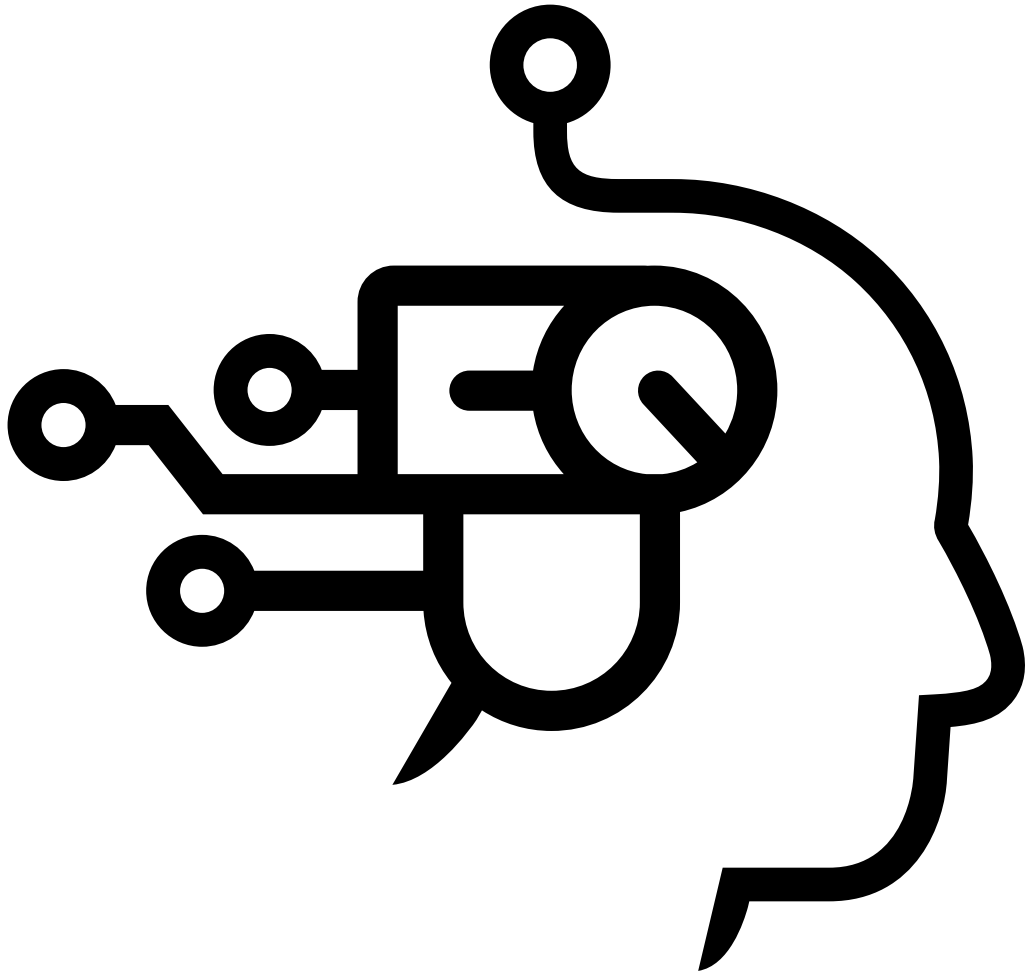
The Machine Revolution



- What economic and labor areas will receive the largest short and medium term impact due to the development of artificial intelligence?
P. 21

- Today we are interested in companies that use their intellectual capital more creative and innovatively.
P. 31

- History shows that new technologies can destroy employment by drastically increasing productivity..
P. 43

- We all know there are several possible solutions on the table. But clearly, no solution will be implemented easily or quickly.
P. 55

"Mental power is at least as important for progress and development —for mastering our physical and intellectual environment to get things done — as physical power. So a vast and unprecedented boost to mental power should be a great boost to humanity".

Erik Brynjolfsson and Andrew McAfee
The Second Age of Machine

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Index

Meeting the challenge:

The changing nature of work

Prologue by **Tammy Erickson.** Professor at London Business School.

We're moving to the drumbeats of change: amazing new technologies, including social media, search, gamification, cloud storage, mobile, and big data analytics are already cutting the cost and time of communication to near nil.

They're making it possible to find almost anyone or anything, anywhere easily and quickly. We've hardly scratched the surface of what these new technologies can do; a far greater magnitude of change lies ahead.

The workforce, too, is changing in remarkable and unprecedented ways – longer life expectancies and lower birth rates combine to create a population that is significantly older in many parts of the world. This new upside down population pyramid means that many traditional career paths are blocked to the young by the overwhelming number of those already entrenched. At the same time, our longer lives are allowing us to experience a new life stage – active old. Demand for ways to engage older works productively will only intensify. And, around the world, we encounter tremendous diversity – ethnic, racial, religious, and attitudinal – bringing differing expectations and preferences to the fore.

And, throughout it all, the nature of much of the work we do is changing, as well. Today, much of our most important and differentiating work leverages in some way the plethora of information that is now available. In some businesses, the key is harnessing small units of knowledge to detect patterns and provide new insights or create new capabilities. In others, it's about innovation: combining different types of knowledge and expertise to come up with

something better. We are challenged detect and responding to market and environmental shifts, customize our relationships with customers and suppliers and evolve as we go, to learn.

That these trends are happening is not debatable, but the implications of them on our organizations are still being discovered. The options for private industry, the role of governments, and the possibilities for future technologies were the subject of intense discussion throughout this forum.

As these trends converge, I anticipate profound changes will occur:

- **A Shift to Tasks:** Rather than dividing the work to be done by job or role, work will be organized by time-bound and outcomes-based projects or tasks.
- **Use of Real-Time Coordination:** Cheaper and easier communication will lessen companies' need to "own" resources; rather, coordination will find the necessary resource or talent as required.
- **A Portfolio Approach to Staffing:** Organizations will no longer be comprised primarily of full-time employees, but will constitute a flexible community of people in a variety of arrangements.
- **Differentiating Value Via Discretionary Effort:** The work that will add the greatest value will not be work that you can codify or instruct people to do well. Organizations must create environments to which people want to give their very best.
- **Leadership to Leverage Intelligence:** Leaders require new approaches: skill in stimulating innovation and collaboration, an openness to new ideas and the ability to invite all interested parties to engage around meaningful work.

Join us to explore these and other exciting possibilities open to those who adopt creative and bold approaches in this Machine Revolution.

Tamara J. Erickson is a McKinsey Award-winning author and a widely-respected authority on leadership, the changing workforce, collaboration and innovation, and the nature of work in intelligent organizations. She has three-times been named one of the 50 most influential living management thinkers in the world by Thinkers50, the respected ranking of global business thinkers. Erickson is a frequent faculty member in Duke CE programs and is an Adjunct Professor, Organisational Behaviour, at London Business School, where she has designed and co-directs the school's premier leadership programme for senior-most executives, Leading Businesses into the Future. She is the Founder and CEO of Tammy Erickson Associates, a research-based firm dedicated to helping clients build intelligent organizations.
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Introduction

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The futurist movie 'Elysium' (Neill Blomkamp, 2013), portrays billions of underprivileged inhabitants of an overpopulated planet Earth trying to scrape by, on the brisk of a natural and humanitarian failure. In the meantime, a privileged, sufficiently wealthy and affluent elite enjoys an exquisite lifestyle, healthcare and wellbeing in a giant, ring-shaped artificial satellite unconceivable for the excluded majority. A world with only two options: super rich or super poor. 'Elysium' is a dystopia set in 2154. But good science fiction can skillfully represent in a future scenario trends that are in fact a reality (at an infinitely lesser scale) at present. That is why 'Elysium' is an exaggerated, pessimistic, aberrant extrapolation of sorts of a reality that is gradually unfolding in front of us.

"This is a new industrial revolution", specifically said **Chris Meyer,** a trustee of the Bankinter Innovation Foundation, during the opening session of the think tank. He reminded us this revolution goes by the name of The Second Age of Machine, as in MIT's

Nicolás Sarries
Finance and Economics
writer and journalist

Unlike the revolution of the mid-18th century, this revolution will not be built upon exceeding the physical limits of human strength, but rather, the mental limits.

Without the right models to manage the potentially massive unemployment brought about by the advancement of intelligent machines, the Western world —the world in general— will face profound challenges in the years to come.

Erik Brynjolfsson and Andrew McAfee's book of the same name. **Unlike the revolution of the mid-18th century, this revolution will not be built upon exceeding the physical limits of human strength, but rather, the mental limits.** This is not a world of steam machines, but rather, super computers capable of making extremely fast calculations, think rationally, have complex interactions with humans or replace humans in high-risk tasks.

We are decidedly walking towards an era where technological progress (robotics and artificial intelligence being prime cases in point) is nurturing a basically unprecedented explosion in productivity. Life expectancy, longevity and connectivity have also increased around the world. Competition between countries, society and growth models is fiercer too. We are progressing towards an era where change and adaptation to the new world will become *the new normal.*

In his opening remarks, **Eugene Kandel,** head of the National Economic Council for the prime minister of Israel, clearly described the type of world towards which we are progressing: "developed economies are entering *terra incognita* at an unprecedented scale. It's like landing on Mars, except that we share a common language. There is not one uncertainty, but rather, a combination of several drivers of uncertainty". In fact, there are many challenges: society is expected to live increasingly longer and birthrates are expected to decrease "if you want to know how the world will look like in a few years, look at Japan". This seriously threatens the welfare states created in developed economies during most of the 20th century. These demographics precede the labor and economic conditions around the corner: people will work longer years and will retire later in life. All this in a framework of countries with low growth levels that (paradoxically) are increasingly open and more openly competing with each other. This situation has already unleashed a currency war between states in the struggle to become the most competitive economies; and populations, capitals and corporations are enjoying unprecedented mobility. As Kandel mentioned, "jobs

migrate; low-wage jobs migrate to countries were wages are low, and high-paid jobs tend to stay, but competition for them is fierce". The governments of these countries must realize that without suitable prospects, their populations might migrate.

