. Aronowitz & J. Cutler, London: Routledge*; Graby, S. (2015). Access to work or liberation from work? Disabled people, autonomy, and post-work politics. *Canadian Journal of Disability Studies*, *4*(2), pp. 132-161; Srnicek, N., & Williams, A. (2015). *Inventing the future: Post-capitalism and a world without work*. Verso Books; Tse, H. L. T., Chan, L. T. J., Liu, H. Y., & Peirson-Smith, A. (2017). Beyond the social centrality of work and post-work conditions: Creative labour's experience and reaction to the crumbling of meaningful employment in the cultural and creative industries. In *The 2017 British Sociological Association's Annual Conference, University of Manchester, United Kingdom*.

[38] Hunnicutt, B. K. (1988). Work without end: abandoning shorter hours for the right to work. Temple University Press.

labor market, and that technological advances will offer new widely available ways to access education. From this perspective, the role of work-based learning should be enhanced to promote successful transitions from school to work and improve the development of quality skills.

At the World Economic Forum in 2016, experts claimed that changes in educational and learning environments are necessary in order to help people stay employable in the labor market of the future, and recommended:

- Rethinking educational systems
- Incentivizing lifelong learning
- Cross-industry and public-private collaboration

The same concept is reported as a finding by the National Academies of Sciences, Engineering, and Medicine (2017):

> As IT continues to complement or substitute for many work tasks, workers will require skills that increasingly emphasize creativity, adaptability, and interpersonal skills over routine information processing and manual tasks. The education system will need to adapt to prepare individuals for the changing labor market. At the same time, recent IT advances offer new and potentially more widely accessible ways to access education[39].

New educational and skills-building programs

Recently, the OECD presented a bleak picture of adults with poor literacy skills (Figure 5), and reported that, on average, one in five adults have poor reading and numeracy skills[40]. In Europe, the Cedefop-European Centre for the Development of Vocational Training calculated that adults with low or no qualifications comprise 30% of the unemployed[41].

[39] National Academies of Sciences, Engineering, and Medicine. (2017). *Information Technology and the US Workforce: Where Are We and Where Do We Go from Here?* National Academies Press, 140.

[40] OECD (2016), Skills matter: further results from the survey of adult skills, OECD Skills Studies, OCED |Publishing.

[41] Dehmel, A. (2013). Return to Work: Work-Based Learning and the Reintegration of Unemployed Adults into the Labour Market. Working Paper no. 21. *Cedefop-European Centre for the Development of Vocational Training*. Available at: https://eric.ed.gov/?id=ED560863; last accessed on 5.29.2017.

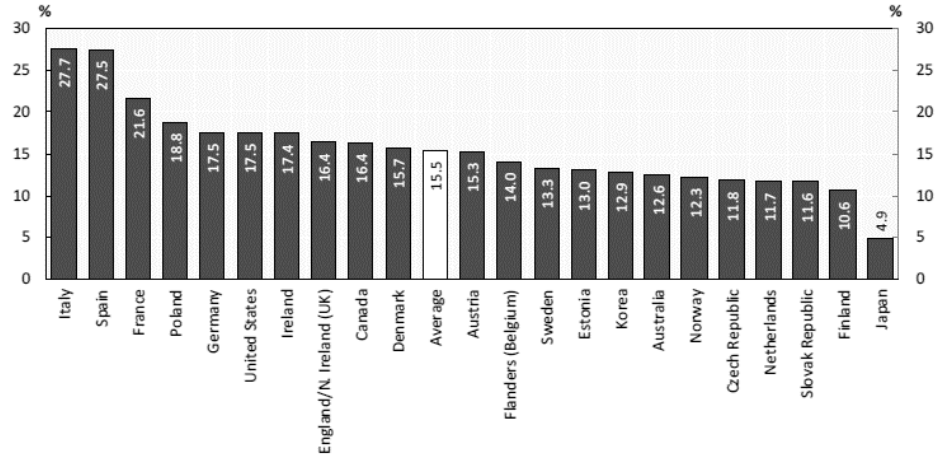

Figure 5. Adults with poor literacy skills, as a percentage of all adults (aged 16 to 65 years)[42]

Regarding education, it is useful to summarize some crucial questions related to the new job skills:

- What are the most important skills needed to succeed in the workforce of the future?
- Which of these skills can be taught effectively via online systems through a self-learning and social learning approach?
- Which skills present teaching challenges?
- What new types of credentialing systems should support non-formal and informal learning programs?

