

FORESIGHT ON NEW AND EMERGING OSH RISKS ASSOCIATED WITH INFORMATION AND COMMUNICATION TECHNOLOGIES BY 2025

1 Introduction

This report summarises the delivery and outcome of a dissemination and promotion workshop for a foresight project on new and emerging occupational safety and health (OSH) risks associated with information and communication technologies (ICT) by 2025 (more information at: <https://osha.europa.eu/en/developments-ict-and-digitalisation-work>). The workshop was designed for and delivered to the European Agency for Safety and Health at Work's (EU-OSHA's) Focal Points on 23 November 2017 (in Bilbao). It was carried out by a consortium of the Health and Safety Laboratory and SAMI Consulting Limited. All documents related to the workshop are available at: <https://osha.europa.eu/en/tools-and-publications/seminars/foresight-new-and-emerging-osh-risks-associated-information-and>

ICT, including ICT-enabled technologies (ICT-ETs) such as robotics and artificial intelligence (AI), are likely to have major impacts on the nature and location of work over the next 10 years. Technologies are diffusing much faster than in the past and many people are talking about a 'Fourth Industrial Revolution'.

A connected Digital Single Market (DSM) is one of the European Commission's (EC's) key priorities (EC, 2015). The Digital Agenda is expected to deliver high levels of employment, productivity and social cohesion by creating a DSM (EC, 2015; Maciejewski and Dimova, 2016).

Current European Community strategic documents (EC, 2014; EC, 2017) identify the need for a proactive approach in identifying future risks to workers' safety and health in a continuously changing world of work. EU-OSHA looks out for risks and challenges to occupational safety and health (OSH) that are emerging as a result of changes in the workplace, which can occur at an increasingly fast pace. Following a successful large-scale pilot foresight project on emerging green jobs and the potential implications for occupational safety and health (EU-OSHA, 2013), EU-OSHA decided in March 2016 to commission a further foresight project on the potential impact on OSH of rapid developments in ICT-ETs.

The basis of foresight is an understanding that the future can evolve in different directions, which can be shaped by the actions of various stakeholders and decisions taken today. Scenario development was, therefore, used as a tool for building visions of possible futures that are clearly relevant to OSH policy.

This project's aims were to provide EU decision-makers, Member States' governments, trade unions and employers with information on changes in ICT, their impact on the nature and location of work, and the emerging challenges to OSH that they may bring. It should help them to:

- have a better understanding of longer term developments that could affect workers and how these may result from current policy decisions;
- consider priorities for OSH research and actions that would prevent the occurrence of the identified possible new and emerging risks or minimise any possible negative impact in the future.

This foresight project was carried out in two distinct work packages. The objective of Work Package One was to identify key trends and contextual drivers of change that could contribute to creating new and emerging OSH risks associated with ICT (EU-OSHA, 2017). The objective of Work Package Two was to use the key trends identified during Work Package One to develop and test scenarios of the future world of work and new and emerging OSH risks associated with ICT in 2025 that will allow policy-makers to consider a range of potential future OSH implications.

The final report and summary report with an explanation of how the scenarios were developed and tested along with the OSH issues identified during the project will be published on [EU-OSHA's website](#) in 2018.

2 Objectives of the workshop

The objectives of the dissemination workshop were to:

- present the foresight project, the scenarios developed and the new and emerging risks identified;
- demonstrate how participants can use the scenarios as a tool to develop robust policies and strategies addressing the OSH challenges identified in the project.

The future will include elements from each of the four scenarios developed during this foresight project, (given in Appendix of this report), in a mix that cannot be predicted. They should, therefore, not be treated as predictions of the future. They are, instead, to be used as a tool to aid thinking and stimulate discussions about a broad range of possible and plausible futures and how to manage the associated uncertainties. They are ideal for use in a workshop, where they allow a multi-disciplinary approach to considering different perspectives.

Scenarios can be used to determine potential new and emerging OSH risks. If risk analysis is restricted to current data and trends, important future risks are likely to be overlooked. Scenarios create an environment for a strategic discussion between stakeholders, challenge people's perceptions and stretch their thinking. This enables a more robust assessment and understanding of a wider range of risks.

Policy is frequently driven by an 'official' or accepted view of the future. By using scenarios, the changing future world of work and its associated impacts or uncertainties can be better addressed without the need to threaten or defend the official view. The respective OSH challenges and opportunities in each scenario developed can be assessed and policy responses to them generated. These policies can then be tested against the other three scenarios to see how robust they are in these different potential futures. This results in a wider range of more robust policies and implementation plans that can also influence what actually happens in the future.

Organisations will face different OSH opportunities and challenges across the four scenarios. Current OSH strategies can be tested to see how robust they are against the scenarios. The plans can then be modified to make them more robust, or the risks reviewed so they can be better managed. This helps to ensure the best possible outcomes.

Scenarios can be used for stakeholder analysis to identify which stakeholders will be most affected (positively or negatively) and which are best placed to manage risks or implement policies. They can also be used to help stakeholders develop a shared understanding of the issues raised by the different potential futures and reach consensus on what should be done.

3 Description of the workshop

The workshop consisted of a combination of presentations, group exercises and plenary discussions over the course of 1 day. At the start of the day, the plan for the workshop was introduced. An initial presentation by John Reynolds, SAMI Consulting, explained some key developments in ICT-ETs that could be in place by 2025 and beyond, and how these could have transformational effects on work. Some of these changes are taking place at an exponential rate. It has been estimated that 65 % of children entering school today will ultimately end up in new jobs that do not yet exist (WEF, 2016) and that 35 % of the skills necessary to thrive in a job today will be different 5 years from now (McLeod and Fisch, 2018). John explained that the time taken to reach 50 million users has accelerated; whereas it took 75 years for the telephone, it now takes a little over a month for popular smartphone apps. Topics covered in the presentation included:

- an explanation of the fact that some technologies can stimulate the economy, whereas others can disrupt it and society as a whole;

- the impact of the increasing availability of big data, the Internet of Things (IoT) and the miniaturisation of ICT-ETs such as wearables, monitoring of worker performance and the use of the human body as an ICT platform;
- a description of key technologies and the impact of how they could be used in the future; these included AI, augmented and virtual reality (AR/VR), three-dimensional (3D) printing, autonomous vehicles including drones, advances in robotics and androids.

This was followed by a presentation on how the four OSH scenarios of the future, shown in Appendix, were developed and their key features.

After the presentations, participants separated into four groups — one group for each of the scenarios — for the first exercise. Participants were asked to read through their scenario description, to become familiar with the scenario that their group had been allocated. They then discussed the world as described and had an initial discussion about the implications of this world for OSH. Finally they produced potential news headlines for OSH in 2025 for their scenario. The headlines were shared across the groups as part of a plenary discussion of the four scenarios (see Section 4).

After exercise 1, a presentation was given by Nicola Stacey, Health and Safety Laboratory, about the impact of ICT in 2025 on OSH and the potential influence of the differences between the scenarios.

The rest of the workshop consisted of exercises and plenary discussions moderated by John Reynolds, SAMI Consulting, that allowed participants to see how scenarios can be used to explore potential OSH issues and possible policy responses.

Exercise 2, done in the same groups with the same scenarios as for the first exercise, involved considering how jobs could have changed by 2025 and the possible OSH implications. Participants were encouraged to discuss the OSH challenges and opportunities, and the sectors and workers most affected, and comment on the potential impacts. The findings were recorded in a table format as shown in Section 4, Tables 1, 3, 5 and 7.