In a world where companies put pressure on executives to supply a high level of human capital, it is impossible to ignore potential, unexpected *tech shocks:* changes to the productive capacity of a certain industry that might carry great impact in the demand for labor. Just like telephone operators (who would manually connect calls) disappeared during the 20th century as processes became automated, new technological shocks will unavoidably replace human jobs with machines in the near future. Moreover, this process will foreseeably accelerate with ever-greater technical progress. "We ignore the origin of the shocks or where will they hit employment hardest, but we know they will have massive impact on employment", added **Kandel.** We also know that no economic model is currently prepared to absorb the potential, massive unemployment byproduct of more productive machines.

Without the right models to manage the potentially massive unemployment brought about by the advancement of intelligent machines, the Western world—the world in general—will face profound challenges in the years to come. The Future Trends Forum (FTF) met precisely to discuss the diagnosis, anticipate scenarios and identify future strategies and policies and classified the discussion in three topics: **1)** creative destruction; that is, the technologies or progress that represent a greater employment challenge; **2)** competences, mobility and labor markets; that is, analyzing whether educational systems are prepared to take on new scenarios, and will they be effective enough to maintain *middle class jobs;* **3)** capitalism and the social contract; that is, discriminate how and towards what will employment and labor markets evolve in this new reality, and how will governments manage the welfare schemes that will foreseeably rise with this new paradigm.

Eugene Kandel
Head of the National Economic Council for the prime minister of Israel.

Chris Meyer
Trustee of the Bankinter Innovation Foundation.

Nobody says the future (as is being built today) will be easy. It is teeming with challenges, risks and uncertainties. But as all the participants at the 24th edition of the FTF saw abundantly clear, the future will be filled with possibilities and opportunities to achieve a more developed world. One of the mottos of this edition was "organizing for prosperity", which I personally subscribe. Society will witness the greatest technological achievements ever made, extending human life beyond what is currently possible will become reality, machines will help us extend our ability to reason and achieve hitherto unimaginable insights. But all this progress, all this prosperity might not be evenly distributed among societies. It is unavoidable to be presented with these contradictions. The FTF participants have tried to come to grips with this impending reality in broad, productive work sessions and discussions that I will try to summarize in these pages. The ideas and proposals that are the outcome of this Forum must lead us towards a better future. Otherwise, the dystopia of 'Elysium' might not be as unconceivable as one would want.

Creative destruction

1

Darío Gil
Vice-President of Science and Technology at IBM Research.

Ramón López de Mántaras
Researcher at CSIC, the Spanish National Research Council.

Darío Floreano
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Camille Beatty
Entrepreneur.

The cognitive era

How humans and machines are forging the future of knowledge and expertise

Prologue by **Darío Gil.** Vice-President of Science and Technology at IBM Research.

As technologies like artificial intelligence and robotics get ever closer to areas we believe are the exclusive territory of human ability, we oscillate between genuine excitement and deep anxiety. Somehow we know that we will not remain untouched.

The debate on the societal consequences of these advancements tends to be cast between two extremes. The utopian version of technological progress sees a nirvana in front of us. In this vision, smart machines do all the work for us. Mankind can finally devote itself to philosophical reflection, poetry and the arts. The dystopian version of the technology story speaks about creating powers we cannot control, playing god to our own demise. We have all seen the Hollywood movies.

The fact of the matter is that something remarkable is going on in the world of technology. The web and the Internet of Things are providing us with vast amounts of digitized knowledge, knowledge that is being used to train machine-learning algorithms. The power of these algorithms is their ability to learn from data, rather than follow only explicitly programmed instructions. And thanks to our super-powerful machines, the algorithms now operate at the scale and speed required to tackle really complex problems. Robotics, self-driving cars, speech and image recognition, medical diagnosis; the applications will reach as far as there are patterns to be discovered.

People working with learning systems in a collaborative relationship we call Cognitive Computing is the future of knowledge and of expertise. Enhancing our expertise matters,

because it allows us to solve problems in the world. Today, we walk past problems we could solve because we don't have the knowledge we need at the right moment. With cognitive computing this knowledge gap could be bridged. Indeed, we pay a significant price for not knowing not knowing what's wrong with a patient; not knowing where to find critical natural resources; not knowing where the risks lie in every investor's portfolio.

Cognitive computing refers to systems that learn at scale, reason with purpose, and interact with humans naturally. Most importantly, rather than being explicitly programmed, they learn and reason from their interactions with us and from their experiences with their environment. They are made possible by advances in a number of scientific fields over the past half-century, and are different in important ways from the information systems that preceded them. Those systems have been deterministic; cognitive systems are probabilistic. They generate not just answers to numerical problems, but hypotheses, reasoned arguments, and recommendations about more complex – and meaningful – bodies of data.

What's more, cognitive systems can make sense of the 80 percent of the world's data that computer scientists call "unstructured." This enables them to keep pace with the volume, complexity, and unpredictability of information and systems in the modern world. None of this involves either sentience or autonomy on the part of machines. Rather, it consists of augmenting the human ability to understand – and act upon – the complex systems of our society. This augmented intelligence is the necessary next step in our ability to harness technology in the pursuit of knowledge, to further our expertise, and to improve the human condition. That is why it represents not just a new technology, but the dawn of a new era of technology, business, and society: The Cognitive Era.

Working with a Cognitive System is a dialogue, a symbiotic relationship. What do we, humans, bring to the table? We bring the problems, the context, our expertise, our common sense and our values to these decisions. The cognitive system brings its analysis and discovery capabilities, unsurpassed in its ability to make connections and retrieve evidence across all available digital knowledge. It is in this very manner that Watson, our first cognitive system, is already working with more than a dozen leading cancer institutes to accelerate clinicians' ability to identify and personalize treatment options for patients. Consider that the average number of articles that a medical researcher reads in a year is in the hundreds. That may sound like a lot, until you realize that the number of medical research articles published every year is in the hundreds of thousands. Watson has already read and made connections across all 23 million abstracts on the MEDLINE repository. The system seeks to reduce from weeks to minutes the time it takes to translate DNA insights, understand an individuals's genetic profile, and gather relevant information from medical literature. The resulting analysis allows doctors to target the specific cancer-causing genetic mutations in each patient. Watson completes the genetic material and medical literature review process in only a few minutes, producing a report and data visualization of the patient's case, and evidence-based insights on potential drugs that may be relevant to an individual patient's unique DNA profile. The clinician can then evaluate the evidence to determine whether a targeted therapy may be more effective than standard care for the patient.

The previous example is illustrative of the fact that the much-hyped drama of "man vs. machine" is a distraction, and it rests on an exciting but misguided fiction. Cognitive systems are not our competitor. Neither the science nor the economics support such fears. Cognitive systems, as they actually exist, are a tool to deepen the relationship that really matters – the relationship between humans and the world. In the 21st century, knowing all the answers won't distinguish someone's intelligence – rather, the ability to ask better questions will be the mark of true genius.

We must however continue to shape the effect of cognitive computing on work and employment. Like

all technology, cognitive computing will change the nature of work done by people. It will help us perform some tasks faster and more accurately. It will make many processes cheaper and more efficient. It will also do some things better than humans, which has been the case since the dawn of civilization. What has always happened is that higher value is found in new skills, and humans and our institutions adapt and evolve. There is no reason to believe it will be different this time. Indeed, given the exponential growth in knowledge, discovery, and opportunity opened up by a Cognitive Era, there is every reason to believe that the work of humans will become ever more interesting, challenging, and valuable.

Equally important is the need for societal controls and safeguards. Again, such concerns are not unique to intelligent systems. Questions about security – both individual and institutional – attach themselves to every transformational technology, from automobiles to pharmaceuticals to mobile phones. These issues are already urgent, and will remain so as cognitive technologies develop. They are fueled especially by today's radical democratization of technology – driven by the rapid spread of networks and the cloud, and the accompanying reduction in costs. We believe that the answer lies not in attempting to limit that democratization, but rather in embracing it, while designing cognitive systems with privacy, security, and human control integrated into their fabric.

I want to conclude this essay by explicitly addressing the fears of being replaced by intelligent machines and by highlighting the need for societal engagement and for democratic politics to shape the destiny of the technologies we create. To make the point, let us play a thought experiment. Imagine we are told of the existence of a new parenting system. The experts that have created it offer to the world compelling evidence that their system consistently delivers better parenting advice than what most of us are capable of producing. I hope you would find self-evident that talk of the system replacing parents would be ludicrous. I will certainly speak for myself when I say that no matter how good the system is, I would never accept a substitution of my role as the father of my two girls. Parenting, relationships, learning, discovery, creation; these cannot be simplistically understood as means to an end. For people, these are ends in themselves, and in free and pluralistic societies their meaning and value will not be determined by technological progress alone. It is a choice that *We, the People* will make. Beware of the utopian and dystopian futures attributed to advances in technology. What they often reveal is the worldview of the messenger.

The creation of technology to extend what our muscles could do freed us from the drudgery of perpetual physical labor, and through the Industrial Revolution, transformed the world. The creation of technology to enhance and scale the capabilities of our beautiful minds has the potential to be even more transformative.

During the sessions of the Bankinter Innovation Foundation, an answer to the question of what technologies will have a greater impact on job destruction was sought; and could there be a trade off with the job creation capacity of such technologies. Another question raised was if these technologies will be limited to specific regions or individuals, while measuring the likelihood of the poorest countries taking part in this development. These questions might not make much sense with one of the options looming in the horizon: the co-working robots that work alongside —but do not replace— humans.