Experts indicate that critical thinking and creative thinking are crucial factors for the success of the future workforce. However, this is true only in the medium-long term. In reality, at present, workers who are really creative and innovative often encounter various difficulties. In countries where corruption and political and patronage relationships dominate the working environment, a creative capacity is not considered to be a value. Indeed, the new technologies will contribute to the elimination of many parasitical levels in elevated workplace hierarchies, particularly in public organizations. At the moment, the problem is that many top managers are not skilled to compete in a globalized and challenging world, and restrain innovative initiatives that they don't understand. This situation is complicated by information systems that are ineffective since their design has not evolved with the times in terms of new emerging needs and societal changes.

[42] http://www.oecd.org/employment/ministerial/How-does-your-country-compare.pdf; last accessed on 06.11.2017.

From this perspective, acquiring skills in computational thinking could be more fruitful. Computational thinking is a method of thought that is used in computer sciences[43], but experts argue that it can also influence the way people solve any type of problem.

Computational thinking can be understood as the mental activity of formulating a problem in such a way as to admit a computational solution[44].

In this regard, learning coding may help to improve the way in which any kind of problem is tackled in an increasingly digitalized world.

In the near future, computational thinking will provide the skills necessary in the sphere of work, but will also bring great social benefits since it can help design innovative solutions for people's livability. Computational thinking enables complex problems to be tackled in efficient ways as well as the upscaling of good solutions.

The future of jobs and skills

Generally speaking, manual working tasks and repetitive intellectual activities will continue to be drastically reduced. This trend is already evident in industrial production and office work. Indeed, since the beginning, the goal of automation was to eliminate physical work and routine low-level intellectual activities, such as ordering data, checking for formal correspondences, performing calculations, etc. The first aim of Artificial Intelligence was to make machines that were able to make things in a way that would be considered intelligent if the work were done by humans.

Currently, most administrative tasks consist of entering data/documents received from users into electronic systems and checking their consistency. Administrative work can be drastically cut if users enter data directly and intelligent programs check it. The advent of home banking has greatly decreased the interactions of a bank's customers with its employees, since customers can arrange many of their transactions by themselves.

Figure 7 shows the seven key principles of future work indicated by the futurist and keynote speaker Jacob Morgan. The development of intelligent software will not only make employees redundant but also computer engineers who, today, provide for the maintenance and management of traditional electronic programs. The availability of more advanced and sophisticated tools will allow normal users to develop applications without coding but simply by assembling ready-made functions and using wizards.

The development of intelligent software will not only make employees redundant but also computer engineers who, today, provide for the maintenance and management of traditional electronic programs. The availability of more advanced and sophisticated tools will

[43] Grover, S., & Pea, R. (2013). Computational thinking in K–12: A review of the state of the field. *Educational Researcher*, *42*(1), pp. 38-43. Available at: http://www.amanyadav.org/CEP991A/wp-content/uploads/2014/08/Grover_Pea_2013.pdf; last accessed on 11.05.2017.

[44] Wing, J. (2014). Computational thinking benefits society. *40th Anniversary Blog of Social Issues in Computing*, *2014*. Available at: http://www.utad.pt/vPT/Area2/eventos/Documents/Artigo%203.pdf; last accessed on 11.05.2017.

allow normal users to develop applications without coding but simply by assembling ready-made functions and using wizards.

Figure 7. The seven principles of future work (source: Morgan, 2014).

However, if new office applications lead to a decrease in administrative staff and a simplification of bureaucratic procedures, their implementation will require new professional figures. To build intelligent applications, machines must be fed with knowledge in machine readable format. Ontologies should be created and knowledge bases should be implemented by knowledge specialists. The building of multilingual knowledge bases and the training of machines will be one of the future jobs that will replace routine office work. Of course, in a later future, this job could itself also be automated.