Exercise 3, again done in the same groups with the same scenarios, consisted of reviewing the OSH challenges and opportunities identified during exercise 2 and discussing possible actions that could be taken to manage them. These were expressed in the form of possible policies. During this exercise, participants were encouraged to consider what was really critical in the scenario, what they would want to happen to avoid things being worse or how to realise the potential benefits. Participants were also encouraged to think about what was novel to the scenario that they were working with, as well as issues that may be of concern today. They were reminded that it was not possible to develop robust policies in a few hours (the purpose of the exercise being to demonstrate how to use the scenarios for policy-making, not to develop actual policies) and that they should focus on a few things that they felt would have the most impact.

A record of the main points from exercise 3 are captured for each scenario in Tables 2, 4, 6 and 8 in Section 4.

The final exercise was done in plenary. Each group was asked to describe a policy that it thought was particularly important or novel to its scenario. All the other groups were then asked to consider to what extent that policy would work in their scenarios and how it would be implemented. Testing policies against a range of scenarios is important, as the future is likely to contain elements of each scenario in a combination that cannot be foreseen. Such testing can help to identify which policies are robust enough to work in a range of different futures as opposed to those that will work in only one. In this way, policies can be ‘future-proofed’. This process is often called ‘wind-tunnelling’. The nature of the plenary discussion and the conclusions that could be drawn from the workshop are described in Section 5.

It was stressed during the workshop that the results of these exercises would require more detailed analysis before they could be used for future policy decisions. The objective was to demonstrate the use of the scenarios to develop and test either existing or potential new policies, not to develop policies for implementation after the workshop.

4 Results of discussions

4.1 Scenario 1: Evolution

Exercise 1: OSH news headlines in scenario for 2025

Top choice: 'Proud to live in a "castle" with shared values and a basic income for everyone'

Key points made:

- moving away from globalisation
- Europe is the 'old castle'
- we are still in the 'old world'
- proud of our social values
- learning from our mistakes
- prosperity without growth

Table 1: Record from exercise 2 — OSH issues in Evolution scenario

OSH issue	Describe: OSH challenge or opportunity?	Sector(s) of the economy	Comments (new or increasing, who most affected, nature of impacts, etc.)
More voluntary work, not covered by legislation	Outside the traditional OSH framework	All sectors, but caring likely to be a major area	An increasing risk due to weak growth and increase in demand
Workers agree on risk but governments need data	The requirement for evidence-based policy-making	All	The need for robust data and a consensus between government and the public/workers in this scenario. Lack of funding for data collection to underpin it
Knowledge gap due to the lack of research funding	Lack of data on new and emerging risks	All	Lack of ability to understand implications of rapidly evolving risks
Increase in unemployment and self-employment	Workers hard to reach Increase in home working Increase in local micro-businesses	Particular problem for platform workers	A major emerging risk, which regulators have difficulty managing
How can ICT-ETs be used to monitor workers and help to manage OSH?	Use of AI and other technologies to monitor and manage OSH	All sectors	Opportunities constrained by lack of investment
Lack of understanding of new risk	The innovation in new technology will create new risks that are not adequately understood	All sectors	Lack of funding for OSH will result in understanding lagging behind exploitation

Table 2: Record from exercise 3 — OSH policies and actions to achieve the best OSH outcome in Evolution scenario

Description of action/policy	Expected OSH benefits	Implementation
Opportunity: EU Directive clarifying roles of worker, employer and workplace; supported by universal basic income	Greater understanding of the respective roles of the social partners Clarification of new work paradigms	Dialogue between the social partners Need agreement at EU level. Probably difficult to get consensus
Challenge: There will be more self-employment, voluntary work and home work, with fewer jobs with a traditional employer-employee relationship, so workers need to take increasing responsibility for their own safety	Workers are more aware of their rights and responsibilities	Change in culture of OSH management. Increased importance of workers' representation and social dialogue
Surprising/novel: Universal basic income	More a social issue	Would be difficult to finance in this scenario

4.2 Scenario 2: Transformation

Exercise 1: OSH news headlines in scenario for 2025

Top choice: 'Guggenheim II opened (on opposite side of river from Guggenheim I) to house AI-generated artworks'

Key points made:

- It may be impossible to identify what is human and what is not.
- Loss of sense of identity.
- Humans could be so enhanced by bionics and AI implants that they are more robot than human.
- Robots/AI demand representation in social dialogue.
- Concept of work/life balance could disappear, as there is nothing to distinguish between what is work and what is not.

Table 3: Exercise 2 — OSH issues in Transformation scenario

OSH issue	Describe: OSH challenge or opportunity?	Sector(s) of the economy	Comments (new or increasing, who most affected, nature of impacts, etc.)
Stress and anxiety for different reasons including: constant monitoring; not having a sufficiently interesting (challenging) job; cognitive overload	Support to workers to help them cope and be able to seek help when needed	All those where ICT is part of the job but less so in creative or leisure sectors	In this scenario, the support would be there so that workers can develop the necessary skills to cope. Work breaks tailored to individuals' needs would be obligatory The right to disconnect would need to be enshrined in OSH regulation

OSH issue	Describe: OSH challenge or opportunity?	Sector(s) of the economy	Comments (new or increasing, who most affected, nature of impacts, etc.)
Loss of sense of identity, personal value due to pressure to conform to social norms. Increasingly distancing ourselves from the physical world, our physical nature, e.g. by interacting with work processes and people via ICT	Potential for increase in psychopathic disorders in workforce	Most except creative or leisure	All workers would need good access to occupational psychology treatment
Humans no longer being in control of work processes as no longer able to understand how they work	Machine learning and AI control and innovate beyond human capabilities. Humans rely on AI to extent that they lose knowledge	All	Carefully thought-through safety protocols would need to be embedded in AI and machine-learning algorithms. An archive of how systems work/make decisions would enable them to be rebuilt if they fail/need to be reset. May need a back-to-basics back-up/knowledge bank
Dirty, dangerous and repetitive work	Human workers no longer required to work in majority of hazardous environments – except when something goes wrong	All	There may be a limit to the extent of automation due to the limited availability of the resources (materials and energy) needed to make and power the automation
Dependence on connection to internet and electricity	Vulnerability to cyber-attack or cascade failure. Inability to access safety information or maintain safety systems if internet connection or electricity fails	Most	Local back-up of information. Alternative low-tech safety systems available
Sedentary work, new ergonomic hazards from new human/machine interfaces	Research required to develop good practice and for monitoring for harm	Most	Priority would need to be given to adapting work to the workers
Ownership of OSH due to change in employee/employer relationships	Many workers self-employed, work through online platforms, frequently change jobs and have several jobs at any one time	Most	OSH may need to be provided as a public service rather than by companies. This would require workers to be empowered to understand their rights. The responsibility for managing OSH would be a shared responsibility between them, those for whom they work,

OSH issue	Describe: OSH challenge or opportunity?	Sector(s) of the economy	Comments (new or increasing, who most affected, nature of impacts, etc.)
			government and other social partners

Table 4: Exercise 3 — OSH policies and actions to achieve the best OSH outcome in Transformation scenario