Jibo is a small household developed in 2014 by a group of American scientists, developers and entrepreneurs thanks to a very successful crowdfunding campaign. According to this company's motto, it is the first "social robot for the home". Among other things, Jibo can see thanks to two high-res cameras and advanced facial recognition software. It can listen thanks to a 360º microphone system, and learn thanks to its artificial intelligence algorithms. It can talk, help with some routine household tasks (agenda, messages...) and even read a story to the kids at bedtime. It is just a first step in the early stages of the robotics and artificial intelligence industry, but the amazing level of complexity of these machines is striking. Basically all FTF experts agreed that the room for improvement in this field is basically unlimited and (even better) it will be within reach in a few years. It is easy to anticipate future versions of Jibo (or another robot) in the near future that lend a hand with household chores and actually perform complex tasks that would befit a housekeeping employee.

The intelligence of machines is obviously developing. Dario Gil, Vice-President of Science and Technology at IBM Research, believes "we are amidst a profound transformation in computing. We have been manufacturing calculators (abacus, personal computers...) for years, but with this new milestone we are starting to build systems that can learn". The point no longer is that machines can store and process information at

Darío Gil
Finance and Economics writer and journalist.

The intelligence of machines is obviously developing.

a certain speed. The point isn't either to do the same task infinitely faster than we did in the past. This is a new paradigm. Machine learning is a new reality in our economies and society. Their contribution to productive processes still in a trial stage will profoundly change how human beings work and interact with machines.

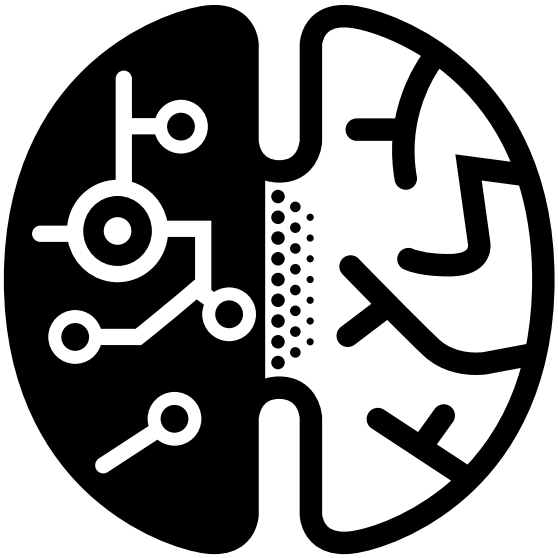
"No individual or institution can afford to ignore this transformative trend", said Gil, who gave evidence of the great progress already made in pattern recognition: faces, languages, and expressions... As of today, machines can learn, albeit limitedly, from their interactions with human beings. Some specialists in Artificial Intelligence, such as Ramón López de Mantaras (Researcher at CSIC, the Spanish National Research Council) believe progress is not as encouraging as others believe ("we are far from a machine that can really understand a conversation"), although there are promising signs of accomplishments towards machines that can undertake intellectual tasks of some complexity and risk.

What economic and labor areas will receive the largest short and medium term impact due to the development of artificial intelligence? Think about the world and classify the problems as pattern recognition problems. Driving a vehicle, for example. Can you analyze that as a pattern recognition problem? If the answer is yes, then the industry will be affected. This is not science fiction... at least not entirely. Since 2012, the technological giant Google has been developing the Google Driverless Car. Beyond controversies and evident limitations, it is proving to be a relatively safe system. How many transportation jobs might be affected if a reliable, affordable, efficient machine-operated system is developed? This impact will be limited by its ability to extend through industries and countries, but in theory, its potential is unlimited. What company wouldn't want a truck or taxi driver who is never tired, never makes a mistake or asks for a raise?

Over the last few years we have seen more progress in the field of language and image

Ramón López de Mántaras
Researcher at CSIC, the Spanish National Research Council.

What economic and labor areas will receive the largest short and medium term impact due to the development of artificial intelligence?



pattern recognition that in all previous decades", explained Darío Gil, who also said that considerable improvement in the machine's ability to interact is being achieved through machine learning systems. It is the so-called field of cognitive computing, where artificial beings can acquire skills and learn hands-on. A project of robots than can learn through interaction is a prime example: machines that can understand commands from the speaker, execute them and gain experience. Machines that can correctly answer: "which of these objects is blue?", identify it and grab it. And then successfully perform a completely different task: "now grab that object" (as the human being pointed at it).

How is this level of pattern recognition even possible? The secret is proliferation and access to "massive data banks" (resulting from the increasingly larger World Wide Web and the Internet of Things), thanks to which machines can "train" and developers can find the right algorithms to learn. "In the 1980s, data banks simply did not exist", said Gil, who believes increasingly numerous and effective pattern recognitions are accomplished thanks to these tools.

The "dramatically" decreasing cost of computing.

Another trend upping the level of cognitive machines is the "dramatically" decreasing cost of computing. Increasingly powerful microprocessors can bring the computation level up exponentially. The most powerful computer in 2011 took up the space of an entire room, but today it would fit in a regular closet, and in a few years it will fit in an iPad. How is this continuous, accelerated improvement capacity possible? A key is the great amount of human talent and intelligence focused on this technological sector. There are hundreds and maybe thousands of start-ups competing in an ultra-competitive market every year: computing and calculation speed. This competition means there is a clear incentive to be better and faster with cheaper, smaller, more efficient materials.

As cognitive computing becomes more sophisticated, it will introduce productive processes and will therefore impact employment. This will precede a very different labor market, filled with machines: "The future of expertise will be defined by individuals and machines working together", says Darío Gil. Human beings will identify the problems to be solved, contribute with their values, and the machine learning systems will use their unparalleled capacity to cross data and knowledge to make discoveries. Does this mean humans will disappear from the labor space? No: there is a trend to work in unison, utilizing machine & human special skills. For example, machines will find and show to investment bankers the best investment opportunities based on some pre-set parameters (undercapitalized companies in the ICT industry that have increased sales in the last year...). There are endless possibilities, and there is no better way to define them than a machine with incomparable computing capacity that can also interact with humans.

Aside cognitive computing, the FTF analyzed another big technological trend: robotics, led by

Darío Floreano, Director of the Intelligent Systems Laboratory in Switzerland. Robots have been with us for the last 50 years, mechanizing productive processes that have improved products, made their price more affordable and more widely available for a greater number of consumers around the world. So far, robots have been constrained to

Darío Floreano
Director of the Intelligent Systems Laboratory in Switzerland.

Camille Beatty
Entrepreneur.

A new type of robot has emerged: intelligent robots that can improvise based on the unknown and interact very practically with the environment.

manufacturing. And it continues to be so: "some 260,000 manufacturing robots are sold every year", said Floreano, who also mentioned how this market is growing at 25% per year roughly.

However, over the last 15 to 20 years, there has been a shift in robotic labs. A new type of robot has emerged: intelligent robots that can improvise based on the unknown and interact very practically with the environment. Thanks to that, robots can learn more, recognize their environment and interact with human beings. All this is supporting machines to gradually exit controlled environments (given their potential dangerousness) and spread throughout society.

Historically, the price points of next-generation robotics have been out of reach for the general audience. How can they spread beyond development and innovation centers? The key is the price of sensors and other essential components of these machines: they are at their lowest price point ever. "I've been in robotics for over 25 years, but only in the last few years I've seen low-price sensors and cameras become widespread", he said. The young entrepreneur Camille Beatty is the living proof of how robotics has reached a price affordable for nearly all. She founded a small family company specialized in manufacturing robots (which Camille and her family do in the garage of their family home).

Unlike the usual "manufacturing" robots of the last 50 years, this new trend is leading us towards mainstreaming "service" robots. This new wave of machines will not arrive in 15 years, but rather 5. It is already in the making. There are many examples with this type of machinery. The most interesting trends in robotics are the following:

1. **Co-working robots:** machines that facilitate or add accuracy to a job that is otherwise performed by human beings; "helping humans build goods with greater accuracy and speed and at a lower price; without replacing humans, but rather working alongside them".

2. **Wearable robots:** such as extremely sophisticated harnesses that help a worker on the assembly line achieve accuracy beyond

Intelligent robots, unlike manufacturing robots, will not replace human beings in the work force, but will rather work and collaborate with us to increase our productivity.

human capabilities, or work in inconceivable positions for humans without risking their physical integrity. They can also be mechanical surgeons that, when managed directly by humans, attain unprecedented sensitivity, safety and accuracy.

3. **Drones:** they offer countless opportunities and increasingly more potential is found in them. "They are the fastest growing sector in robotics measured in units sold", he said, given the many uses they have been given: "They are used to draw maps, in architecture, in the movie industry, in the mining industry and in agriculture..." Personal privacy regulation, for one, could curb growth in this sector, as a world teething with drones flying over our heads make us imagine illegitimate espionage uses or invasions of privacy.

This new generation of intelligent robots, unlike manufacturing robots, will not replace human beings in the work force, but will rather work and collaborate with us to increase our productivity. They are not initially designed to be autonomous bots, but to complement or enhance human work. Therefore, no massive replacements of human beings by machines are to be expected. In this scenario, our experts agreed in a near future where each worker will have one or several robots within reach to collaborate, so that they will help human beings perform more effectively, efficiently and precisely. This new generation of machines is designed to make our lives better.