We can argue that the digital revolution will bring people to spend their time working with information and knowledge as well as in performing cognitive tasks and communicating with others (both humans and machines).

Recently, the Foundation for Young Australians' (FYA) and the AlphaBeta Corporation Ltd (2017) have explored how automation, globalization, and flexibility are changing the future of work, highlighting what the main implications will be for young Australians. Some interesting indications contained in this analysis are the following:

- Future pharmacy assistant - the time spent on store admin tasks (such as stocktaking and ordering) will be reduced from 22 hours per week in 2006 to 6 hours in 2030.
- Future electronics technician - the time spent inspecting equipment will decrease from 9 hours per week in 2006 to 3 hours per week in 2030, whilst scheduling will also be cut (down from 11 hours to 1 hour); on the contrary, time spent interacting with customers or colleagues will increase from less than 1 hour to 4 hours, and time spent analyzing product data will increase from 0 hours to 2 hours.
- Future teaching/learning - by 2030, teachers will routinely use digital technology for lessons and to support students' self-learning. People will spend many hours learning on the job, and continuous learning will be a relevant part of everyday engagement in work.

There is a broad consensus that smart thinking will be a crucial future skill[45]. Since many administrative tasks will been automated, workers will need strong skills in problem solving, communication, and the use of digital platforms.

Moreover, it is expected that non-permanent and remote workers will make up the majority of workers, and consequently the need to collaborate across networks and lead by influence will increase.

Finally, future work will be more flexible and independent and, accordingly, workers will also need to have an entrepreneurial mindset.

Critical skills in a transition period

A recent study, conducted using original survey data gathered from a sample of 10,000 individuals, analyzed the possible impacts of artificial intelligence and robotics on employment. The results of this investigation suggest that:

> […] malleable/adaptable high skills acquired through higher education, particularly in science and engineering, are complementary with new technologies such as AI and robotics. At the same time, occupation-specific skills acquired by attending professional schools or holding occupational licenses, particularly those related to human-intensive personal services, are not easily replaced by AI and robots[46].

What emerges from the above study is the importance of developing malleable high-level skills through postgraduate education and the development of personal skills specific to human-intensive services. In fact, skill shortages can compromise the ability of firms to innovate and adopt new technologies, whilst skill mismatches reduce labor productivity due

[45] Vaughan, M. (2013). The thinking effect: Rethinking thinking to create great leaders and the new value worker. Hachette UK; Buzan, T., & Dottino, T. (2016). Grass roots leaders: The BrainSmart revolution in business. CRC Press.

[46] Morikawa, M. (2017). *Who Are Afraid of Losing Their Jobs to Artificial Intelligence and Robots? Evidence from a Survey* (no. 71). GLO Discussion Paper. Available at: http://www.rieti.go.jp/jp/publications/dp/17e069.pdf; last accessed on 11.08.2017, p.10.

to the misallocation of workers to jobs[47]. As a consequence, anticipating emerging skills is crucial to harmonizing the impact of technology in the labor world.

It has been observed that the ability to assess and anticipate skill shortages and mismatches should become a major policy concern (OECD, ILO, IBRD, & IMF, 2016), whilst the importance of understanding changing skill needs in order to ensure a better alignment between skill demand and supply is widely recognized.

Nevertheless, in order to respond to emerging skill needs, appropriate policies should be developed and, in order to provide effective results, investments in time and money will be necessary. It has been amply demonstrated that a person's skills tend to deteriorate over time if they are not used frequently[48].

Finally, we have to consider that the mere accessibility of technology is only a precondition for moving towards a digitalized society; the quality of that technology and the cultural empowerment of users also play an important role[49].

Conclusion

Continuous advances in computing and communication technologies are having a profound impact on our society. Technology will, on a global level, affect every sector of human life, creating big opportunities for economic growth but also leading to significant changes.