Description of action/policy	Expected OSH benefits	Implementation
<p>Opportunity:</p> <p>Society has shared values which include OSH so that there is a culture of prevention, which is adequately funded</p>	<p>OSH is built in to majority of work activities so that incidence of injury and ill-health is very low</p>	<p>Shared values created from early age through education and reinforced through lifelong learning, which include ethics, critical thinking and use of information</p> <p>Good-quality data analysis using AI</p>
<p>Challenge:</p> <p>Mental health due to anxiety, stress, loss of personal identity and value, feeling out of control</p>	<p>If properly recognised, regulated and managed, then incidence of mental health problems would be kept to a minimum</p>	<p>Work breaks tailored to individuals' needs would need to be obligatory. The right to disconnect would need to be enshrined in OSH regulation and suitable places available – 'ICT-free reservations'</p> <p>All workers would need access to good-quality occupational psychology treatment</p> <p>AI could be used to identify risks</p> <p>The point where profits are made would need to be taxed to pay for all this</p>
<p>Surprising/novel:</p> <p>AI-based labour inspectorate and law enforcement facilitated by the Internet of all Things</p>	<p>All-encompassing AI-based OSH regulation would be affordable and self-learning, thus efficiently reducing incidence of injury and ill-health to a minimum</p>	<p>A national OSH and cyber-security service rather than employer-based OSH and management would be needed, funded by companies, which would be incentivised to do so by receiving something they need in return, such as high-quality cyber-security infrastructure and services</p> <p>This would be a new method of regulation, which would also require new models of stakeholder input</p> <p>Thought would need to be given to how to accommodate those unable or unwilling to adapt</p>

4.3 Scenario 3: Exploitation

Exercise 1: OSH news headlines in scenario for 2025

Top choice: 'Shut up and adapt!'

Key points made:

- This scenario is stressful; you need to look after yourself.
- OSH regulation has not evolved with changes, so there is a need to switch to more flexible regulation.
- We should talk about the work *station*, rather than the work *place*. What type of work do workers do and where do they do it?
- Employers have a duty to consult with and involve workers; but how do they do that in this scenario?
- How can we give workers the psychological strength to be resilient in this scenario and effectively exploit technology?

Table 5: Exercise 2 — OSH issues in Exploitation scenario

OSH issue	Describe: OSH challenge or opportunity?	Sector(s) of the economy	Comments (new or increasing, who most affected, nature of impacts, etc.)
Huge demand on workers, exploitation is common	We need to change our philosophy and approach to education to help influence both young people (digital natives) and those in charge of education policy to integrate OSH	All	It will not be possible to regulate OSH as we do now. Impact increasing, all workers affected. OSH responsibility is increasingly transferred to workers. There is a race to the bottom — you have to accept what you get as a job, and the conditions. There is strong competition
Individual responsibility for lifelong learning and quality of OSH training	This is an individualistic society; people will be much more autonomous than today. Workers' skills need to be extremely generic in this scenario. There will also be a need to be very flexible, be able to market yourself, network well, react quickly and be very resilient. Not many people have all these skills	All	Most workers are employed in micro-enterprises or (pseudo-)self-employed and may need to change their job several times a week, and their career many times over their extended working lifetime. There will be a need for personal skills coaches, but also online training and AI trainers. The market will offer these training options. But who would monitor the OSH quality of the training offered for workers? Those who are not able to sell themselves will be unemployed
Poor OSH regulatory framework and funding. OSH regulators are deprived of tools	There is a need for an extremely generic regulatory framework to cope with these dramatic changes	All	Increasing impact. If there is no trust, it is difficult to agree what core areas to develop. Businesses will step in, but it will be hard to convince them of the importance of OSH; how could we do this?

OSH issue	Describe: OSH challenge or opportunity?	Sector(s) of the economy	Comments (new or increasing, who most affected, nature of impacts, etc.)
What is work? Who is responsible for OSH?	Do we need to redefine work?	All	Is OSH everyone's responsibility
How to establish values in a society of low trust	OSH regulators could disappear and be replaced by cooperative organisations, such as guilds, which will have their own internal OSH rules and negotiate on workers' behalf. But how do we create trust within these networks so that they keep promises and agreements and share good knowledge?	All	There may be a resurgence of tribalism. Some actors will have lots of power, others none. Also, if you have constantly changing professions, what do you organise around?
There will be a levelling of workers	There will be increased opportunity for the disabled at work and less discrimination because no one cares what crowd workers look like; you just need to be good at what you do	Most sectors	

Table 6: Exercise 3 — OSH policies and actions to achieve the best OSH outcome in Exploitation scenario

Description of action/policy	Expected OSH benefits	Implementation
Economic incentives for OSH	Improved OSH performance of organisations	Use insurance to mainstream OSH Differentiation of taxes based on OSH investment/performance Integrate OSH into procurement Companies that advise on tax etc. could be used to help influence in terms of OSH
An approach to mainstream OSH into education (Napo ¹ for teachers)	OSH is integrated into education	Empower children; enable them to build strong intellectual capital, OSH consciousness and resilience Education to help young people adapt to rapid technology change Law to oblige universities to include OSH in all their degree courses
Health, workability and employability policy for workers	Healthcare providers to provide OSH support to individuals	Empower the healthcare sector; use an intersectoral approach, e.g. better cooperation between GPs (family doctors) and occupational physicians.

¹ Napo is a character in a series of animated films, produced by EU-OSHA to provide light-hearted, discussion-provoking introductions to OSH topics and risk prevention.

Description of action/policy	Expected OSH benefits	Implementation
		The leverage to achieve this is to make the business case for OSH, or it could be achieved through a social impact bond (businesses funds OSH public service providers and get financially rewarded for positive OSH results)
Individual responsibility for OSH	Workers manage their OSH effectively	Try to influence individuals on OSH, e.g. encourage them to sign agreements to improve OSH and rate the organisations they work for (TripAdvisor for employers)

4.4 Scenario 4: Fragmentation

Exercise 1: OSH news headlines in scenario for 2025

Top choice: 'Closure of EU-OSHA announced – no funds available for OSH'

Key points made:

- Shadowy influencers could affect elections.
- New technologies could increase divisions in society.
- Grey economy could be 'ruled' by robots.
- Who would be held accountable if, say, a robot kills people accidentally or on purpose?
- Politicians could be 'owned' by those made super-rich.