This betterment, alas, will spread equally around the world, according to our experts. In fact, we are already seriously risking the widening of the gap between the poor and the rich, the highly skilled workers (more prone to leverage on the advantages of these new intelligent machines) and low-skilled workers. "Surgeons and oncologists have been the first professionals to use these technologies. They have had the skill and economic power to access them. The gap becoming wider is of great concern", said Darío Gil, who mentioned another concerning fact: so far, this technical progress is mainly focused on English-speaking countries.

Skills, mobility and labor market

2

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Skills, mobility and labor markets

Prologue by **John Martin.** Labor market advisor of the Irish and French governments.

OECD labour markets are having to adjust to significant shocks to demand and supply. The Great Recession led to a significant jump in unemployment in many countries which is slowly being unwound.

However, there is a large legacy of long-term unemployed who struggle to find new jobs. At the same time, labour markets are having to cope with major structural changes. Rapid technical change associated with the ICT revolution and the looming AI era has once again raised the spectre of large-scale technological unemployment. Globalisation has combined with technical change to raise the demand for high-skilled labour at the expanse of low-skilled and middle-skilled workers, generating widening earnings and income inequality. Increasing migration flows have added to this pressure. Finally, there is the overarching challenge of adjusting to rapidly ageing populations and workforces.

One key to meeting these challenges successfully is to ensure that the working-age population has the requisite skills to meet changing job requirements, and that employers and workers assign a sufficiently high priority to investing enough in skills. But in order to do this, it is important to have accurate and up-to-date information on existing skills, both cognitive and non-cognitive, and how skill requirements are expected to evolve in line with changing demands. In addition, it is vital to disseminate this information widely to education and training institutions, workers and employers so that they can make timely decisions on skill investments.

This is no mean task since comparable data on skills and skill requirements across countries are scarce on the ground. However, help is at hand thanks to a recent major international skills survey undertaken by the OECD. I now turn to a brief description of the survey and then highlight some of the main findings.

The OECD survey of adult skills[1]

The survey was conducted in 2011-12 in 22 OECD countries and is currently being completed in another 6. Large representative samples of adults aged 16-64 were surveyed in all countries and the data base consists of over 200 000 respondents. The survey measured their literacy, numeracy and ICT-literacy skills[2], and it collected a rich set of background

information on respondents' individual characteristics, their educational and labour market outcomes and how their skills are being utilised in the workplace.

The survey is incredibly rich in terms of data and policy insights. Among its many findings, I would highlight the following as being particularly germane to the theme of this conference[3]:

1. **Like the poor, the unskilled are always with us.** The size of the low-skilled adult population is significant in all countries and, in some of the countries surveyed, alarmingly so. The fact that large numbers of working-age adults in many OECD countries have such low skills must be a major concern for policy makers. It is also really worrying that there are large pools of young people with low skills in some countries. These youth are the real "lost generation" and assisting them to acquire more and relevant skills must be the priority in the fight against high youth unemployment.

2. **ICT-literacy skills are scarce, especially at the highest proficiency level[4].** It is striking that the proportions of working-age adults with the highest levels of ICT-literacy skills are so low in all countries: in no country did this share exceed 10% of the adults surveyed. Not surprisingly, young adults outperformed their older peers on ICT-literacy proficiency but, even among them, one in every three could only perform at the lowest skill level.

   Increasing the stock of ICT-literacy skills and ensuring that the distribution of such skills across the working-age population is more equal must play a central role in future skills strategies if OECD countries are to keep abreast of changing comparative advantage in international trade in goods and services.

3. **For older workers, the skills picture is worrying.** It appears that skill proficiency in literacy, numeracy and ICT peaks around the age of 30 in almost all countries and then declines steadily at older ages. It is extremely hard to motivate older workers and their employers to invest more in their skills. The lesson I draw from this is that it vital to invest more in skills upgrading during the mid-career years between the ages of 30 and 50.

   It will not be easy to achieve this since the mid-career period involves a difficult juggling of work and family/caring responsibilities for most workers, especially women.

1. Low-skilled workers lose out on all fronts. Not only do the low-skilled lose out in terms of access to employment and jobs with good career prospects, the Survey shows clearly that they also lose out heavily in terms of participation rates in further education and training/on-the-job training. Employers in all OECD countries invest much more in training their high-skilled workers than their low-skilled workers. This tendency exacerbates any technological unemployment. Hence, developing incentives that enable both low-skilled workers and their employers to invest more in their skills must be a high priority. But this is no mean task.

In sum, this pioneering OECD survey highlights the many existing skill gaps which need to be tackled vigorously if OECD countries are to continue to provide enough employment opportunities for their populations and to make inroads into reducing inequality. If this is not assigned a high enough priority by policy makers, the threat of large-scale technological unemployment could yet become a reality.

1. The full name of the survey is the Programme for the International Assessment of Adult Competencies (PIAAC).
2. Strictly speaking, it surveyed their problem-solving skills in a technology-rich environment, i.e. their capacity to use ICT tools to solve practical problems.
3. See OECD (2013), **OECD Skills Outlook 2013: First Results from the Survey of Adult Skills,** OECD Publishing, for a full description of the survey and the first results.
4. See OECD (2015), **Adults, Computers and Problem Solving: What's the Problem?** OECD Publishing.

'Gattaca' (Andrew Niccol, 1997) is another American science-fiction movie set in a not-so-distant future, where human beings can control genetic engineering finely enough to design babies à-la-carte. In this world, governments control the production processes and social structure to such an extent that each human being born has a pre-established mission: only genetically perfect humans are able for space travel; and those considered less able must make a living with lower skilled, lower social value jobs. This futuristic society cancels out the chance and uncertainty endowed to humans by natural selection. The ability to improvise and take it as it comes is also cancelled.

Fortunately—or not—it is not feasible, realistic or desirable to expect a government as in Gattaca's to efficiently allocate all available human resources in the near future. However, basically all experts present at the FTF agreed with this statement: an economic-technological paradigm shift is coming. Because of it, we will face hitherto unseen challenges of this magnitude. The so-called The Machine Revolution will most likely entail—as mentioned in previous chapters—the destruction or radical overhaul of millions of jobs that are carried out by human beings to date, but that will be performed by machines in the foreseeable future.

An economic-technological paradigm shift is coming. Because of it, we will face hitherto unseen challenges of this magnitude.

The technological and industrial revolution in progress hints at how progressive automation of productive processes will leave millions of workers out of a job. Moreover, there will be millions of unemployable people, unless governments and the international community prioritize these trends in their agendas. The increased productivity and well-being that will undoubtedly come may not be in the least distributed/shared by the majority of the population if educational and vocational training systems do not step up to the challenging changes already underway.

"Meaning is the new money"

Tammy Erickson, of the London Business School, has studied the ability and potential of corporations to innovate, along with future labor market trends, for over 30 years. There are five points she believes will "specifically" change in the coming years as we adapt to the new technologies at our doorstep. 1) The essential question to be asked by future leaders who want to build a great, even "iconic" organization is how to harness technological and human intelligence in its fullest. The iconic companies of the 20th century (Ford, Arcelor Mittal....) were able to produce at big scale and the lowest possible cost; for this they needed specialized workers and standardized processes. But this paradigm has changed for companies that want to be iconic in the future; it simply doesn't make sense any more. Today we are interested in companies that use their intellectual capital more creative and innovatively. The type of questions to be asked of the upcoming leading corporations relate to breaking pre-established ideas "and help people keep their minds open", or ask the right questions "to jog people's minds".

The concept of "ability to collaborate" comes into play at this point. It encompasses adopting a corporate structure radically different from the common corporate organization of the past century (very hierarchical systems, scant flows of information). Future innovative companies, among other things, will innovate their internal organization and

how they make the most of all their human and technological resources. How can you attract all that talent, capture it and make the most of it?

1. A very suggestive idea by professor Erickson is that the amount of money paid to employees will no longer by a key factor to obtain their best performance. Bringing "meaning" to their job will be the key factor. Based on the type of efforts essential for tomorrow's jobs, motivation and self-realization will be more important than the economic retribution per se, and the leaders that identify these levers the best will be better positioned to truly make a difference with their companies.

2. The need to re-structure how we organize work. Instead of being structured in big roles, work should be structured around tasks. That is, a job can be performed anywhere and at any time. The point is to have it done. This new concept will bring many advantages to adaptable industries and activities, as explained at the FTF: it gives people a better chance to choose what they want to do, be more specifically focused on areas where more technology should be added, and enable greater mobility within companies...

3. Harness the technology to implement task integration. For years, companies have put together plans, schedules and calendars... But communications today are much easier, cheaper and accessible than ever before, basically enabling real-time coordination from any point. Innovation in many future companies on their way to make the most of all their employees might mean going beyond traditional, on-site desk locations, or workdays as we experience them today.

The potential of technology to change how tasks are performed could therefore bring about another point:

4. how individuals relate to work. Should we all be free spirits of sorts in our relationship with the company? It isn't so much about generalizing this type of work relationship as an increasingly common one, but rather, it is about progressive diversification. For example: basically just photographers and writers freelance for newspapers nowadays. In the future, there might be greater flexibility—along with the peculiarities of each case—extending

Tammy Erickson
Professor at London Business School.

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to other departments and sections that are currently closely linked to the core of each publishing company. Work in the future will not wipe out full-time employment, but is likely to reduce it to a minimum and replace it with jobs linked to specific tasks, with tighter space and time limitations. It isn't really about expanding casual jobs, but rather, about workers adding great value when they can work for many companies and projects. This leads us to the idea of future companies resembling "talent agencies", as with Hollywood's film stars, technicians and workers. However, this new employment scene will not only be restricted to high-added value industries or intellectual jobs. As professor Erickson mentioned, there already are manufacturing companies where six out of ten employees work under this modern task-based approach.