The world of labor and the workforce will undergo radical transformations. Technology will change the way in which humans produce goods and run services. Some types of human labor, both physical and intellectual, will be replaced by intelligent programs and robots. Many jobs will be eliminated whilst others will be created. This means that future workers should be prepared to change their jobs and, perhaps, to work for more than one employer at the same time.

An effort is needed to understand the future technology trends and develop strategies to support the changes in the labor market. Experts suggest investing in education to exploit the opportunities offered by the technological revolution. However, ongoing transformations will not wait for the reform of the current educational system, it is therefore urgent and critical to prepare educational programs in order to re-train the current workforce. In this regard, governments should develop effective policies to sustain the educational effort and favor innovation, especially social innovation, making people aware of the challenges awaiting them.

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[47] McGowan, M. A., & Andrews, D. (2015). *Skill mismatch and public policy in OECD countries*. OECD Working Paper. Available at: http://search.oecd.org/eco/growth/Skill-mismatch-and-public-policy-in-OECD-countries.pdf; last accessed on 11.08.2017.

[48] European Commission (2013). The Survey of Adult Skills (PIAAC): Implications for education and training policies in Europe. *European Commission. DG Education and Culture*. Available at: http://ec.europa.eu/dgs/education_culture/repository/education/policy/strategic-framework/doc/piaac_en.pdf; last accessed on 11.08.2017.

[49] Evangelista, R., Guerrieri, P., & Meliciani, V. (2014). The economic impact of digital technologies in Europe. *Economics of Innovation and New Technology*, *23*(8), pp. 802-824.

References

Aronowitz, S., Esposito, D., DiFazio, W., & Yard, M. (1998). The post-work manifesto. *Post-work. S. Aronowitz & J. Cutler, London: Routledge*.

Avent, R. (2016). A world without work is coming – it could be utopia or it could be hell, The Guardian, 19.11.2016. Available at: https://www.theguardian.com/commentisfree/2016/sep/19/world-without-work-utopia-hell-human-labour-obsolete; last accessed on 11.19.2017.

Baller, S., Dutta, S., & Lanvin, B. (Eds.) (2016). The global information technology report 2016. In *World Economic Forum.* Available at: http://www.aciem.org/home/images/Prensa/Newsletter/PDF_Notas_Prensa_Int_Gen_07_Jul_2016.pdf; last accessed on 11.05.2017.

Bauman, Z., & Donskis, L. (2016). *Liquid Evil*. John Wiley & Sons.

Bekkers, V. J. J. M., Tummers, L. G., & Voorberg, W. H. (2013). From public innovation to social innovation in the public sector: A literature review of relevant drivers and barriers. *Rotterdam: Erasmus University Rotterdam*. Available at: http://www.lipse.org/userfiles/uploads/From%20public%20innovation%20to%20social%20innovation%20in%20the%20public%20sector.pdf; last accessed 6.12.2017.

Bowers, C. A. (2014). *The false promises of the digital revolution: how computers transform education, work, and international development in ways that are ecologically unsustainable*. Peter Lang Publishing.

Bria, F. (2014). *Digital Social Innovation. Interim Report.* A deliverable of the project "Digital Social Innovation". Brussels: European Commission, DG Connect.

Bria, F. (2015). Growing a digital social innovation ecosystem for Europe. *Digital Social Innovation Final Report*. Available at: https://www.nesta.org.uk/sites/default/files/dsireport.pdf; last accessed on 8.28.2017.

Brynjolfsson, E., & McAfee, A. (2012). *Race against the machine: How the digital revolution is accelerating innovation, driving productivity, and irreversibly transforming employment and the economy*. Brynjolfsson and McAfee.

Buzan, T., & Dottino, T. (2016). *Grass roots leaders: The BrainSmart revolution in business*. CRC Press.

Choudhury, N. (2014). *4.0 Department of Computer Science and Engineering. Sikkim Manipal Institute of Technology*. International Journal of Computer Science and Information Technologies, Vol. 5 (6)

Coad, A., Pellegrino, G., & Savona, M. (2016). Barriers to innovation and firm productivity. *Economics of Innovation and New Technology*, *25*(3).

