Cotec Europa

The future of work: Educational implications

Mafra, 7th February 2018

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Introduction

"The world to come will need professionals with scientific and different technical training able to imagine, design, control and operate these technologies. Nevertheless, humanities are always to play a very prominent role. Philosophy, ethics, psychology, sociology, law, they will all help us to set the rules for coexisting as well as the boundaries of the robotics world.

Amongst the most humanistic knowledge, I would like to point out the urgent need to revert to education sciences, since it is hard to imagine any robot or algorithm would be able to review our most human and irreplaceable essence: independence, leadership, profound understanding of emotions, personal and social responsibility, the ability to reflect or proactivity. Also critical thinking, creativity, teamwork, persuasion, empathy, flexibility and continuous learning are some of the abilities that in the years to come could become the very core of education.

It is not the first time you hear me say, and many experts agree, that education may be the most important priority of all for the next coming decades. And many teachers who collaborate with our Foundation have confirmed they need, as do other professionals, new technological tools and rules and strategies, not technological, to tackle the profound education change that the knowledge society demands.

Only by being well aware of the facts, alternatives and their consequences we will be able to make the right choices about the future of youth employment. Only by making sure both citizens and companies are trained and capable we will be able to guarantee an integrating and inclusive economy and a digital society. Only by educating our children both in talent and human abilities we will be able to lead a future in which machines will replace workforce.

Education, technology and employment are all related concepts. Technology is the solution to many of our problems but, above all, it should be a tool at the service of people."

Excerpt from His Majesty King Felipe VI´s speech at Princesa de Girona Foundation Awards (29th, June 2017)

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Characteristics of the new workplace

Excerpt from Mr. José Manuel González Páramo induction speech at the Spanish Royal Academy of Moral and Political Sciences (December 5th, 2017).

Jose Manuel González Páramo is an economist, Executive Director of BBVA and Board Member of Cotec.

The First and Second Industrial Revolution: Effects on Employment

The development of the first Industrial Revolution, which began around 1770 in Great Britain and concluded six decades later, was favored in part by a **change in the perception of technological development**. A shift in social attitudes which took two factors into consideration. On the one hand, the working middle class had been gradually acquiring greater political power with respect to nobility and, on the other, unskilled workers were the great beneficiaries of advances in mechanization with respect to craftsmen.

The **first Industrial Revolution**, with the steam engine and railroads, and the **second Industrial Revolution**, which spanned over half a century since 1860, with electrification, petroleum, chemistry and pharmaceutical products, used **mass production**, which allowed to reduce production costs and time significantly, therefore increasing productivity to a great extent. The work previously done by highly qualified craftsmen was broken down into **smaller and specialized tasks**, which required fewer skills, but a bigger workforce to execute.

The development of the Ford T model in 1908 is as an illustrative example. The implementation of assembly lines allowed incorporating more low-skilled workers, as well as reducing the number of total working hours needed to manufacture a vehicle. This also helped to introduce the 5-day workweek in September 1926. Ford's logic was overwhelming: workers had money to buy his cars and leisure time to enjoy them.

This relationship between working hours and technological progress underlies John M. Keynes' prediction, with the prospect of 2030 in mind. Just a few years to that date, the forecast of 15 weekly hours has not yet been fulfilled, but we can see is a slight downward trend in work hours. For example, in Spain, where the workweek has gone from 47 to 35

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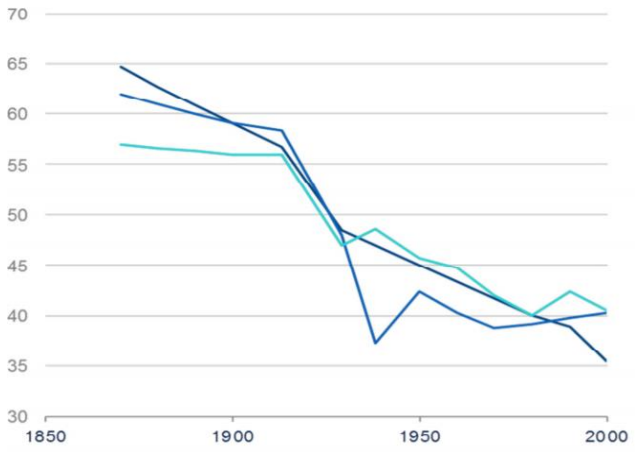
between 1930 and 2010, a trend that, as shown in Figure 1, also occurs in other developed countries, such as the United Kingdom and the United States, where the 40-hour workweek seems like a base. Nevertheless, hour reduction is much greater, between 17 and 30 hours per week, if 1870 is taken as a reference.



Graphic 1: **Hours of work per week in USA, United Kingdom and Spain (1870-2000)**
Source: "The future of work" (2017), BBVA Research

The availability of more free time favored the creation of new demands and, therefore, new industries and jobs. Tourism industry is a perfect example, barely significant back in 1900, and employing 235 million people in 2011, 8% of the workforce worldwide.