Table 7: Exercise 2 — OSH issues in Fragmentation scenario

OSH issue	Describe: OSH challenge or opportunity?	Sector(s) of the economy	Comments (new or increasing, who most affected, nature of impacts, etc.)
Who is the employer? Who is responsible for OSH?	In an economy where many people have more than one job, it may be hard to tell who a worker is working for when an accident occurs, especially when working remotely	Mainly desk-based, knowledge-based roles; professional and science and technology/ICT; admin and support	Worker may be multi-tasking on different jobs Increasing as remote working increases
How can OSH be enforced on those working from home?	Enforcement, e.g. of ergonomic standards, virtually impossible Working hours untrackable; working weekends, no holidays Lack of inspectors anyway No right to examine people's own homes	Mainly desk-based, knowledge-based roles; professional and science and technology/ICT; admin and support	Increasing as home working increases
New technologies make for more complex accidents	Fewer inspectors, lacking training to deal with complex accidents from new technology, so find it	Manufacturing, distributive trades, transport, construction	Mainly manual workers affected Increasing with new technology, but may be

OSH issue	Describe: OSH challenge or opportunity?	Sector(s) of the economy	Comments (new or increasing, who most affected, nature of impacts, etc.)
	hard to identify causes of accidents Support from research laboratories etc. is cut back		slower than some scenarios
Poor maintenance of equipment	Cutbacks in spending lead to corners being cut	Manufacturing, distributive trades, transport, construction	
Counterfeit parts, poor-quality cheap imports	Cutbacks in spending lead to corners being cut	Manufacturing, distributive trades, transport, construction, admin/support	
Wearables used for micro-supervision cause increased stress		All sectors	
Weakened trade unions unable to lobby for OSH; maternity leave and other social security benefits come under pressure		All sectors	
Use new technology to remove workers from hazards – cheaper not to have accidents	Opportunity!	Manufacturing, distributive trades, transport, construction	

Table 8: Exercise 3 — OSH policies and actions to achieve the best OSH outcome in Fragmentation scenario

Description of action/policy	Expected OSH benefits	Implementation
Opportunity: Encourage use of new technologies to reduce workers' exposure to hazardous environments and improve monitoring – e.g. drones over construction sites	Fewer accidents	Tax incentives Publicity campaigns – fewer accidents means more profit
Challenge: Encourage culture change towards self-responsibility for OSH to overcome enforcement issues in the 'grey economy', and among the self-employed and multi-employed	Fewer corners cut	Combined culture change programme, involving: <ul style="list-style-type: none"> government (limited), trades unions (though weak) social media (like the #MeToo campaign) cultural leaders

Description of action/policy	Expected OSH benefits	Implementation
		<ul style="list-style-type: none"> focus on safety = profit (if you're self-employed you can't afford not to work)
Surprising/novel: Use of fingerprint technology to monitor working hours Increasing use of medication to help people cope		

5 Plenary discussion and conclusions

The discussions that took place during the workshop indicated that it met the objectives of presenting the foresight project, the scenarios developed and the new and emerging risks identified.

Focal points were able to engage with the scenarios and follow the guidance to accept the world as described in the scenario that they had been allocated. In response to the question of which scenario was considered likely to be the dominant one, there were numerous votes for each of the scenarios, which suggests that they were all seen as plausible and useful. Participants were also biased towards the scenarios that they had been working with, which suggests that they had fully engaged with their scenarios.

To achieve such a result, it is important to explain, at the beginning, the purpose of scenarios and what to expect during the workshop, and also to allow participants time to become familiar with the scenarios and express their concerns about the issues raised. Participants considered that the scenarios were a representative range of possible futures and that they were plausible.

The scenarios generated different strategic discussions on the future of work and the new and emerging risks associated with ICT-ET. They stretched participants' thinking, created new insights and in some cases challenged current assumptions. While the objective of the workshop was not to agree policy, the participants were able to propose possible policy options (see Section 4) that had the potential to achieve the best OSH outcomes in each scenario. This indicated that the workshop met the objectives of demonstrating how participants can use the scenarios as a tool to develop robust policies and strategies that address the OSH challenges identified in the project.

The plenary wind-tunnelling exercise found that some policies had benefits in all scenarios but that most of them did not deliver benefits in at least one of the other scenarios. This demonstrated that the success of many policies is significantly dependent on assumptions about the future. The wind-tunnelling process is used to facilitate cross-scenario consideration of policies and, if stakeholders are engaged in this process, it can provide a good framework for facilitating a strategic discussion. It also illustrated that the four scenarios were sufficiently different to generate a strategic discussion of a broader range of future policies than would have been possible by simply considering the trends and drivers of change. This is useful, as it helps to overcome assumptions based on an 'official' view of the future. It also provides a more robust policy analysis and better understanding of future risks.

The discussions that took place indicated that the scenarios could also be used as a tool to consider who the winners and losers would be in the different futures described. They could also be used to consider the range of future challenges for different social partners. Moreover, it would be useful to consider possible policies that could be implemented now in order to prevent unwanted aspects of any of the scenarios of the future from actually happening.

The success of the workshop in promoting the outcomes of the project was further illustrated by the fact that a number of focal points expressed an interest in organising similar workshops in their own countries and using the scenarios to support OSH analysis.

This workshop met its objectives: raising awareness of the results of the project and demonstrating how the scenarios could be used to understand potential new and emerging OSH challenges. It is important to recognise (as was stressed during the workshop) that the results of these exercises should not be

used for future policy decisions, as more detailed analysis than was possible in this workshop would be required.

6 References

- EC - European Commission, 2017. Safer and Healthier Work for All - Modernisation of the EU Occupational Safety and Health Legislation Policy. Available at: <http://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:52017DC0012&from=EN>
- EC - European Commission, 2015. A digital single market strategy for Europe. Available at: <http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52015DC0192&from=EN>
- EC - European Commission, 2014. An EU strategic framework on health and safety at work 2014-2020. Available at: <http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52014DC0332>
- EU-OSHA - European Agency for Safety and Health at Work, 2017. Key trends and drivers of change in information and communication technologies and work location. Available at: <https://osha.europa.eu/en/tools-and-publications/publications/key-trends-and-drivers-change-information-and-communication/view>
- EU-OSHA - European Agency for Safety and Health at Work, 2013. Green jobs and occupational safety and health: Foresight on new and emerging risks associated with new technologies by 2020. Available at: <https://osha.europa.eu/en/tools-and-publications/publications/reports/green-jobs-foresight-new-emerging-risks-technologies>
- Maciejewski, M. and Dimova, M., 2016. The ubiquitous digital single market, Fact Sheets on the European Union. Available at: http://www.europarl.europa.eu/atyourservice/en/displayFtu.html?ftuId=FTU_5.9.4.html
- McLeod, S and Fisch, K, 2018. Shift Happens youtube video. Available at: <https://www.youtube.com/watch?v=u06BXgWbGvA>
- WEF - World Economic Forum, 2016. The Future of Jobs: Employment, Skills and Workforce Strategy for the Fourth Industrial Revolution, Global Challenge Insight Report. Available at: <https://www.weforum.org/reports/the-future-of-jobs>

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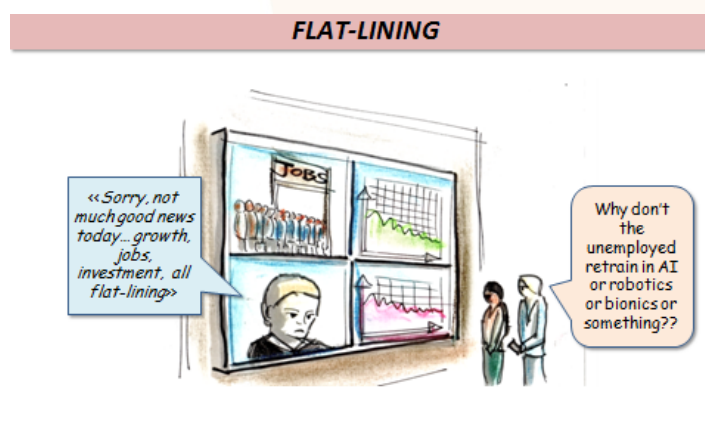
Appendix – Scenario descriptions