Convertino, G., & Frishberg, N. (2017). Why agile teams fail without UX research. *Communications of the ACM*, *60*(9).

Dehmel, A. (2013). Return to Work: Work-Based Learning and the Reintegration of Unemployed Adults into the Labour Market. Working Paper no. 21. *Cedefop-European Centre for the Development of Vocational Training*. Available at: https://eric.ed.gov/?id=ED560863; last accessed on 5.29.2017.

Elliott, S. W. (2014). Anticipating a Luddite revival. *Issues in Science and Technology*, *30*(3).

European Commission (2013). The Survey of Adult Skills (PIAAC): Implications for education and training policies in Europe. *European Commission. DG Education and Culture*. Available at: http://ec.europa.eu/dgs/education_culture/repository/education/policy/strategic-framework/doc/piaac_en.pdf; last accessed on 11.08.2017.

Evangelista, R., Guerrieri, P., & Meliciani, V. (2014). The economic impact of digital technologies in Europe. *Economics of Innovation and New Technology*, *23*(8).

Fan, W., & Bifet, A. (2013). Mining big data: current status, and forecast to the future. *ACM sIGKDD Explorations Newsletter*, *14*(2), 1-5.

Feldman, D. C. (2000). The Dilbert syndrome: How employee cynicism about ineffective management is changing the nature of careers in organizations. *American Behavioral Scientist*, *43*(8).

Ford, M. (2015). *The rise of the robots: Technology and the threat of mass unemployment*. Oneworld Publications.

Foundation for Young Australians (FYA) & AlphaBeta Consulting Ltd. (2017). The new work smarts: thriving in the new work order. Available at: http://www.voced.edu.au/content/ngv:77182; last accessed on 11.05.2017.

Franklin, B. (2014). The Future of Journalism: In an age of digital media and economic uncertainty. *Journalism Studies*, *15*(5).

Graby, S. (2015). Access to work or liberation from work? Disabled people, autonomy, and post-work politics. *Canadian Journal of Disability Studies*, *4*(2).

Grover, S., & Pea, R. (2013). Computational thinking in K–12: A review of the state of the field. *Educational Researcher*, *42*(1), pp. 38-43. Available at: http://www.amanyadav.org/CEP991A/wp-content/uploads/2014/08/Grover_Pea_2013.pdf; last accessed on 11.05.2017.

Hamel, G. (2008). The future of management. *Human Resource Management International Digest*, *16*(6).

Harigaya, T. (2017). *Effects of digitization on financial behaviors: Experimental evidence from the Philippines*. Semantic Scholar. Available at: https://pdfs.semanticscholar.org/1316/0107ab47963d79b809decbc3b3276fc0572c.pdf?_ga=2.3443568.1308685912.1566018693-579986055.1563366335; last accessed on 08.18.2019.

Helbing, D., Frey, B. S., Gigerenzer, G., Hafen, E., Hagner, M., Hofstetter, Y., ... & Zwitter, A. (2017). Will Democracy Survive Big Data and Artificial Intelligence. *Scientific American. February*, *25*. Available at: https://www.bsfrey.ch/articles/D_283_2017.pdf; last accessed on 11.08.2017.

Hermann, M., Pentek, T., & Otto, B. (2016, January). Design principles for industrie 4.0 scenarios. In *System Sciences (HICSS), 2016 49th Hawaii International Conference,* 3928-3937. Available at: http://www.snom.mb.tu-dortmund.de/cms/de/forschung/Arbeitsberichte/Design-Principles-for-Industrie-4_0-Scenarios.pdf; last accessed on 11.06.2017.

Hewson, C., & Stewart, D. W. (2016). *Internet research methods*. John Wiley & Sons, Ltd.

Hunnicutt, B. K. (1988). *Work without end: abandoning shorter hours for the right to work*. Temple University Press

Jain, K. (2015). *Internet of Things (IoT) and its impact on data science*, blog post, 15 April. Available: https://www.analyticsvidhya.com/blog/2015/04/internet-of-things-impact-data-science/ ; last accessed on 11.11.2017.