The steam engine, railway and electrification, among many other technological advances during the 18th and 19th centuries, undoubtedly destroyed many jobs, but many more were created. Historical evidence proves two contrasting developments with both winners and losers. On the one hand, there was an increase in employment and wages of complementary workers (most of them underqualified) with new technologies and machines, while the salary of substitute workers, many of them skilled craftsmen, decreased and some occupations even disappeared, generating important transition costs for some groups.

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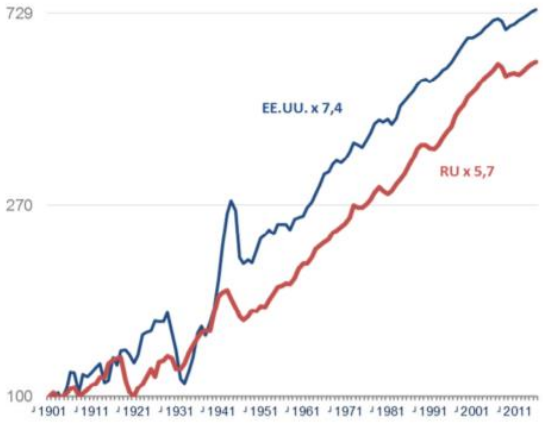
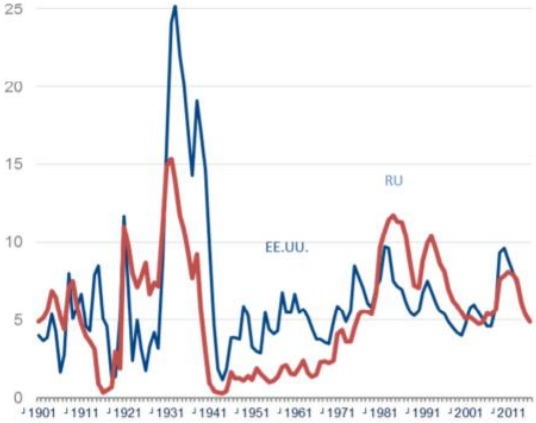


Graphic 2: GDP per capita in USA and United Kingdom, 1901-2016 (1901=100)
Source: "The future of work" (2017), BBVA Research



Graphic 3: Unemployment rate in USA and United Kingdom, 1901-2016
Source: "The future of work" (2017), BBVA Research

But the aggregate result was clearly positive. Economic progress and social welfare during these two centuries were reflected in **aggregate increases in productivity, wages and average income per-person**. While both in the US and UK GDP per capita was more than 7 and almost 6 times, respectively, between 1901 and 2016, both countries presented an average unemployment rate of 5%, as observed in Charts 2 and 3. All this great progress was the result of a creative destruction process and a structural transformation of employment, reallocating resources among the different productive sectors that would last for more than two centuries.

The Third Industrial Revolution: Qualified Employment Is the Winner

The **third Industrial Revolution**, characterized by the progressive introduction of computers, computing and telematics over the last 40 years of the 20th century, brings with it an important change in the interaction between machines and employment with respect to the two previous technological revolutions. As Acemoglu points out, "*the idea that* ***technological advances favor more skilled workers*** *is a 20th-century phenomenon*". Probably due to a greater abundance of skilled workers, new technologies were developed as complementary to qualification, to allow greater benefits. And, in turn, a greater demand for qualified

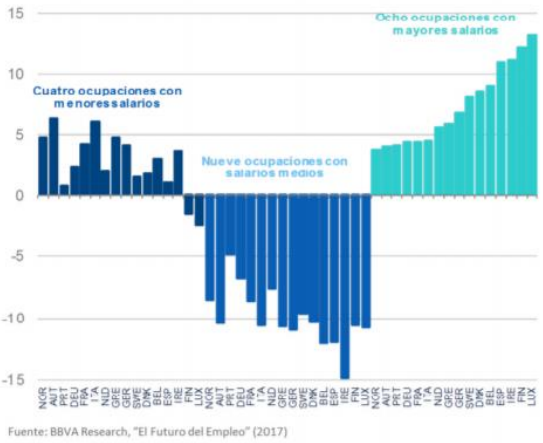
employment can be explained by a price decline of the tasks performed by computers and other machines, which would complement and require services more associated with abstract and creative thinking. Therefore, qualified jobs with a high education level are the winners of this era. Although during the first and second industrial revolutions, weavers and craftsmen steel smiths were eradicated by the mechanical loom and Bessemer and Siemens converters, recently automation has reduced the demand for many medium-skilled jobs associated with the growth of the middle class after World War II. A large number of typists, phone operators, bank tellers and many other production line-based jobs have disappeared, such as those in the metallurgical and automotive sectors.

While reviewing our most recent history, one question comes to mind: **has the industry's progressive automation destroyed employment during the last 3 or 4 decades?** There is evidence of mixed effects, at least in the short and medium term, which are difficult to separate from other forces that have shaped economy in recent years, among which globalization plays a prominent role, to which I will refer later.