Scenario 1 – Evolution

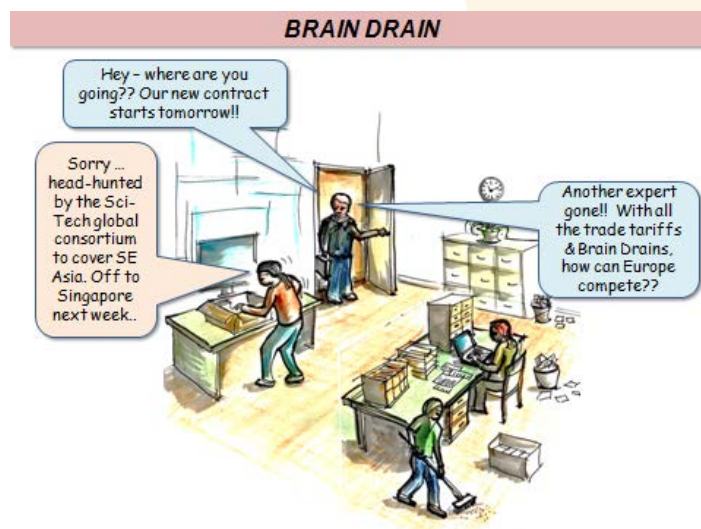
Europe in 2025

During a decade of low economic growth, the governments of Europe have sought to regain the trust of the voters and maintain social cohesion by focusing on workers' rights, social welfare, health/social care and education. Employees, workers' representatives, business leaders and governments have worked together through social dialogue to build a consensus on the benefits of the exploitation of ICT-ET at work. There is mix of both participation and trust management on the one hand and command and control on the other. This approach has been successful in so far as it has helped to maintain public confidence in government and new technology.

The slow pace of economic growth means that there have been limited funds for government and business investment in building the physical and research infrastructure required to support new technologies. Exploitation of these technologies has therefore been constrained, despite the acceptance of the potential benefits.



There have been continuing levels of relatively high unemployment and a loss of confidence in the benefits of international trade. In response to popular concerns, Europe seeks to protect its economies through strict trade and migration policies. However, there is global competition for highly skilled people who can work in a rapidly changing world driven by technological change, which has led to a 'brain drain' of people who moved to faster-developing economies.



There is a mix of workplace innovation and more traditional work organisation, human resource management (HRM) and labour relations. In some places, groups of people or local governments have

formed their own micro-economic communities of interest and local enterprises. This is patchy, but where it has happened it is a positive response to the problems affecting Europe as a whole, and offers potential examples for others to follow.

PRINTER JAM



By 2025, the richest few have increased their share of the total wealth. Most other people will be relatively poorer, with young people and middle-income workers particularly badly affected by the low economic growth. Although public sector jobs have been maintained, pay is generally poor, except in those areas where people have taken joint action to protect themselves and foster local micro-economies.

Gross domestic product (GDP) growth throughout the period remains low, averaging around 1 % per annum. Businesses have been looking to survive and build a more secure future, and ICT investment is focused on areas where costs are lower or where profits are highest. There are some parts of Europe that continue to do better than others because they started from a stronger position in terms of ICT infrastructure, investment, skills and adoption. There have not been the necessary Europe-wide strategies and investments to bridge the gaps, so they are widening.

Europe is not seen as a leader in new technologies. The speed of adoption of new technology, which is much lower than in the USA and parts of Asia, means that the rate of change in the labour market has been relatively low. Only about 10 % of jobs have disappeared but about 40 % have been moderately changed by support from new technology. Real wages have fallen.

This relatively slow rate of change in work helps to maintain a sense of social solidarity, meaning that there is plenty of work for nurses and carers and in the public/state sector.

The combination of the exodus of young potential high earners and new efforts to constrain immigration means that population projections are now pointing to a reduction in Europe's total working-age population, with further negative implications for GDP growth.

Technological change

The application of new technology and skills has been slow and left mainly to the big international corporations, motivated individuals or local initiatives. The low levels of GDP growth and governments' focus on protecting 'old' jobs and maintaining social cohesion mean that there is a relatively low priority given to research and development of new technologies. Global corporations continue to invest – but do so in the context of their own business strategies. Existing technology, which is seen as a more reliable and safer investment, is more widely diffused across sectors, whereas the pace of introduction of new technologies is quite slow.

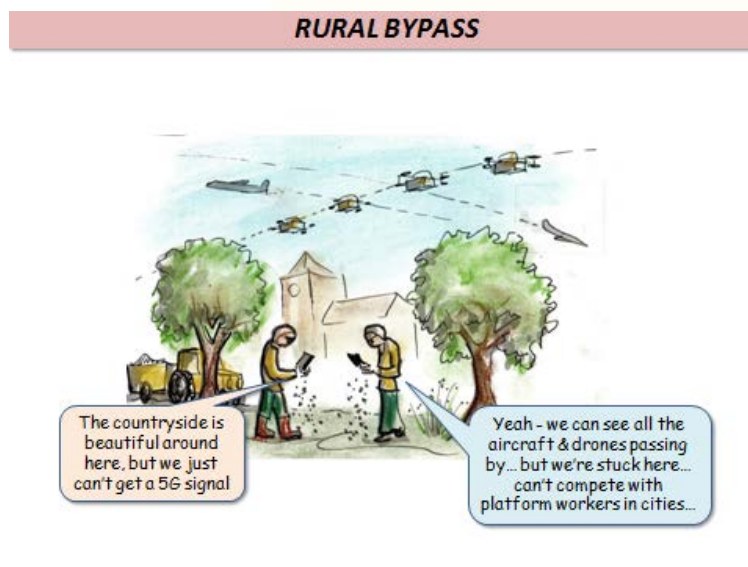
There has been relatively slow development in cutting-edge technologies, such as AI, that drive the IoT. The use of basic AI and voice control interfaces has increased moderately, but more advanced AI and human-machine interfaces (for example eye tracking, gesture and direct brain to computer) are used only where they will significantly reduce costs. Examples include the management of more complex process and distribution systems. The majority of robots are still mainly undertaking repetitive tasks.

Robots working collaboratively with humans or undertaking more complex tasks requiring greater dexterity are limited in number.

Additive manufacturing is beginning to disrupt traditional manufacturing industries and create new business models, including small start-ups.

Cyber-attacks have increased and are a serious threat, as it has not been possible to finance the increasingly high levels of investment needed to counter them.

The use of online work platforms has steadily increased during the decade, particularly where micro-economic communities exist. 5G broadband has been rolled out over the urban areas of the EU, but access in most remote regions is still limited. As a result, some people in more remote areas have been excluded from the growth in mobile and home working and the online labour market.



OSH environment

The priority for the private sector is staying in business and for the public sector, because it is reducing, dealing with the issues associated with unemployment. Governments support workers' rights, and work with the social partners to ensure that OSH is given importance – using a consultative approach to work within the constraint that there are limited funds and resources for OSH regulation, research and training. The increase in the numbers of self-employed and online platform workers has removed a significant proportion of workers from regulatory oversight.

There are pockets of good OSH practice but the loss of management jobs has fundamentally changed employment hierarchies and worker relationships, which can be detrimental to good OSH management. The tendency to diffuse existing technology more widely, rather than rapidly adopt new technologies, means that OSH hazards and their prevention are generally well known. The manageable pace of change means that OSH regulation is generally able to keep up and there are opportunities for OSH hazards to be designed out and best practice shared before widespread use. Social media is also used to give information on OSH issues.