Jones, S. E. (2013). *Against technology: From the Luddites to neo-Luddism*. Routledge.

Lee, I. (Ed) (2017). *The Internet of Things in the Modern Business Environment*, IGI-Global.

Loebbecke, C., & Picot, A. (2015). Reflections on societal and business model transformation arising from digitization and big data analytics: A research agenda. The Journal of Strategic Information Systems, 24(3).

McChesney, R. W. (2015). *Rich media, poor democracy: Communication politics in dubious times*. The New Press.

McGowan, M. A., & Andrews, D. (2015). *Skill mismatch and public policy in OECD countries*. OECD Working Paper. Available at: http://search.oecd.org/eco/growth/Skill-mismatch-and-public-policy-in-OECD-countries.pdf; last accessed on 11.08.2017.

Minsky, M. (1988). The Society of Mind. Simon and Schuster.

Morandi, C., Rolando, A., & Di Vita, S. (2016). *From Smart City to Smart Region: Digital Services for an Internet of Places*. Springer.

Morgan, J. (2014). *The future of work: Attract new talent, build better leaders, and create a competitive organization*. John Wiley & Sons.

Morikawa, M. (2017). *Who Are Afraid of Losing Their Jobs to Artificial Intelligence and Robots? Evidence from a Survey* (no. 71). GLO Discussion Paper. Available at: http://www.rieti.go.jp/jp/publications/dp/17e069.pdf; last accessed on 11.08.2017.

National Academies of Sciences, Engineering, and Medicine. (2017). *Information Technology and the US Workforce: Where Are We and Where Do We Go from Here?* National Academies Press.

OECD (2016), *Skills matter: further results from the survey of adult skills*, OECD Skills Studies, OCED Publishing.

Organisation for Economic Co-operation and Development (OECD); International Labour Organisation (ILO); World Bank (IBRD); International Monetary Fund (IMF) (2016). Enhancing employability: report prepared for the G20 Employment Working Group. Available at: https://www.oecd.org/g20/topics/employment-and-social-policy/Enhancing-Employability-G20-Report-2016.pdf; last accessed on 11.08.2017.

Pellegrino, G. (2016). Barriers to innovation in young and mature firms. *Journal of Evolutionary Economics*.

Piatt, J., Nagata, S., Šabanović, S., Cheng, W. L., Bennett, C., Hee Rin Lee, M. S., & Hakken, D. (2017). Companionship with a robot? Therapists' perspectives on socially assistive

robots as therapeutic interventions in community mental health for older adults. *American Journal of Recreation Therapy*, *15* (4).

Piva, M., & Vivarelli, M. (2013). The impact of technological change on employment and skills. In Morone, P. (Ed.). *Knowledge, Innovation and Internationalisation: Essays in Honour of Cesare Imbriani*.

Priban, J. (2016). *Liquid society and its law*. Routledge.

Quinn, D., Chen, L., Mulvenna, M.D., & Bond, R. (2016). Exploring the relationship between online social network site usage and the impact on quality of life for older and younger users: An interaction analysis. *Journal of medical Internet research*, *18*(9).

Rittinghouse, J.W., & Ransome, J.F. (2017). *Cloud computing: implementation, management, and security*. CRC press.

Schiffer, S., Wortmann, A., & Lakemeyer, G. (2010). Self-maintenance for autonomous robots controlled by readyLog. In *Proceedings of the 7th IARP Workshop on Technical Challenges for Dependable Robots in Human Environments*.

Siciliano, B., & Khatib, O. (Eds.). (2016). *Springer handbook of robotics*. Springer.

Smith, A. (2016). Public predictions for the future of workforce automation. *Pew Research Center*. Available at: http://www.pewinternet.org/2016/03/10/public-predictions-for-the-future-of-workforce-automation/; last accessed on 11.09.2017.