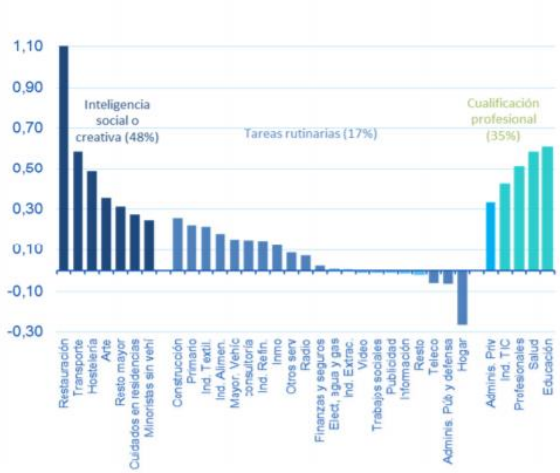
Focusing on automation, those countries with higher **robotization** rates have lower **unemployment** rates from an aggregate standpoint. Thus, evidence shows that such developed countries with the highest percentage of robots per employee, such as Japan, Singapore or South Korea, have the lowest aggregate unemployment rates. There is a similar result with digitization indexes: the most advanced countries in digitization, such as the Nordic or Asian countries mentioned, have the lowest unemployment. However, according to a study conducted by Acemoglu and Restrepo[14], in which they analyze metropolitan areas in United States between 1990 and 2007, the conclusion is that an additional robot per every thousand employees reduces the **employment** rate between 0.18 and 0.34% and salaries between 0.25 and 0.5%. Results are therefore mixed.

Although at the aggregate level evidence does not indicate that there is a significant unemployment increase, the progressive automation of the last 40 years has generated an

increasingly polarized labor market, because of three different effects. First, machines complement workers who perform non-routine abstract tasks and with a high degree of interaction between people. Second, these machines and robots replace jobs that perform routine tasks associated with the perception of average wages. And third, machines do not seem to have a negative effect on workers who perform non-routine manual tasks, which in most cases have lower wages. Such polarity is well illustrated in Figure 4. And as shown in Figure 5, for Spain there is a polarized contribution of each sector to employment growth in recent years, with a greater advance of job positions with a high cognitive content or specific qualification requirements, as well as those associated with low salaries related to customer service or non-routine manual skills



Graphic 4: **Employment change between 1993 and 2010 in 16 European countries**
Source: "The future of work" (2017), BBVA Research



Graphic 5: **Employment change between 2013 and 2016 in Spain**
Source: "The future of work" (2017), BBVA Research

The Fourth Industrial Revolution: What Will Be the Employment of the Future?

Let's focus on the fourth Industrial Revolution. The massive adoption of digital technologies originated in the last decade of the 20th century, such as Internet and smartphones, together with the extraordinary growth of computing and storage capacity at a lower cost, as well as other exponential digital technologies, are transforming the world, profoundly changing personal relationships and business organizations patterns and, in general, the way economic value grows.

The combination of advances in digital technologies and different social and economic dynamics has given rise to **three powerful transformation forces**: first, the new behavior of the consumer and, in particular, the so-called *millennials*; second, the irruption of technology, characterized by mobility and hyper-connectivity, data exploitation, artificial intelligence and the development of new infrastructures such as blockchain or cloud computing; and third, the emergence of new business models, which arise from the digital world without expensive technological, labor or regulatory legacies. These three changing forces combined have led to the so-called **fourth Industrial Revolution**. The digital tsunami is affecting almost every industry in the world for just over a decade, so deeply that both economy and society are being reshaped, and will continue to be in the future, generating disruptive changes at an unprecedented speed', and exponential rate, not linear. This paradigm shift raises the same questions that have been raised since 1770 to this date: **what role will human beings play** in a technology-dominated world? What will the **future labor market** look like?

There is an unmistakable reality: the fourth Industrial Revolution, also known as the Digital Revolution or Industry 4.0, will have a disruptive effect on employment, although it is still too early to accurately predict the scale of this change, despite the significant figures mentioned at the beginning of this presentation.

The development of automation and robots over the past 30 years does not seem to be entirely conclusive. As we have seen, although unemployment does not grow at an

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aggregate level, we do have a more polarized labor market. But maybe it is too much a risk to extrapolate into the future the behavior of employment in the past few years.

However, there is no doubt that robots, the Internet of Things, artificial intelligence and big data will **move current workers away from some activities, while new activities will be developed that will lead to new jobs**. For economic historian Joel Mokyr, "techno-pessimists" frequently suffer from a lack of imagination. In fact, the future will bring us new jobs that will be as strange to us as many of the current ones were to our grandparents. Web pages and mobile apps designer, digital traffic manager, digital marketing expert, digital sales manager, user experience designer, data scientist, community manager or cybersecurity specialist are just some examples of **highly demanded job positions that did not exist** just 10 or 15 years ago.

With a prospective vision, as society becomes richer, both in capital and free time, with greater automation of routine tasks or with low added value, more **services are demanded from more intensive work sectors in which innovation, experience and personal relationships are the priority**. Services for which society would be willing to pay a higher price, and together with productivity gains, would lead to higher wages. If we add to this scenario that people live longer and with better health conditions, it can be expected that sectors such as healthcare, personal care, education, the leisure and tourism industry and services for families and people will probably survive in this new environment. On the other hand, sectors such as distribution, agriculture or transport will give rise to routine job positions with a high automation potential and, therefore, with a high probability that they will be executed by machines in the not too distant future.