5. Understand how the real value of a job is created. The key does not lie in teaching or directing each employee to carry out a certain task. The leaders sought out in the future will drive their employees to make the most of it and their "discretionary effort"—the key that will make some companies stand out from the pack. The more adept a company is at extracting differential effort, capacity and talent from its employees, the more successful it will be. It must be capable of achieving, nurturing and harnessing this performance. There are few better ways to innovate than make employees voluntarily and actively contribute to its betterment. Schibsted, a Norwegian multinational specialized in written press (newspapers and magazines) and classified ads, is very adept at this. For years, most of their best innovations—which have led this group to become a top performer in Northern Europe—come from their base-level employees, since different internal systems have been set up to apply their best ideas. Despite its apparent simplicity, one system has shown to be a factory of great ideas: a simple blackboard in the middle of the editorial department where each worker can jot down ideas. Then, ideas are discussed and put to practice when deemed appropriate. If proven valuable, the employee that proposed such innovative change will receive their due recognition—not in the form of money or other incentives, but rather, "meaning", making people feel they are participating in something greater than themselves, a purpose.

Skills are the key to the future labor market

Beyond future trends looming in the horizon, Europe and most developed economies are facing urgent challenges today to achieve an efficient, effective and sustainable labor market. There are important obstacles along the way, such as

long periods of time with high unemployment in the Euro zone, for one. Another challenge has to do with Europe and the Western world in general becoming an increasingly older society and productive force. Are the Western public opinion, authorities and the productive structures themselves ready to manage such a crisis? Besides, the great skill and capacity gap among citizens and between geographies is an added difficulty.

The global economic crisis has somehow already profoundly reset Europe's labor market, even more so in Southern European countries. As a whole, the EU-28 unemployment rate has spiked from 7% at the beginning of the crisis to a high above 11%. Spain and Greece for example have stringed together more than six years with unemployment percentages in the vicinity of 20%; while Germany's unemployment rate, for instance, remained below 5%. Since 2013 a slow and budding improvement has been flourishing in the European Union as a whole. From the floor hit between the second half of 2012 and the first half of 2013, the unemployment rate of the 28 EU members has gradually decreased, down to 9.7% approximately by mid 2015.

The labor market seems to be on a slow but determined rebound. However, experts as John Martin (labor market advisor of the Irish and French governments) believe the coming years project tremendous concerns on two very specific areas. The first is related to designing quick solutions for persistent, long-term (more than one year) unemployment. There are four out of ten people without a job in the European Union, a rate that has increased during the crisis, as the hardest-hit countries have not been able to tackle this specific problem. Beyond the personal drama of each person affected by long-term unemployment, there is a problem with severe consequences for the economies of the hardest-hit countries: budgetary tensions, etc. Foreseeably, a broad recovery of the labor market may help the employability of these long-term unemployed workers. However, evidence points to how additional measures are needed to bring this specific group of workers back to the market.

The second concern relates to the high youth unemployment rate, which affects more than a fourth of the youth willing to work in the European Union. These rates are so high in some countries (once again Spain and Greece are well above 50%) that there are increasingly more voices warning us about a lost generation, as a greater portion of these cohorts is excluded from the normal workings of labor markets. The rates are alarming, but they are not rare in developed economies, as is Europe. Similar youth unemployment rates have been registered in the past, and they subsided as the broad economic recovery gained momentum. What can be done? The evidence shows that countries where more flexible and adaptable learning on-the-job and internship programs have been implemented enjoy the lowest youth unemployment rates.

The progress of technology—and its potential to replace the human workforce—seems to affect low-skilled workers the most, more so than the unemployed youth or the long-term unemployed. This is not a new process; it came about years ago, when China and other giants started competing in the international market for goods and services. Machines and low-income earners are the worst competition of Western low-skilled workers: they

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can do the same job more efficiently (that is, using less resources per unit produced). But these trends are progressing so fast that they have also come to affect medium-skilled workers.

Martin sees the progressive, unstoppable ageing of the population as a short-term threat, both in Western economies and developing economies such as China. It is really a straightforward process: greater life expectancy and lower birth rates lead inexorably to an older population.

Although this process has not been as notorious as long-term unemployment or other recent events in the labor market, an ageing workforce obviously means a greater portion of older people working. In Germany, for example, the rate of workers older than 65 years of age has grown by 30% since early 2000. Even in France, home of retirement at 62, the figure of older workers has increased by 70% in this new century. It seems this trend will persist and might even accelerate as new policies are adopted to extend retirement age from 65 to 67 years of age, for example. Not everything is 'good news': the phenomenon of increasingly more older workers is only due to the fact that they decide to remain active in the company that is employing them. The truth is that the employability rate among the elderly is actually very low: there are barely any job offers for them (5% on average in the EU).

This brings us back to the issue of talent and skills. Experts have verified that the older the worker, the greater the skills. This presents quite a challenge in the future: if everybody agrees it is necessary to work more years, but the older workers are subject to the worst employability, and in fact low-skilled workers mostly belong to the ranks of the older population... what can we do?

Despite the concern for the older population, the situation of new generations at risk of never adapting to the new technological and competitive environment is of greater concern. "There are big pockets of low-skilled youth that really run the risk of becoming a lost generation. Helping them develop more and better skills must be a priority for authorities".

It might seem hard to raise awareness about how it is a forward-looking priority to invest more effective efforts in reinforcing the abilities and skills of adult workers. It seems more "essential" to invest more resources in education during the midyears, before it is too late for workers. Most workers acquire their skills before they are 30. However, it might be critical to start spending more resources and investment in training workers between 30 and 55 years of age. It would also be convenient to revert a widespread trend around the world: companies invest a greater percentage of resources training highly qualified workers. Then, companies allocate a smaller amount to train low-skilled workers. This vicious circle stresses income inequalities, career prospects, etc. Therefore, implementing effective policies to counteract these trends seems a priority to attain a more inclusive, sustainable labor market.

More experiences, less materialism

"We'll always have Paris". This is a legendary quote out of the script of a legendary, all-time movie ('Casablanca', 1941). Evocative and simple as the line is, it holds a great truth, according to Tom Gilovich, a psychologist at Cornell University (USA). The truth is that the experience is more fulfilling than the purely material good. What we experience and enjoy become more relevant and significant in our lives than what we own or spend. Oddly, the predicament of Tyler Durden in The Fight Club offers a more extreme case of the same reasoning: a person focused on acquiring a picture-perfect life, being fashionable and owning a big, high-end apartment. But this person cannot find true happiness or motivation in life until he starts punching other equally—or more— alienated guys, with whom he engages to squeeze life one punch at a time. It is an extreme case, but the same underlying concept: motivation and true engagement

of workers will come from emotional implications, experiences and the feeling of "meaning" that companies can bring to their employees' experiences.

How can even ephemeral experiences make us happier and more satisfied than lasting, material goods? There are several reasons, mainly that "experiences connect us closer with other people": owning the same iPad might create some sort of connection; but in no case will the connection compare to sharing a backpacking trip through New Zealand.

The latest psychology research shows that the closest (not just time-wise) our best experiences are, the more generous, collaborative or positive we can be. This is by no means similar to what material goods will bring out in you. One can extract from the teaching of these findings that companies that work in favor of experiences, rather than material goods, will most likely build a more involved, motivated and better disposed team to make the most of it for the company. There is a long ways to go towards the so-called "experience economy" that focuses on the ability of people to enjoy experiences rather than buy material goods.

Long-term unemployment will come to an end (or will be substantially reduced) within a company or department in a chain. It's time to reinvent oneself.

Tom Gilovich
Psychologist at Cornell University.

John Martin
Labor market advisor of the Irish and French governments.

What skills should workers have in the future?

In Modern Times (1936), the brilliant director Charles Chaplin portrayed the work dystopia of the future; a neo-Taylorism nightmare of sorts where workers are part of an endless assembly chain and must repeat the same movement at breakneck speed for hours on end. Chaplin's character, in particular, had to tighten the screws in a certain direction. The assembly line was so fast that the worker couldn't even scratch his nose or the whole assembly meticulously designed by a mastermind would collapse.

Being a master of interpretation and filmmaking, Chaplin conveyed sharp criticism of the capitalist economic and social system developed in the mid 1930s around the world. However, this wasn't very useful to anticipate future work-related tends, taking into account the summary of analysis discussed at the XXIV FTF.

The way work will be organized in the coming years (as is currently shaping up) will be remotely similar to how it has been traditionally organized so far. If Tammy Erickson's forecast comes to be, work will be organized around tasks as opposed to roles. Workers will perceive this trend first. Long-term unemployment will come to an end (or will be substantially reduced) within a company or department in a chain. It's time to reinvent oneself.

Workers adapted to this new productive and competitive environment. Beyond becoming multi-purpose, flexible and mobile.

This new reality will necessarily involve more volatile, flexible employment, and also greater choice for those who can adapt best to the new work environment. Young workers do not want to carry out the same job over and over at the same company. They would rather work on a task-based approach, drawing the most satisfaction or motivation from each moment and task.
The way people relate to work is changing; it is becoming less rigid and regulated. This trend will need workers adapted to this new productive and competitive environment. Beyond becoming multi-purpose, flexible and mobile, what are the skills and characteristics of these future workers?

Even today, most of the work performed in some very innovative companies depends to a great extent on the ability to discover and connect apparently disjointed dots and trends, understand and sense emerging needs. "There is no paved road; just a finishing line". As individuals, these new workers are called to create on the go (or find new points of view and approaches) and interpret and respond to complex signals. Nobody said it would be easy! In essence, it will mean learning to navigate the complexity.