A gradual but patchy increase in levels of automation, robotics and use of augmented reality (AR) and virtual reality (VR) remove some people from hazardous working environments. However, some of these may not be well maintained because of businesses' limited finances and/or understanding of the risks. Connected robots/machines could also be vulnerable to cyber-attack that causes them to malfunction in a hazardous way.

There is a risk of work-related stress due, for example, to being monitored at work, working alongside robots and in some sectors job insecurity. However, wearable technology is also used to help individuals monitor and manage stress.

Scenario 2 – Transformation

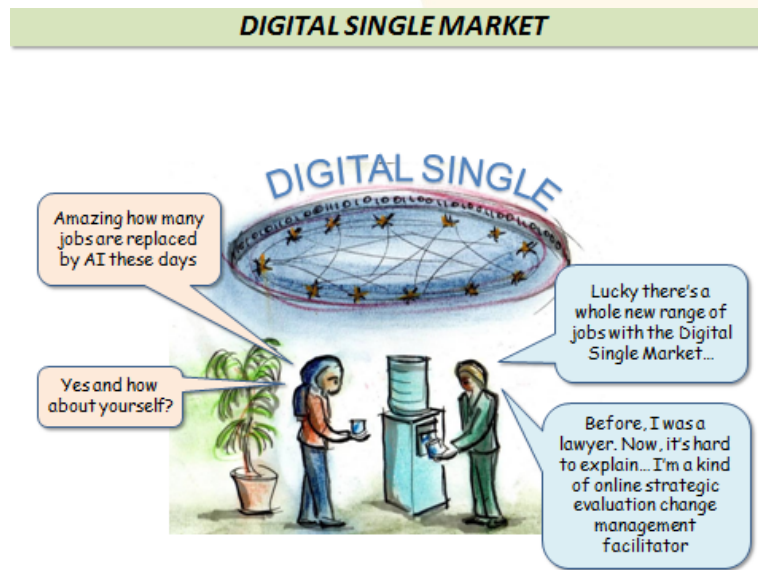
Europe in 2025

The political and social landscape of Europe has undergone a transformation to one that is more collaborative, consensual and ethical. Policy making is evidence based, responsive and resilient. Under this new 'social contract', acceptable behaviour is reinforced through social norms and values.

An increasingly connected, environmentally and socially aware public embraces new technology. Workers (and people more generally) use ICT very effectively to create radical new and innovative ways of organising labour so that, in general, no group is particularly disadvantaged. Mechanisms are available to make governments accountable over a wide range of issues including the regulation of new technology, online privacy, healthy/sustainable work practices and care of the environment. This creates, among most, a high level of trust in policy makers and, in general, acceptance of new technology. Society is also less discriminatory and more equal, as ICT supports workers irrespective of their demographic (for example age or class).

Political alliances, established during the successful implementation of the European DSM, have resulted in governments across Europe working well together. Governments have embraced the efficiencies offered by ICT-ETs and found innovative ways of regulating new technologies and working patterns. They have the necessary funds and the knowledge to support sound investments in infrastructure, cyber-security, education and training. This enables ongoing technological change and economic growth of 3 % to be sustained.

The labour market is characterised by frequent changes in the type and nature of jobs available. During the last 10 years, 50 % of jobs have fundamentally changed or disappeared, with many new jobs being created. It is common to have several jobs that fit around workers' personal lives. There is a complete blurring of work and personal life, with people moving almost seamlessly between one and the other. The majority of workers are capable of protecting their work/life balance, which is supported by AI supervisory algorithms built into work interfaces. People also change jobs frequently with ease and often continue to work healthily into their 80s. The average life expectancy is 100.



Unemployment remains generally low thanks to widespread good-quality skills among workers, innovative job search tools and new jobs replacing lost ones. Workers' disposable income is generally good, with less disparity between most people. This has created high levels of migration into Europe.

There has been a fundamental change in the underlying principles, structure and control of the internet, including the creation of a digital version of the Geneva Convention. Despite this, cyber-security is an ever more important and challenging job.

The approach to education and training has been transformed. Human-trainer led teaching is blended with high-quality interactive massive open online courses (MOOCs), which are made widely available.

Quality is assured through accreditation by online worker cooperatives, employment associations and trades unions. Workers, employers and governments all recognise the importance of lifelong learning. Good-quality ICT skills, as well as interpersonal skills, are, therefore, kept up to date across the wide demographic of workers.

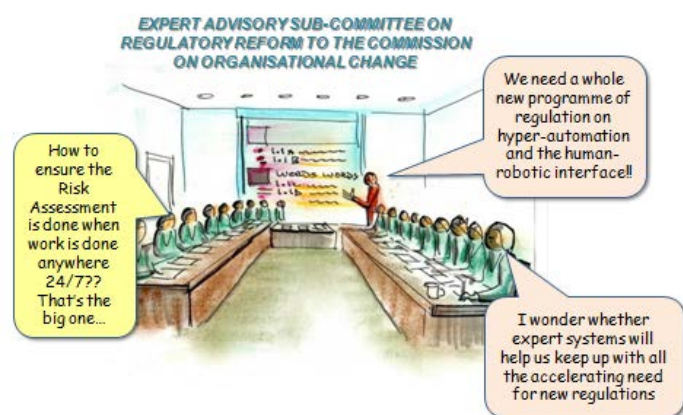
TARGET PRACTICE



There is an expectation that people will comply with social norms driven (in part) by insurance and employment implications. Most workers are comfortable with this. For those who are not, it has led to a feeling that they have lost their sense of identity, as they are rarely completely free from being assisted and monitored by AI algorithms, which record attendance, performance and productivity. This has created an underclass of people living on the fringes of society, who do not want to be permanently monitored by ICT-ETs, are 'disconnected' and have lost access to many work opportunities and services that rely on ICT.

The pace of change (technological and ways of working) is moderated by the need to reach consensus between the social partners, which can sometimes slow down decision making.

REFORM FOR REFORMERS



Technological change

5G broadband was rolled out across Europe some time ago, including in rural areas. The IoT is widespread, such that most devices at work and at home are smart and connected.

The use of narrow/basic AI is part of many aspects of people's personal life and work, and most people work in teams supported and advised by AI systems. This helps workers be more productive by removing the routine aspects of jobs. For example, health workers are provided with patient information

and a likely prognosis by an AI system. Workers are generally monitored and directed by AI systems that can learn and help to manage stress, promote wellbeing and encourage safer, more productive working practices. These AI systems assess a range of data from the worker, including physiological data collected through wearable devices.

Artificial general intelligence (AGI) is beginning to replace higher-skilled jobs across a range of sectors. In some areas of work, AGI is recognised as being better at data analysis and running processes and systems than humans. These AGIs now make decisions and act upon them without human supervision or intervention. However, there are some concerns around how much control AGIs have and how they make decisions.

Empathy algorithms are used to tailor the nature and format of advice according to the varying needs of different users.