We should wait to see if this prospective vision of possible **winners** and **losers** is confirmed, which will depend on the evolution of multiple factors. The **experience of the last years forces us to be cautious**. For example, the massive adoption of email 20 years ago led some to predict the disappearance of traditional postal mail, which would have put a large number of jobs at risk. However, the rise of e-commerce during the last decade, especially in the last five years, is taking the capacity of logistics companies to the limit. This increase in demand

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forces postal companies to resize their staff and fleets, and to invest in logistics centers (warehouses and distribution centers), as well as in technology and innovation.

We do not have a crystal ball that allows us to be more precise about the evolution of employment in the next 20 years, but we can assume the three **major characteristics** that will shape the working environment of the future:

- Employment will be **less routine and standard**. In the new digital environment, we must forget about the traditional classification of economic activities in industrial and non-industrial sectors. The differentiating factor of labor in the digital era will be that of **routine versus non-routine tasks**. Routine tasks, whether they require qualification or not, can be easily automated, versus a greater demand for non-routine tasks, which must be innovative in nature, or individual interaction-oriented. The concept of "non-routine" should be understood from a wide perspective, including those tasks that require a human touch or interpersonal relationships, complex conversations and pattern identification. The excellence in these skills is what makes Zara's store employees relatively immune to robotization, for example. In the last few decades, the most common business practice was to transfer routine tasks to countries with lower wages in order to gain competitiveness. Now a new paradigm emerges in which companies tend to "outsource" routine tasks to robots and machines, a trend that will sure accelerate in the future.

- Employment will be **more fragmented**. **Collaborative economy** and the **emergence of digital platforms** are two elements already shaping the labor market. Both allow economic activity to move to many individual entrepreneurs and jobs on demand. Currently, full-time jobs could be divided into tasks and projects, causing an increase in the autonomous workforce. The emergence of numerous digital platforms such as Cabify, Uber, Airbnb or Upwork that facilitate earning nonemployment income is an example of this trend. These new work forms raise concerns about the quality of employment and social protection, since they are positions somehow in between

worlds, self-employment and full-time employment, which do not fully comply with current legislation. Welcome to gig economy!

This platform phenomenon is still in its infancy and the available data on its relevance in terms of employment are still scarce. Regarding the United States, at the end of 2012, only 0.1% of the workforce had had monthly income through different collaborative platforms, while by mid-2016 this figure had already reached 1%.

In the EU, it is estimated that at the end of 2015 there were 65,000 active Uber drivers and about 100,000 active workers in the entire EU's collaborative economy, which represents 0.05% of the total workforce. These seemingly limited figures should not lead to underestimate its growth potential.

According to the McKinsey's analysis, platform economy could increase global production by 3% in 2025, thanks to greater labor participation (47 million full-time equivalent workers), greater employment (25 million equivalent workers) and higher productivity. All this for the direct benefit of about 550 million people.

- Employment will be subject to **continuous changes**. In the future, employment, whether workers are self-employed or employed, will be characterized by a constant interaction between workers and machines, and a steady technological innovation will establish at all times the demand for employment characteristics. The exponential nature of the current technological development requires **greater flexibility** in job positions as well as in the skills that will be needed. According to economist and historian James Bessen, the work of the future will be increasingly determined by rapid technological changes and continuous innovation. For illustrative purposes, in 2012 Flash programming technology was an essential standard for the development of many web pages; nowadays, Flash-based programming is totally obsolete and has been replaced by HTML5 and other standards.

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In many job positions, tasks and roles will constantly change and it is difficult to imagine that a large majority of jobs would not have to face this scenario. For this reason, and in order not to lose employability, the jobs of the future will not only be more flexible, but will also require from workers a greater **capacity to reinvent themselves and a lower overspecialization**. This is one of the reasons behind Mercadona's success, a Spanish company that trains its employees in different small tasks, from customer-facing positions to placing orders or handling inventories. This allows them to move from one role to another based on demand. Reinvention and cross-training in different tasks is the path to employment stability. But in other cases, it will be a source of work changes, more leveraged towards skills enabling the adaptation to new scenarios, and less towards consolidated professional profiles' knowledge and practices.

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Educational implications of New Labor Scenario

The relationship between the education system and the labor market is not always direct or immediate. The definition of such relationship is out of scope in our study, but it seems obvious that the new labor scenario described above has an effect on the educational context and processes.

The distinction between routine versus non-routine tasks has a double implication. On the one hand, **it does not make any sense to teach certain contents and academic skills focused on task repetition**. It is important to differentiate between the need to repeat a task as a learning strategy -for example, making additions to learn how to add-, teaching tasks whose nature is routine in itself -for example, something as common in educational processes as writing down content (texts, content from a board, statements, textbooks). When talking about removing routine tasks from the educational system, we refer to this second case: students should be freed from those repetitive tasks that do not contribute to their learning process. Practice is indeed necessary, but not as much repetition. Even in the first example, learning how to add cannot focus exclusively on "making additions", but in order to internalize the concept of addition, mathematical thinking must be developed, something that is not achieved by just repeating a large number of operations. The concept of "practicing" must be open to integrate other academic dimensions and approaches that allow for a less task-centric training and focus on the educational process as a whole.