A trend that will clearly gain momentum in the new work ecosystem will consist of workers (independent

professionals or freelancers) who can bring huge added value to a certain productive process in a specific and short period of time. Companies will only want these workers under contract for a few months the workers themselves will not be interested in a longer term work relationship, as they will be aware their differential value can only be applied during a short period of time. A TV or film casting crew could be one current example. In order to start an audiovisual production, you need specialists to select the most suitable cast. Being able to tell who's got the talent to make the production work is essential. This is done by the casting staff. Once the process has been carried out, they are no longer needed in that production. They will be needed in many other productions, so neither party wants to extend that work relationship longer than necessary.

A task can be performed at any time of day, anywhere in the world. Its true value stems from the worker's discretion, from their honest effort, rooted in deep motivation, almost self-realization that links the meaning and identification of the employee with their organization. But this economic model requires increasingly skilled workers, which will challenge the political authorities facing these problems. In all developed economies there are significant pools of people with low or very low skill levels. This is not exclusive of the older population, closer to retirement. Among the youth there are broad pools of workers with low levels of education. Workers in this bucket would loose "at all levels", as John Martin warned. They would loose in terms of access to employment or jobs with good career prospects. They would loose in access to training programs at work. Companies do invest more and better in higher skilled workers than in lower skilled workers.

This is the future shaping up at present, where workers will become increasingly aware of how important it is to acquire proper training and competences to stay or grow in the labor market. This will entail greater individual responsibility vis-à-vis the training and education each of us will get. Increasingly mainstream open education systems, for one, will open the way towards the trend of à-la-carte training.

Educational and training systems in the Western world are relatively failing to adapt plans to the needs of companies and the production system in general. Because of this, experts talk about a mismatch between the educational supply and the demand. Over the last few years, what companies and organizations expect from us as workers is changing. However, educational patterns are not adapting to this new reality. Experts such as Erickson are convinced that the leading companies of tomorrow will lead because they will act on their own initiative and train their employees. Finding the employee with the right skills at the right moment will not suffice. This worker will probably need to recycle and attend continuous or discontinuous training. The most ambitious companies must be aware of these challenges.

This economic model requires increasingly skilled workers, which will challenge the political authorities facing these problems.

Capitalism and the social contract

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A highly technological future society

Prologue by **Eduardo Porter.** Author of the Economic Scene column at the New York Times

Tech enthusiasts hoping to rewrite the future of the world tend to think like engineers. Social challenges appear to them as bugs to be fixed through appropriate engineering.

They have little time for the convoluted political paths which solutions must inevitably navigate; the tough trade-offs in which they often get stuck. They would improve society in an instant if they could only design all those complicated, unpredictable humans out of the system. And they keep trying, it seems, to do just that.

In their view, of course governments around the world will deploy Basic Universal Income schemes to address massive technological unemployment — to keep hundreds of millions, nay billions of jobless people properly fed, housed and entertained. What jobs remain for humans to do will be re-organized into tasks, presumably performed on-demand through some future rendition of Task Rabbit or Amazon's Mechanical Turk. It will be efficient. It will make sense. It will be great!

I would propose that we have no idea whether anything like this will ever come to pass. Even were I to trust technologists' propositions about technological progress, I do not buy their understanding of how it will embed itself in the political and social messiness of human societies. One hundred years from now, the nature of work might look nothing like it does in the present. Governments around the world may deploy Universal Basic Income schemes to address labor markets buckling under the technological strain. They may impose massive tax hikes to pay for this. Cars may, finally, fly. Or they might not.

What can the present tell us about a future, tech-heavy society? For starters, it calls for a tad more humility. The slowing productivity growth we've

experienced over the past decade is hardly a ringing endorsement of the breathless forecasts of a shiny hi-tech future. The data, today, suggests that the turmoil over the last couple of decades in the labor markets of rich industrial nations may persist into the future. But it does not point to a future without jobs. And from Capitol Hill to the German Bundestag, there is nothing in the political debates of the present that suggests a Universal Basic Income will be the predominant mechanism to spread income across a labor-less society of the future.

The unfolding of information technology requires our close attention. The technorati are right to underscore how relentlessly information technology is embedding itself into every economic activity. We must pay attention how this interacts with our other social and economic institutions —what tradeoffs it brings to the fore. But I would invite more uncertainty into this examination; a recognition of the messiness of human dynamics. Its purpose cannot be to merely identify the winners; announce each breakthrough breathlessly as evidence of an expanding human frontier. We must think carefully, modestly, about all the new trade-offs each breakthrough will inevitably bring about.

The movie 'Total Recall' (Paul Verhoeven, 1990) is set in the near future. Human beings have settled in other planets, although the economic and social structures are similar to those of a developed country in the early 20th century. Technological and scientific progress apparently has not improved the quality of life of millions of inhabitants on Earth or Mars. The distribution of wealth is unfair. Citizens fight the estrangement with the mind travel developed by the latest companies, providing customers an opportunity to go anywhere and be anybody: an adventurer, a spy or a rebel leader. The social contract is not abided, but rather replaced by more or less anesthetic dreams. Total Recall portrays a despairingly harsh future, once again. Whatever the future holds will certainly be a challenge, but it doesn't seem to go down the same path as in this movie.

The world has experienced five great industrial revolutions so far.

Carlota Pérez
Professor at London School of Economics.

As Professor Carlota Pérez (London School of Economics) explained in the panel of experts analyzing the evolving trends of employment, the world has experienced five great industrial revolutions so far, and they have always followed a similar pattern: first a bubble builds up and financial resources and money overflow new markets and industries. This period usually lasts several decades, and is followed by a sharp decline (the bubble bursts), when society defines how these technologies will be developed moving forward.

The world at present is immersed in the fifth revolution, linked to the explosion of information technologies, communication networks and knowledge in general. "We are at a point where we need to decide how these technologies will be defined. I believe we could have a golden, global and sustainable era, but we need to get to it. We need to make it happen. The market on its own won't make it happen". History shows that new technologies can destroy employment by drastically increasing productivity. However, what we can do in the face of these economic and social changes is not written. By way of example, take Hitler's and Roosevelt's very different method and strategy to face the development of machinery in the 1930s and 1940s.

The key for the newly created technological revolution to become a true golden era is for technological changes and developments to become widespread across populations; that is, make sure they are not the privilege of a minority. Attaining a golden era would prove elusive, given our current lifestyle — that of the Western world, increasingly being mirrored by countries around the world jumping on the bandwagon of development. But we can change that. We must choose between a US-inspired model that tends to standardize societies (which ends up being unsustainable in the long

term) and an alternative model to attain more diverse societies where the degree of satisfaction and wellbeing of the people is somewhat fair.

We run the risk of applying the values and classifications of the past to this newly created technological revolution, which would certainly make it incoherent. We must completely rethink this revolution; rethink how these new technologies will connect and develop, and what institutional fabric is designed to respond to this new model. Experts expect institutions and schemes like the basic universal income or the basic negative income tax will be necessary to guarantee decent living and minimum vital needs to the large pools of workers that might end up excluded from this revolution. This is an increasingly rich and productive society, and we cannot afford a large percentage of the population excluded from welfare benefits.

Hypothetically speaking, a way to solve the global problems we are facing with the ICT revolution requires fulfilling several future scenarios:

1. **Cheap and universal access to the main information and communication technologies.** This will extend knowledge widely across the world. Any smartphone with an Internet connection has more data and knowledge than the biggest library imaginable in the 19th century. The potential of connecting the world to this gigantic source of knowledge —that is, to ICTs— is endless. Besides, this measure would not be an act of charity, as broadening these markets massively would benefit more developed economies, which could profit from the large infrastructure investments necessary to implement these technologies effectively across the world.

2. **Necessarily green and sustainable growth and development.** The Earth's resources are limited. Expanding the Western economic model to all countries and societies is out of reach, as it would require the resources and raw materials of several planets like this. Therefore, the (real) threat of climate change must be an enabler. It is not a welcomed problem, but it should become a catalyst for a necessary economic and productive change that finally leads us to a more sustainable economy, environmentally speaking. Seriously facing the challenge of evolving towards a green economy includes many different challenges: multiple innovations in all sorts of industries would be required (transportation, logistics, etc.) to really attain a sustainable model.

> History shows that new technologies can destroy employment by drastically increasing productivity.

3. **The intangible economy. This new economy will require a deep transformation in cultural and consumption habits.** Concepts such as acquiring personal, disposable consumer goods will gradually give way to renting, recycling or upkeeping more durable goods. New concepts that somehow limit the frenzied production of goods for all. New economic sectors stemming from this new culture could well replace the jobs washed away in the wreck of the current model. We must walk more decisively even towards an intangible economy, to the detriment of the tangible economy. A shift from massification and standardization to diversity and adaptability. According to our experts, this new reality will produce a broad range of job opportunities in the future. Jobs we cannot imagine as of today. Take as a token the thousands of workers employed

The potential of connecting the world to this gigantic source of knowledge —that is, to ICTs— is endless.

today in the videogame industry. 50 years ago these possibilities were unthinkable, but nothing can seemingly stop the growth of jobs linked to contents and intangible or meaningful products in the coming decades.

All these scenarios will only develop to its fullest potential if there are political leaders fully aware of the future awaiting us. They must be daring and innovative too to undertake the necessary, essential institutional changes for the society of tomorrow to become a second technological golden era.

Singapore as a success case

Are there specific cases of how some advanced countries are facing the challenges of The Machine Revolution? Are there any inspiring models? To illustrate a relatively successful case, Beh Swan Gin took the floor at the XXIV FTF. He is member of the Economic Development Board of Singapore (EDB). This small Asian country has recently celebrated its 50th anniversary of full political independence. Fifty successful years, although few believed at first in the feasibility of this micro-state expelled from Malaysia.