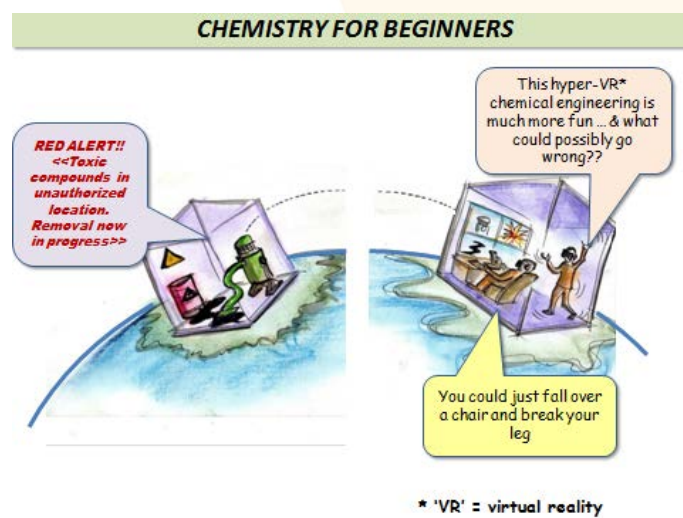
Interfacing with ICT (and other people remotely) is more natural and immersive. There is widespread use of voice recognition, eye tracking and gesture control. The use of direct brain-to-computer interfaces, while not widespread, is no longer seen as niche.

Additive manufacturing has created new business models such as bespoke local on-demand manufacturing.

Self-driving autonomous cars and other means of transport (including drones) are common and car ownership is low.

There are significant numbers of fully autonomous robots that can undertake complex tasks, including those requiring high dexterity.

'Lights out' manufacturing is quite common in several industrial sectors, with many factories being fully automated with no, or minimal remote, human supervision and intervention.



OSH environment

Good OSH is a priority for all social partners, driven by ethics and recognised as good for a sustainable society and business. This has created a culture of continuous improvement, common standards and effective self-regulation. Social norms promote good OSH management along with safe and healthy behaviour of workers.

The new social contract means that there is trust, transparency, shared values and openness between governments and social partners that encourage collaboration on OSH. There is also a preference for a consensual, evidence-based approach to decision making, with governments made accountable by well-coordinated direct action from social partners. Work organisation mirrors this, generally following a participation and trust management regime. This has allowed innovative partnerships, workplace innovation and ICT-based approaches to regulation to be implemented.

There is funding for good-quality OSH research, with access to large quantities of relevant data from the widespread use of wearables and the IoT. As a result, OSH tends to be built into ICT-ETs and work

processes. Therefore, on the whole, there is a resilience to the moderately rapid pace of change (technological and ways of working). However, a consensual approach can occasionally lead to a lack of efficiency and an overly precautionary approach. Regulation can also sometimes lag behind the introduction of new technology.

The pressure of social norms and/or the need to conform can cause stress/anxiety; some individuals worry that they are not able to perform or behave well enough to the expected societal level. The pressure to conform can also sometimes lead to 'group-think' such that emerging risks are missed.

Organisations and regulators, in general, have the knowledge and skills to manage OSH effectively. The working environment in Europe attracts and retains motivated, experienced and highly skilled workers. This, along with the open intellectual property movement and good-quality innovative approaches to training and knowledge transfer, mitigates the impact of workers having several jobs and changing them regularly.

However, changes in employment patterns and hierarchies can mean that there is a lack of clarity about who is responsible for OSH, particularly where work is done via online platforms or where workers have AI bosses. Some workers may also fall outside formal regulation due to their employment status or because their location is hidden behind an online platform. Most people work short-term contracts for different companies around the world, or do small jobs or tasks through online platforms.

Generally people work alongside AI systems or cobots (collaborative robots) and many are supervised, assessed, coached, managed and monitored by AI. This can put excessive cognitive loads on some individuals. Others suffer stress/anxiety due to the loss of control or responsibility and peer support at work or are concerned about how much they are monitored.

There are not many fixed places of work, and the realistic nature of VR and AR means that most people work from home, in shared communal spaces or in public places. Most work meetings are held in VR and, while this improves efficiency and reduces travel costs, some feel a lack of real social interaction and support. Homes, public spaces and means of transport have in general evolved to be more worker friendly from an ergonomic perspective. Human-machine interfaces are generally more ergonomic but new ways of interfacing may reveal new cognitive and musculoskeletal disorder (MSD) risks as well as possible harm to the voice or vision.

Increasing levels of automation and robotics remove many workers from physically, chemically and biologically hazardous working environments. AR and VR are used for immersive training and to support maintenance tasks that can often be done remotely, which also contributes to removing workers from hazardous environments, but can cause cognitive issues and disorientation between the real and virtual worlds, and occasionally accidents happen. Where people need to work in hazardous environments, they are protected by smart personal protective equipment that can alert users to exposure to hazardous substances and tailor advice to the needs of the user. In addition, DNA profiling can be used to screen out workers who are susceptible to certain chemicals or allergens.

The use of autonomous vehicles, bionics and exoskeletons enables an ageing population to continue to work. However, their use may cause loss of bone or muscle density and/or joint flexibility.

Good cyber-security and ICT reliability are essential because of the number of online smart devices and dependence on networked ICT systems for many work activities, which if hacked could cause hazardous malfunctions.

Despite this, technology is, on the whole, very reliable and work processes are generally safer. However, when something does go wrong it could take time to realise that there is a problem, and workers will have little or no experience on which to rely when deciding how to manage the situation (because technology rarely goes wrong). This could be exacerbated by the fact that many work processes will be remotely supervised by just a few workers, who may have little to do most of the time.

People are generally better able to balance personal and work-related demands thanks to the highly flexible nature of most work. In addition, AI supervisory algorithms are built into work interfaces to prevent unhealthy working practices. However, stress can still be an issue for some people because of the temptation to work intensively; the blurring of work and private life; increased task complexity; being continually monitored; the expectation to conform; and the loss of human interaction at work. As a consequence of automation, robotisation and AI, some workers may also suffer from stress due to task deprivation, that is, not having enough to do, their job being monotonous or its not requiring them to use their cognitive skills.

Scenario 3 – Exploitation

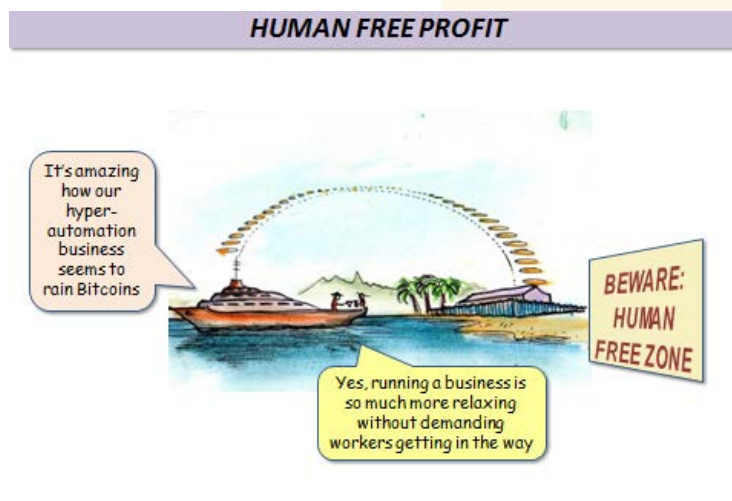
Europe in 2025

Economic growth has risen during the past 5 years to about 3 % of GDP, with increased business investment in research and development, infrastructure and capital assets. Market forces and rapid technological change lead to enforced adaptation by the workforce. During the last decade, the social partners (employers' organisations and trades unions) and governments generally failed to work together and lacked the resources to ensure that regulatory frameworks kept up with the rapid pace of changes of ICT-ETs and the changes they triggered in relation to (flexible) employment, work arrangements, the nature of work and work location. This included an inability to modernise the collection of taxes, starving governments of the necessary funding for education, skills, infrastructure, and research and development.