On the other hand, by integrating "the human touch" and "interpersonal relationships" as part of the "non-routine" concept, the **human component** acquires an essential relevance within the educational process, both in its **contents** -training in interpersonal skills, leadership, negotiation, teamwork, etc. is necessary-, as in **values** -relationship with peers, the ability to listen, empathy, etc.

The second characteristic described in the above paragraphs -a more fragmented employment- has also a double educational impact. First, as a consequence of the collaborative economy's boom, in which the **concept of community**, as a whole, as a group, is paramount. Teamwork and the ability to manage, negotiate, agree and interact with others, becomes a priority in labor relations. Secondly, the role that entrepreneurship and the autonomous workforce play in this scenario makes it necessary to train students in and for work options that, on the most part, **no longer seem to be working for third parties**. In a recent study by Cotec Foundation (2015) on the perceptions of the so-called *Young Innovative Digital Entrepreneurs* (*JEDIs*), all of them complained about the education system only showing a single work model -working for others-, avoiding transmitting other processes, actors or alternative structures that are currently present in the labor market, specially entrepreneurship. The question is not whether to train for entrepreneurship or not -we won't discuss it in this study- but the need for the educational system, especially higher education, to **showcase other work models that are far from the full-time jobs** currently in place.

Finally, flexible job positions and the need for "reinvention" implied, makes the so called **"learning how to learn" a key element of educational discourse.**

New employment scenarios also have an effect on educational scenarios, beyond the classroom. Non-formal and informal education contexts, and self-taught processes coexist along regulated and official training. This scenario, which goes beyond traditional educational institutions, together with a life-spanning learning framework, places the ability to learning how to learn as the axis to shape the learning process around: therefore, students can decide, on their own, what, how, when and with whom he learns, and be aware of how this process takes place in him.

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And finally, if employment undergoes a dynamic constant change, it will require less over-specialization. After decades of listening and promoting specialization as a key element for employability in a global world, both from the educational and labor environments, automation again emphasizes the value not only of a **more open and versatile training**, but also the requirement of such training being **multidisciplinary**. In a work environment that seems to be dominated by technological elements, the humanistic dimension of the educational process is paramount to manage and relate to the machines, but also to protect, enhance, and use what makes us specifically and differentially human.

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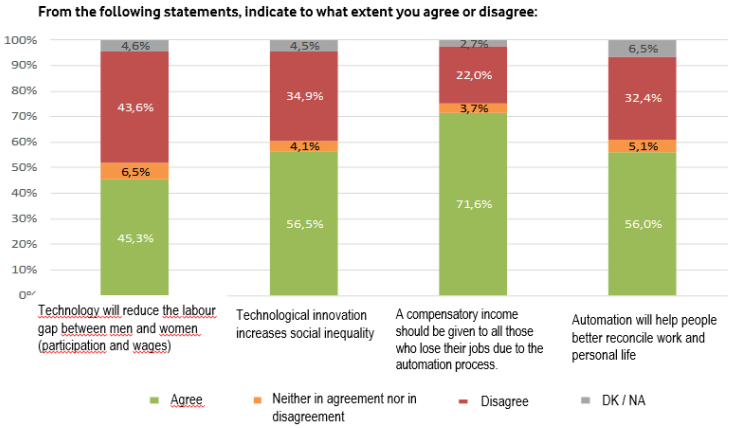
Are we ready for the future of work? Cotec España Survey on the Future of Employment

As it happens during all industrial revolutions, the current one reopens old and classic discussions, both economic and social, about the relationship between technological change and employment; and introduces new ones, of an ethical nature.

Cotec España, together with *Sigma2*, has conducted a demoscopic survey on a wide and representative sample of the population with about 2,400 interviews, in an effort to outline the Spanish society's attitude towards technological change and the degree of concern generated by phenomena such as automation, robotics and artificial intelligence. The study, presented on July 2017, was created bearing in mind its continuity over time.

If we had to summarize the large number of results obtained, we could conclude that Spaniards consider **technological change has a positive net effect on employment, but negative effects in terms of generating inequality**.

It was noted that more than half of the Spanish active population (52% of the total) considers technological change generates more jobs than it destroys (compared to the not insignificant figure of 43% that believes otherwise). Nevertheless, at the same time 57% believes that technological change leads to widening existing social gaps.