With no natural market to drive demand and without access to natural resources, authorities set to work in order to find the levers to create jobs and wealth for Singapore. Given the low domestic potential, they made a bold move to appeal foreign investment, which soon led to full employment and drove wages and purchasing power up. The greater prosperity allowed the country to invest more in education and training, which in turn brought increasingly more capital-extensive companies. As a result, the knowledge service industry and exportable, high value added services in general (finance, auditing, accounting...) have rocketed over the last 20 years.

In 50 years of existence, Singapore has proven its determination to adapt to a changing environment. The Government's determination to appeal companies of increasingly higher value added led to authorities fully supporting the best education and training for their citizens, so that they could meet the demands of companies looking to settle in their territory. These policies have been so successful that this micro-state has passed from the third to the first world in one generation.

Public support to education does not mean in any way to level off at the lowest level. Quite the opposite, Singapore's model is extraordinarily based on internal competition, individual accountability and strict meritocracy. The social security system, for instance, is based upon the individual contributions of each worker. They are saved in a common pension fund from where the welfare state of this Asian country draws the payments.

But what jobs will Singapore offer in the future? Swan Gin and other experts believe the disruption brought about by the impending industrial and technological revolution will be reflected in the next 5 to 10 years, and it will be directly linked to the intellectually superior machine learning systems, able to think and replace the work of human beings. There are at least 250 million intellectual jobs in the world. They pay good salaries, middle-income workers hold them, and they will be at risk in the medium to long term. Machines will not only replace repetitive, manual jobs, but also more delicate, detail-oriented jobs, as the new machines can adapt. As these machines become widespread, they will

replace well-paid positions that have so far been essential to understand and sustain the middle class in a country like Singapore. How can the people be prepared for the coming wave? How can you be better prepared for the future around the corner?

The progressive destruction of jobs will be compounded by an increasing polarization of revenues. The breach of inequality will widen, those who adapt and harness technological change will capture increasingly more wealth. Large pools of people will not enjoy this wealth unless the challenges are successfully faced.

The solution of Singapore and its authorities includes two major strategic decisions. First, the educational paradigm is shifting: how citizens understand acquiring skills and knowledge is changing. Greater focus on education as a life-long endeavor will be required, as opposed to the current approach to education as an initial stage. How? With increasingly better and more extensive interning programs, both before and after the formal education stage. Those who already hold a job must receive the tools to adapt on-the-go to the coming technological changes.

Along with the lifelong learning approach, there is the promotion of success as a path you can reach from different angles. So far, the path seemed to be clear, as the evolution from manual, repetitive jobs to intellectual, creative jobs was a mainstream path

Economic and productive change that finally leads us to a more sustainable economy, environmentally speaking.

Beh Swan Gin
Member of the Economic Development Board of Singapore (EDB).

to success. But the new revolution will question this paradigm, as an immense range of opportunities spans to offer customized services to all citizens. Citizens will expectedly enjoy more free time (as productivity increases, less hours will be required to accomplish the same task), and therefore there will be an explosion in all industries offering personal or customized services. As citizens take in that success can be reached through different paths, this will create the necessary flexibility to adapt to the new times, which will require a (intellectual or otherwise) workforce ready to change an industry in a short period of time.

Always in the line of individual responsibility, Singaporean authorities are also considering the creation of a public unemployment protection system based on these same premises. The premise is to help those who have helped themselves and have learned the skills to be employable. Regardless of whether they have the money to pay for their education or healthcare, provided they have been conscientious and have worked to attain something. This is a radical

Calum Chace
Philosopher and Writer.

change compared with the previous model, based on extensive, broad rights for the entire population.

The Singaporean authorities will dedicate in full to encourage their citizens to keep their jobs, although hypothetically they might not provide them with a salary high enough to access basic services. Under this scheme, authorities would create tax policies (negative income tax, direct aid...) to compensate low wages with a full range of measures that guarantee a decent living for those who cannot afford one, despite deserving it.

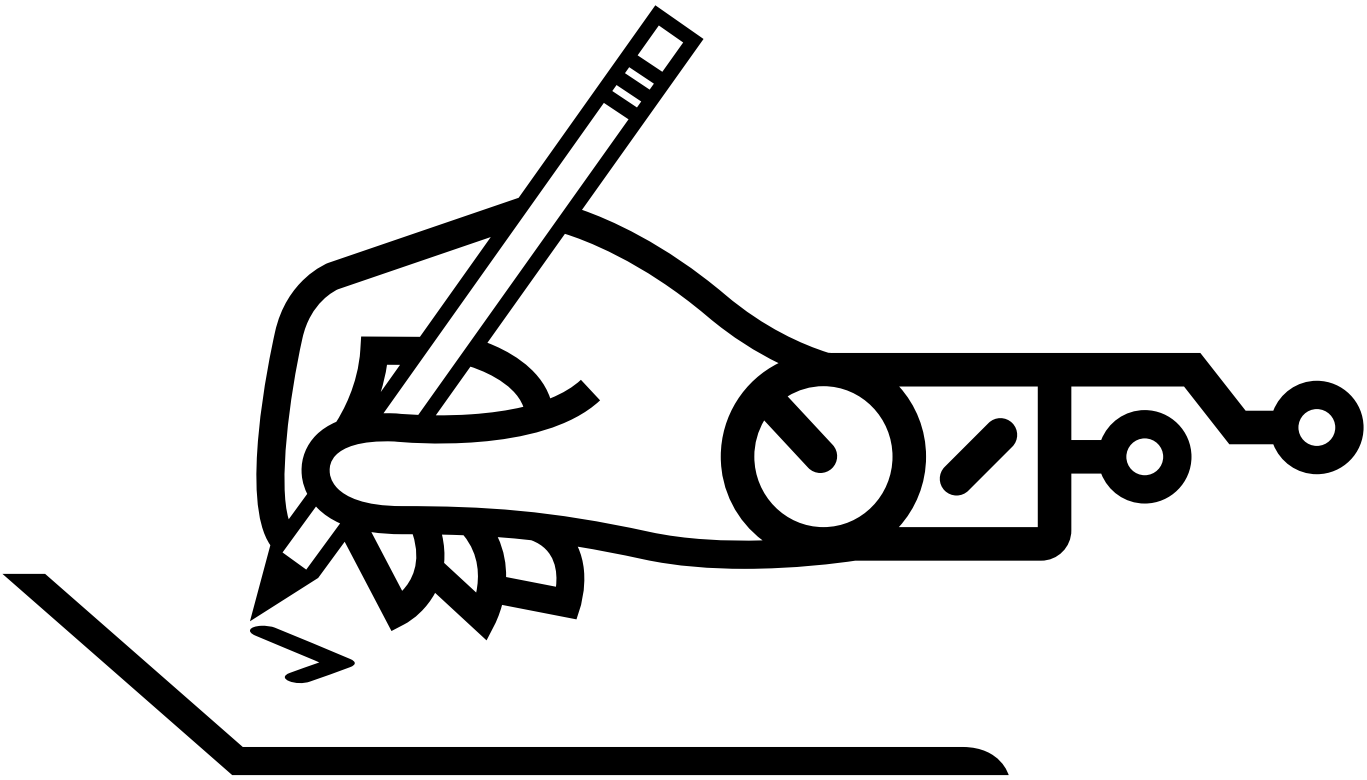
But Singapore is a small, developed country. The challenge lies in offering these skills and abilities to the largest number of people possible around the world. Democratizing tools as the access to information and education, and the increasingly widespread access to advanced business organizations (startups...) should be a priority for all governments and international authorities going forward.

Facing the massive risks of artificial intelligence

Are we really prepared for the arrival of artificial intelligence? Are we aware of the fact that sooner rather than later we will produce machines capable of processing countless data at incomparable speed, and they will think and feel, that is, they will be creative, adaptable and even innovative! What role will human beings play as these machines permeate the economy and society? In the words of the philosopher and writer Calum Chace, the landscape of the coming years includes "massive" risks for employment and society in general. Nevertheless, he remains optimistic about how countries will manage the impending changes.

Chace estimates the US society will see close to 45% of its currently existing jobs disappear in the next 20 years. A major portion of these jobs will be destroyed in transportation and logistics, two industries at the core of the main technological innovations. Another significant portion of jobs will be destroyed in intellectual sectors (managers, executives and even artists).

An intangible economy, to the detriment of the tangible economy. A shift from massification and standardization to diversity and adaptability.



Let us illustrate the point with a typical case; a job threatened by the hypothetical progress of robotics and artificial intelligence: drivers. They can be taxi drivers, chauffeurs or bus drivers. The market disruption of a (technological) player that can automatically, quickly, effectively and safely drive would jeopardize millions of jobs. Google and the likes have been researching and developing technologies to promote automatic driving for years. The developments are not fine tuned yet, but progress is spectacular and leads to speculate about the emergence of the driverless car as a reality in the not so distant future.

Other cases. The progress in Artificial Intelligence has already produced machines that can create music comparable to human compositions (within certain limitations). This is an industry still in its infant stages; we can only expect new progress from it. The increasingly better pattern recognition systems show a clear direction towards machines increasingly capable of navigating complexity, improvising and even being creative. This threatens all types of jobs of an intellectual nature; those that had best withstood technological developments so far.

A scenario where millions of citizens will virtually become unemployable.

Artificial intelligence is a reality around the world, although it is focused on English-speaking countries so far and it is based upon the questions and concerns of the Western world. Google is just one of many examples in an increasingly extended trend. The truth is that achievements and improvements

In 50 years of existence, Singapore has proven its determination to adapt to a changing environment.

in this sector are increasing exponentially. Something seemingly impossible yesterday is no longer so, and will be fully feasible tomorrow.