Smith, A., & Anderson, J. (2014). AI, Robotics, and the Future of Jobs. *Pew Research Center*. Available at: http://www.pewinternet.org/2014/08/06/future-of-jobs/; last accessed on 11.10.2017.

Srnicek, N., & Williams, A. (2015). *Inventing the future: Post-capitalism and a world without work*. Verso Books.

Subramanian, S., Nadarajan, R., Rao, S., & Sheen, S. (Eds.). (2016). *Digital Connectivity–Social Impact: 51st Annual Convention of the Computer Society of India, CSI 2016, Coimbatore, India, December 8-9, 2016, Proceedings* (Vol. 679). Springer.

Takahara, S., & Jeong, S. (2014). Prototype design of robotic mobility aid to assist elderly's standing-sitting, walking, and wheelchair driving in daily life. In *Control, Automation and Systems (ICCAS), 2014, 14th International Conference.*

The Economist (2016). The end of the line, The Economist 2.16.2016; Available at: https://www.economist.com/news/international/21690041-call-centres-have-created-millions-good-jobs-emerging-world-technology-threatens?fsrc=scn/ln_ec/the_end_of_the_line; last accessed on 11.09.2017.

Tsai, C. W., Lai, C.F., Chao, H.C., & Vasilakos, A.V. (2016). Big data analytics. In *Big data technologies and applications*. Springer, Cham.

Tse, H. L. T., Chan, L. T. J., Liu, H. Y., & Peirson-Smith, A. (2017). Beyond the social centrality of work and post-work conditions: Creative labour's experience and reaction to the crumbling of meaningful employment in the cultural and creative industries. In *The 2017 British Sociological Association's Annual Conference, University of Manchester, United Kingdom.*

Vaughan, M. (2013). *The thinking effect: Rethinking thinking to create great leaders and the new value worker*. Hachette UK.

Vivarelli, M. (2013). Technology, employment and skills: an interpretative framework. *Eurasian Business Review*, *3*(1).

Wing, J. (2014). Computational thinking benefits society. *40th Anniversary Blog of Social Issues in Computing*, *2014.* Available at: http://www.utad.pt/vPT/Area2/eventos/Documents/Artigo%203.pdf; last accessed on 11.05.2017.

World Economic Forum. (2016). *The future of jobs: Employment, skills and workforce strategy for the fourth industrial revolution*, Geneva, Switzerland, World Economic Forum.

Wu, X., Zhu, X., Wu, G. Q., & Ding, W. (2014). Data mining with big data. *ieee transactions on knowledge and data engineering*, *26*(1).

Zimmermann, K. F. (2017). *Migration for Development: From Challenges to Opportunities* (no. 70). GLO Discussion Paper. Available at: https://www.econstor.eu/handle/10419/158004; last accessed on 11.04.2017.

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Future changes in the labor market

New technologies have thoroughly penetrated into our everyday life, affecting leisure, interpersonal relationships, science or business. Many permanent and radical changes in the labour market have been experimented in the last twenty five years which have transformed work organization, management processes, personnel policies, as well as the workplace design. Nevertheless, new technologies not only offer revolutionary, but also pose some serious problems. An effort is needed to understand the future technology trends and develop strategies to support the changes in the labor market.

Keywords: labor market, new technologies, digital technology, socio-economic transformation.

Przyszłe zmiany na rynku pracy

Nowe technologie przeniknęły do naszego codziennego życia, wpływając na czas wolny, relacje międzyludzkie, naukę czy biznes. W ciągu ostatnich dwudziestu pięciu lat nastąpiło wiele trwałych i radykalnych przemian na rynku pracy, które zmieniły organizację pracy, procesy zarządzania, politykę personalną, a także kształt miejsca pracy. Niemniej jednak nowe technologie nie tylko oferują rewolucyjne rozwiązania, ale także stwarzają pewne poważne problemy. Konieczne jest podjęcie wysiłku, aby zrozumieć przyszłe trendy technologiczne i opracować strategie wspierające zmiany na rynku pracy.

Słowa kluczowe: rynek pracy, nowe technologie, technologia cyfrowa, transformacja społeczno-gospodarcza.

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