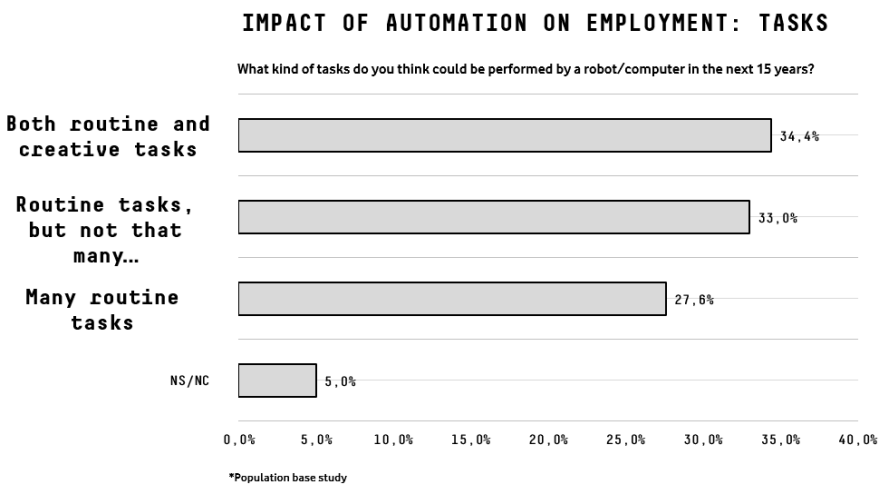


The effect of technological change on social inequality is more worrying than the level of employment

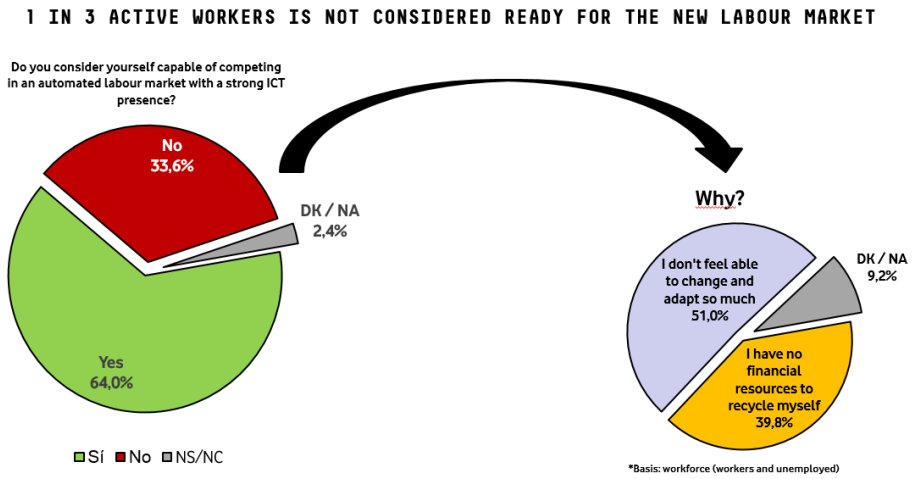
*Population base study

The Impact of the Technological Revolution on Employment

67% of the Spanish population believes that many or many of current job positions will be held by robots or computers in 15 years, although 52% trusts those jobs will be compensated by new ones being created. At the same time, 34% of participants believe that machines will perform not only routine tasks, but also creative tasks.



According to the survey, 64% of the Spanish active population **feels capable of competing in an increasingly automated and technological labor market**. The biggest differences in the answers are those related to training level and age. 76% of participants with higher education considered themselves prepared for this new labor market, while only 45% of those who did not pass primary school feel the same. Similarly, confidence grows up to 73% among people under 30, the so-called *millennials* and, on the contrary, falls to 55% among people over 45.



The **youngest participants are indeed most aware of the disruptive effects of the technological change we are experiencing**. They believe automation may go beyond routine tasks, reaching those of a more creative nature. Similarly, **young people are more convinced**

of their own abilities to compete in the new labor market, coexisting with technology. The study also reflects a bigger confidence in their own abilities when facing challenge of technological-oriented employment among male workers (68%) than among female workers (64%). Men are also more convinced that "there is no way" a machine can replace him in his current position (53% vs. 48% women, and 51% overall average).

Social Impact of the Technological Revolution

With regard to the social impact of the technological revolution, the survey highlights that 72% of Spaniards believe **technology will improve the conciliation of personal and family life**. Only 45% expect the labor gap between men and women to be reduced (confidence drops to 41% among women, by 50% among men).

There is a 56% who believes **technology will increase social inequality**, and a similar percentage thinks a compensatory income should be provided to those affected by the so-called technological unemployment.

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New Professional Profiles: Talent & Educational Offer

Case 1: Generation of Big Data talent in Spain

Conclusions derived from Cotec's "Big Data" Workgroup

- Big Data's current impact is as wide as its transversality. A report from the market research company IDC points out that the **revenue generated around data and data analysis will increase from $122 billion in 2015 to $187 billion in 2019.** This implies a growth of more than 50% in less than five years. The estimated value of the data economy in Europe reached EUR 272 billion in 2015, representing 1.87% of the member countries' GDP and being able to go up to 4.7% in 2020.

- The **lack of talent in Big Data** exposes an alarming fact: digital revolution has resulted in an important gap of competencies in which **the education system is falling behind.**

- It is crucial to give complete support for a **wide literacy model in schools**. For both the current and the forthcoming societies, teaching how to read and how to write is not the only literacy process. There are other equally important languages (mathematical and technological) that are still in the background regarding the achievement of basic competencies.

- New didactic methodologies must be developed so that students do not picture science curriculum as "demanding", "boring" and very little appealing. This perception commonly discourages students from pursuing a scientific-technological career.

- The abilities of **exploiting information, interpreting and visualizing data sets, using basic tools such as databases and spreadsheets**, must be fostered during the first three years of Compulsory Secondary Education (ESO).