Could we create employment to replace jobs seemingly doomed to become extinct? Experience tells us the human capacity to come up with new jobs and businesses is apparently limitless. Making a living as web designers, community managers or video bloggers was unthinkable for our grandfathers. The world is an unpredictable place. One can imagine—although its feasibility remains to be seen—that a full range of new jobs is created in the next few years, in adaptation to the new machine age. Looking at history, this is not very likely, as the ability to create new jobs will compete with artificial intelligence and its exponentially growing potential.

This depicts a scenario where millions of citizens will virtually become unemployable. How is this to be managed? The scenario may apparently include some sort of basic income or alternative scheme to provide basic, decent means of support for all those excluded from the labor market in the wake of the machine revolution.

But every cloud has a silver lining. The rise of machines and artificial intelligence may well bring a spectacular increase in global wealth. That is, there will be more to share. Sharing 100 gr of cake among 10 people does not compare with sharing 1,000 gr of cake among 15 people. And radical increases in productivity lead us to speculate, albeit hypothetically, that the future society will be much richer than what we know today.

Despite the unquestionable growth of wealth, a future where everybody can access the American standard lifestyle (so to speak) is improbable. But in an increasingly globalized world, everybody will shoot for the highest standards. In this contradiction between what is possible and what is desirable, virtual reality can play an important role. This side of technology is barely budding today, but just like artificial intelligence, it is progressing exponentially (despite the lack of agreement between the experts). Not everybody might be able to afford a beach house, but thanks to this technology, we may all have the memory and experience of having spent a summer at the beach. Just as the main character in Total Recall would hire a company to live a more thrilling life, this type of imaginative solutions might guarantee social peace. What is the point? Having been at the beach or the memory of having been there?

Conclusion

4

Eduardo Porter
Author of the Economic Scene column at the New York Times.

Calum Chace
Philosopher and writer.

Concluding remarks and future

Prologue by **Calum Chace.** Philosopher and writer

The idea that artificial intelligence may cause widespread technological unemployment within the next few decades is controversial, to say the least.

In a poll of the delegates at the FTF meeting in Madrid in June, a slight majority declared that it will not happen: they believe that we will work with machines rather than being replaced by them. The idea is that automation will displace jobs which are dangerous, onerous or tedious, but that more and better jobs will be created to replace them. This is what has always happened before, the argument goes, and to believe that large numbers of people will remain unemployed forever is to succumb to the "Luddite Fallacy", which has been disproved many times.

The new jobs will involve work that humans are equipped to do and computers are not. It may involve abstract reasoning, for instance, or it may require empathy and human understanding. Perhaps we will invent entirely new categories of work – activities for which we currently don't even have names. Dream wranglers, perhaps, or emotion coaches.

Some people go so far as to argue that the technological change we are witnessing today is over-hyped, and is less dramatic than the experience of people in the early 20th century when electricity arrived in the home, along with labour-saving domestic devices and cheap transportation. They observe that for all the talk about their exponential growth, computers are adding little or nothing to measures of economic productivity.

Those who worry that technological unemployment is a serious possibility reply that this time it really might be different. Previous rounds of automation mostly replaced human and muscle power with machine power. The mechanisation of farm work

in the 20th century displaced the horse entirely - it had nothing to offer beyond its muscle power. The population of horses in the USA declined from 21m to 3m between 1900 and 1960[1], and most horses today are engaged in leisure activities, not work. In the same period, the percentage of the US human workforce employed in agriculture fell from 41% to 4%[2], but unlike the horses, humans had something else to offer: their cognitive ability.

This time the AIs are bringing cognitive ability to the automation process. As computers take over the role of ingesting, processing and transmitting information, there may be nowhere higher up the value chain for many humans to retreat to.

Time will tell, but if technological unemployment is a serious possibility, we should at least be watching out for it, because the outcome could be very good, or it could be very bad. We should, as a species, be investing a certain amount of time in figuring out how to ensure the outcome is a positive one.

1. http://www.americanequestrian.com/pdf/us-equine-demographics.pdf
2. http://www.ers.usda.gov/media/259572/eib3_1_.pdf (The period here was 1900 to 1970 instead of 1900 to 1960, but the point stands).

Increasingly widespread and developed technologies, such as Artificial Intelligence or robotics, will cause the destruction of hundreds of thousands, millions of jobs around the world in the near future. The vast majority of experts (divided between techno-optimists and labor pessimists) agree that the greater productivity brought about by the second machine age will not affect all countries, or all citizens, evenly. It will open a wealth of opportunities to create new industries, sectors and jobs, but also significant challenges that we must start analyzing as soon as possible. The job pie will become smaller for the world as a whole, although new opportunities and ways to create wealth will emerge. Machines will perform many jobs performed by human beings today. This trend will affect all countries and industries, although not equally. Everything points towards a future world where less people (although longer and better trained) will work more, compared with the far worse

This challenge will also mark the future success of companies, those that can effectively implement task-based (as opposed to role-based) productive models.

New opportunities and ways to create wealth will emerge.

prospects of the unemployable workers. This presents the first challenge: how can the pie be shared in a way society can digest this new reality? The analysis seems to be clear, and therefore, potentially applicable solutions seem to be clearly defined, at least partly. But the true conflict revolves around the political will (or lack thereof) to take these decisions.

There are today, in basically all countries, a complex fabric of regulations, prohibitions and laws that one way or another limit the flexibility needed in the impending scenario. Rigidities in labor law impose certain types of contracts, for one. There are also rigidities in immigration law and the entry and exit of different countries. Countries that adapt to the new times will be set apart from the rest based on how they tackle these challenges and overcome the unavoidable resistance that imposing solutions will bring.

This challenge will also mark the future success of companies, those that can effectively implement task-based (as opposed to role-based) productive models. It will not be easy. How will work be priced in this new market? The demise of the old model and the emergence of the new model will presumably give rise to friction and issues.

Solutions such as *flexicurity,* the negative income tax or the universal basic revenue seem possible and doable in the future to face "extensive unemployment" situations. Because of their high economic cost and tax burden, it remains to be seen whether they could be practicable in the case of overall, massive unemployment, as opposed to just *high* unemployment. What will be the best tax policy in these situations? Countries such as Denmark have successfully developed this type of model. It remains to be seen whether it is extendable to other countries. Another challenge when transitioning to the new scenario involves mass media and the public opinion of countries. The right consensus and stories will be required to convince society of the need for certain ideas and measures. The foreseeable income re-distribution from the richer to the future pools of unemployable might undermine the idea of public justice, and it should be approached without creating resistance that eventually builds up and makes the trend unfeasible.

We all are aware of the problem; we all know there are several possible solutions on the table. But clearly, no solution will be implemented easily or quickly. Will the necessary political, social and business leaders step up to face the challenges of The Machine Revolution?

We all know there are several possible solutions on the table. But clearly, no solution will be implemented easily or quickly.

The Machine Revolution Predictions

	2016	2020	2030
Government		Knee-jerk reaction of governments to civil unrest. Massive privately held data set is nationalized/ declared a public good. US changes immigration policy to support high skilled global workers. Immigration laws are tightened in US and Europe. Skills are welcomed.	Many governments will introduce negative income taxes/universal basic incomes. Negative income tax goes into effect in most of EU and USA. Life expectancy goes up to 100. Insufficient pension funds & jobs to sustain life. First social profit fund established in USA. 50% of all stocks nationalized.
Civil Society		AI & robots increase average life span by 10 years. Robot council formed to represent robot´s interests. A wearable robot will have me play golf like Rory McIlroy.	Climate upheaval causes vast disruption in Africa/South Asia. Mass migration flows. First AI-Human weddings (San Francisco). Robot council announces human beings surplus to requirements. Africa becomes a talent hub for the world. Retirement age will be 70 and rising in most countries.
Education	Cognitive development to stay young & sharp! Open platform shared for learning. Younger ones teach & coach older ones. Internet based social learning. Traditional education system change: from focus on education to focus on learning. Education for entrepreneurship & employment as a subject.	Young people´s primary education is via gaming & other online means. Khan partners the University of California system to confer degrees. Curriculums developed by organizations, learners and local authorities. Ministries of Education disappear. MOOCs reach a tipping point, so the composition of faculties is massively altered; scholarship threatened. Universities are accountable for outcome employment/jobs/skills/ startups. Watson does the graduations speech at HBS.	Speech recognition eliminates need to learn to write. First MOOC entirely offered by AI. First open source tertiary degree granted. Peer to peer learning takes over universities. Tracking starting age 3 announced by US department of education. Education has moved online.
Technology	Robots will learn how to learn (or continue to). Flexible to accept changes.	Cars will interact with each other to reduce accidents, ease traffic congestion and improve fuel efficiency. Robot cost effective. Most people between 60 and 80 are engaged in constructive work at lea part-time. Siri Becomes Watson. Cognitive computer demonstrate common sense reasoning. Virtual reality becomes real; even better than real.	Technology physically adapts to humans to ensure AI and HI in everyday activity. Robots will begin to be seen doing service tasks, such as automated hotels and restaurants and driverless transportations. Multitask robot improves our quality of life. Technology in the field of human brains will be advanced enough to research robots controlled by thoughts. Domestic robots do many daily tasks at home. Problems related energy and water shortages solved by technology/ autonomous robots coordinated.
Industry	Robotics is included at primary schools worldwide.w	Massive online learning based on AI is the main learning methodology. MOOC´s generalized. Job loss among truck drivers offset by creation of other job opportunities. 50% of US trucks have no human driver.	Block chain based (DAO) systems provide 50% of internet services. Last IP/Patent law firm shut down! Open source/data is the new normal. It will grow the market of products and services related with personal services.