- At university level it is imperative to **create new degrees and Postgraduate programs**. Besides that, regardless of the knowledge domain, the **inclusion of subjects related to basic aspects of information analysis** is considered necessary for all university degrees.

- Major universities, with the U.S, at the top of the list, have already reacted quickly and established **degrees and postgraduate programs on data science.** Other countries, including Spain, have not yet created any specific degree program on Big Data.

- It is crucial for companies to prepare their work teams to transform themselves into **data-based organizations**. The whole workforce of a corporation, from technical experts to senior leadership teams, should receive the appropriate training in order to capitalize the competitive advantage given by data.

- Big organizations should enable their teams to provide **specific profiles** for each role. SMEs should foster the development of mixed profiles, with knowledge in different areas. For micro-enterprises it would be advisable that Public Administration invests its resources to provide training for entrepreneurs.

- For **SMEs,** which make up 73% of Spain's workforce, the availability of free online learning will allow a faster profile creation and the identification of the possibilities that Big Data can provide. Another way to achieve that goal is by participating in collaborative projects with bigger companies, to make knowledge transfer easier.

- The role of **public institutions** in the adoption of Big Data technologies is to **collaborate with the private sector** and **promote education programs**. Besides, to efficiently accomplish this task, Public Administration should provide its labor force with the capabilities and training they need to handle Big Data.

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- One of the responsibilities of Public Administrations is **to define a set of ethical standards for data management**. They can also enforce laws to ensure the users´ safety and privacy, as well as to create regulatory frameworks to protect intellectual property.

- Other advisable measures are the allocation of funds for academic institutions, to develop data related degree programs; the reduction of migratory restrictions; and, the **encouragement of technology adoption** among the different government services offered.

- One last way of generating talent in Spain is by **sharing knowledge and experiences trough networks.** This networking must be driven by talent innovation and creation in unofficial environments. The first stage of this project would be to forge a national wide initiative to ensure **data security** and to create new legal and technical standards, as well as to promote a national federation to integrate new work environments-where the biggest Big Data challenges could be addressed.

- Another aspect we have to consider when creating new talent is financial support. It is advisable to support - not to hinder- independent actions, such as the ***Maker movement,*** that are experimenting new ways of sensitizing and giving information, providing areas of experimentation, complementary data sets and guidance on exploitation models.

Cotec's "Big Data" Workgroup (May 2016-January 2017)

Coordinated by Telefónica

Member of the Workgroup: ArcelorMittal, Aditech Corporación Tecnológica, Agencia Canaria de Investigación, Innovación y Sociedad de la Información, Banco Santander, CaixaBank, Consejería de Desarrollo Económico e Innovación de La Rioja, Consejería de Empleo, Empresa y Comercio de la Junta de Andalucía, Corporación Tecnológica de Andalucía, Deloitte, Everis, Ferrovial, Fundació Univerisitat-Empresa de València, Gómez-Acebo & Pombo, Iberdrola, Instituto de Fomento de la Región de Murcia, Ivace, Junta de Extremadura, PricewaterhouseCoopers, Tecnalia Research & Innovation, TMC Employenerus España.

Case 2: Analysis of the Internet of Things Educational Offer

Conclusions derived from Cotec's "Internet of Things (IoT)" Workgroup

- The Internet of Things (IoT) is a concept in constant evolution that has presently become an integration mechanism which allows the **coordination of different digital technologies**.

- **IoT is expected to grow exponentially.** Average global growth is estimated at 20% in 2020, in terms of business. It has also been predicted that intelligent devices connected to the internet will triple between 2016 and 2020, increasing from 6,400 million to 20,400 million.

- **IoT brings along the need for new profiles and skills, whose demand will also experience a strong growth in the forthcoming years.** IoT architect, connectivity specialist, cybersecurity expert, IoT programmer, can be **highlighted among the new job positions that will arise.**

- **The shortage of new professional profiles may be an important barrier to IoT deployment**, an issue that has already been reported by some companies (taking a fourth position as an inhibitor, in terms of relevance, behind "security", "privacy" and "lack of business case").

- **In Spain, training opportunities for IoT are scarce.** There is not a professional training program and there are very few university degrees and post degrees. The meager existing programs are taken over by engineering schools (IT and telecommunications), and they are entirely technology oriented.

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- **The European university system suffers from the same lack of IoT training than Spain's.** Only 5 EU countries benefit from specific degrees: 2 in UK, Ireland and Germany, and 1 in France and Finland.

- **The IoT training offer in US is differently shaped. It is based on MOOCS** (Massive Open Online Courses) **and SPOC** (Small Private Online Courses), more flexible, brief and affordable.

- According to surveys conducted by the Workgroup on a sample of companies, **the priority and most demanded profiles in the local market** are those related to data collection and analysis, information systems protection (cybersecurity expert), regulations legal framework and business model development.

- **There is a gap between the companies´ needs and the education system´s offers.** If that gap is not filled it will become an obstacle to the rise of professionals with the profiles and skills required for IoT development.

- **To fill this gap, it is necessary to implement new programs, and add new curriculum, into the national education system,** such as: A specific IoT professional training module, degree and post degree programs intended for technical and business profiles, flexible in-company training adapted to the corporation's real needs, as well as to create non-regulated environments that would encourage experience and knowledge sharing (Fab Labs, IoT demonstrators, etc.).

Cotec's "Internet of Thing" Workgroup (May 2015-April 2017)

Coordinated by Indra

Member of the Workgroup: Agencia Canaria de Investigación, Innovación y Sociedad de la Información, Agencia de Desarrollo Económico de La Rioja, CaixaBank, Consejería de Empleo, Empresa y Comercio de la Junta de Andalucía, Corporación Tecnológica de Andalucía, Deloitte, Everis, Fundació Universitat-Empresa de València, Gómez&Pombo Abogados, Grupo Antolín Irausa, Iberdrola, Instituto de Fomento de la Región de Murcia, Junta de Extremadura, PricewaterhouseCoopers, TECNALIA Research&Innovation, TMC Employenerus España.

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Call for Action

What should the education system do?

- **Emerging and multiple literacies**

The incorporation of an extensive literacy program that includes the so-called emergent languages is paramount. Nowadays, the concept of literacy cannot be restricted to linguistic competence (reading and writing) and mathematics. There are multiple languages that besides being part of society, and a shaping agent, are also making an important impact on economy and labor. We are talking about digital languages -in a general sense, from the most basic tools to those generated by networks- artistic languages -narrative, visual, musical, corporal, etc.-, as well as visual , data, financial and scientific languages. All of them must be incorporated into school dynamics and curricula, because the knowledge and use of them open a vast space that not only will foster student employability but also will ensure their active participation as citizens in a global world.

- **Articulation of education processes around challenges: multidisciplinary and cooperation**

Global world issues are articulated around challenges. It has two important educational implications:

- ✓ On one hand, a **multidisciplinary approach** is needed. Challenges are of such significance that they do not affect just one dimension or area. Implications are always multiple and its discussion requires different points of view, different approaches, the combination of different solutions and the use of different languages. Thus, the division that has been established between sciences and humanities not only avoids the current epistemological dynamics, but it is also not operative. It means that it is crucial to call into question the fragmentation of knowledge into disciplines, which necessarily entails a challenge to didactic methods: turning work tasks and activities into work projects. Projects articulate around unanswered questions that require

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the alignment of different disciplines, teachers, tools, contents and education processes.

- ✓ On the other hand, there is a need of **teamwork**, which will become an indispensable factor in the future. It has many implications for education processes and contexts. The current education model is built around the individual, not the group: activities -most of them designed to be individually performed-, spaces -with rows of chairs and desks that force students to turn their backs to each other-, supplies -each student has a textbook- and time management -Does the school allow time for students and teachers to work as a team? -.

- **The value of human assets: learning interpersonal skills**

In a future automated environment where many of the activities that we currently perform will be digitalized, the identification of the strictly human component will serve to highlight the difference between human beings and machines. Furthermore, automation will free us from routine and mechanical tasks, making us able to focus on specific human activities. The most in-demand skills will be the so-called soft skills or social and interpersonal skills: critical thinking, creativity, negotiation and relationship, emotional intelligence, communication skills, in other words, behavioral competencies that will complete the learning process.

- **Metacognitive strategies: Autonomy, flexibility and versatility**

A constantly changing work environment that needs to be frequently reinvented requires an active and autonomous participation of the individual in his or her own learning process. In this context, developing autonomous learning becomes necessary. Students have "to learn how to learn", a skill that will serve them their whole lives.

- **Integration of open innovation processes into the education system**

The current education process develops in such a way that traditional education institutions cannot catch up. Experiences derived from non-formal and informal environments, outlying school's time and space, with agents that go beyond the nearby scholar community and integrate knowledge generated both in traditional spaces (universities, research centers, corporations) and informal environments (street, family and social dynamics, civil society, etc.) add to the learning generated in and from school. In addition, it meets the increasing relevance of autonomous learning (being autodidact), thanks to the quick and easy access to the information available on the net.

What should companies do?

- **Recycling the workforce: continuous training**

New tasks, new skills and new knowledge bring about the reformulation of many professional profiles. As a first consequence, it is paramount to create continuous training plans directed to current workers, for them to be familiar with the digitalization processes that are already impacting their work environments. These plans not only must offer courses on new contents, as it has been done so far through the traditional continuous training model, they must also integrate authentic global training experiences that allow workers not only to update their knowledge, but also integrate new working procedures, incorporate innovation and entrepreneurship process into their work, and generate group dynamics.

- **Talent: diversity, management and combination.**

Human capital and talent are not new elements in business policies, but what is new is the need to identify and integrate a great diversity of talents. In order to face today´s challenges, derived from a group context, the articulation of different talents is required. Big data, whose relevance within the automated environment seems clear, is much more than programming, software or algorithm elaboration; data must be contextualized, analyzed, visualized, and it

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is necessary to build a sharable and communicable narrative. It implies the cooperation between talents. Because the big challenge that companies will face is not the creation of talent but its combination.

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