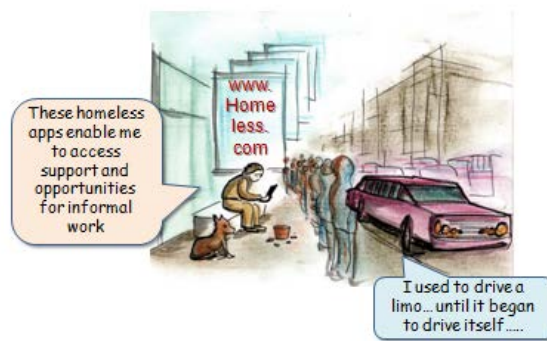
ICT skills are funded where there is an immediate need or where skills cannot be brought in through online platforms, or offshored. Businesses are mostly doing well and seek to maintain their positions by investing in research and development to maximise technology exploitation, primarily in the areas that yield the quickest and greatest profit. However, disruptive ICT-ETs can put companies out of business quite suddenly, despite national governments' interventions to try to protect their workers' jobs.

Rapid advances in ICT have had a widespread and profound impact on work. There is an increasing rate of change in the European labour market. The economy is dominated by increased freelancing, zero-hours contracts and short term contracts (the so-called 'gig economy'). Many people work for at least five employers at any one time, are enrolled with a number of online platforms and frequently change jobs. About 60 % of jobs have been fundamentally changed or lost. Around 40 % of these jobs have been lost as a result of the automation of routine and repetitive work activities. The societal benefits of work are not valued and only about 10 % of jobs are newly created. Available work is primarily unskilled, with only a small proportion of partly standardised high-skilled work.

There are very high levels of unemployment and much greater inequality between the high and low paid. Workers' interests and their training are a lower priority, as it is easy to buy in skills, as required. What jobs there are are generally unstable and insecure in nature and work is often challenging and intense.



There is a 'digital divide' between the 'haves' (highly skilled individuals who compete for the best jobs) and the 'have-nots' (unemployed or in precarious employment). There has been a decline in public trust and workers' rights, and a lack of government leadership. Those still in work feel threatened by the ongoing rapid pace of ICT developments. There has been an ongoing decline in trade union membership and a resulting lack of collective bargaining power. By 2025, workers' discontent is high and there is ongoing unrest. Protests, including direct action, coordinated and mobilised via social media, are common.

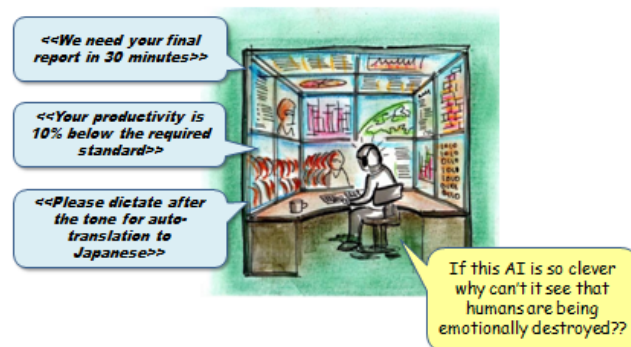
WORKERS ARE EVERYWHERE

As a result of significant ICT skills gaps towards the beginning of the decade, businesses attempted to upskill the workers needed to use advanced ICT-ETs. This means that there are opportunities for less wealthy EU countries to benefit from the ICT revolution. Increasingly, individuals use widely available MOOCs to upskill themselves. This leads to a rise in social mobility for some. However, the demand for high-level ICT skills still outstrips supply, so there are high wages available for those with the best skills. Job opportunities are increasingly dependent on having good ICT skills. Creative/artisan and interpersonal skills are also highly valued. However, use of online training also means that broader skills, for example social skills, can be poor. High value is attached to education and training for those who can afford it, or borrow money to pay for it. Face-to-face training is primarily available to only the most affluent workers.

Technological change

There is limited choice for workers in this scenario; technology will be 'done to you' rather than be 'there for you'.

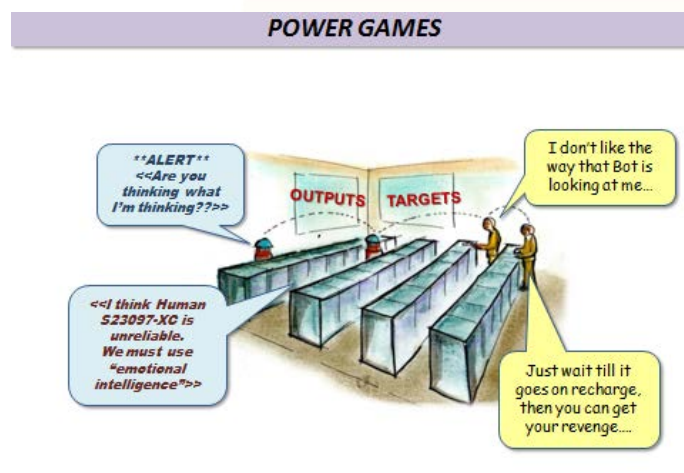
AI and robotics are ubiquitous in the workplace. Businesses have realised the improvements AI could bring to productivity and efficiency, and systems are now widely adopted to direct, monitor and assess worker performance and productivity. Management is usually of a command-and-control nature, overseen by AI supervisors.

PRODUCTIVITY PROBLEMS

Robots and computer algorithms now carry out the majority of routine and repetitive tasks. Skilled professional jobs have also been significantly affected. Robots are commonly working collaboratively with humans and can undertake increasingly complex and powerful tasks. Biomechanical devices, such as exoskeletons, are commonly being used in workplaces, for example for care work, maintenance and logistics. However, there are issues around the security and control of biomechanical devices, particularly smart devices that are connected to the IoT.

Interfaces using voice recognition, eye tracking and gesture control are common in some sectors and there is early adoption of direct brain-to-computer interfaces. Traditional large manufacturing activities have been significantly disrupted by additive manufacturing; small and medium-sized enterprises (SMEs) and start-ups are increasingly providing products locally.

The IoT is now part of most aspects of daily life and most workers are monitored constantly online and via IoT-connected wearables. However, there is patchy coverage across Europe, with many rural areas lacking access. Internet profiling of prospective and current workers by businesses, including during leisure time, is routine (to monitor for a healthy lifestyle because of the link to productivity benefits).



Throughout the decade, cyber-attacks have been increasingly common, because of a lack of a robust, co-ordinated response to the threat from both governments and businesses. This has resulted in a loss of public trust. Infrastructure, power and utilities have all been disrupted by cyber-attacks and this is part of everyday life.

OSH environment

A lack of government leadership, public trust and dialogue, or support from business, means that regulatory frameworks are generally inadequate and unable to keep up with the rapid pace of change in ICT and working patterns. This is exacerbated by a lack of effective collective bargaining for good working conditions, due to reducing trades union membership and limited access to alternative bargaining approaches.

There is patchy investment in OSH research and training, and poor access to good-quality OSH information. Workers frequently change jobs, do not have the time or money for high-quality training and experience extended periods of unemployment. Employers commonly transfer the responsibility for OSH management to the workers with pseudo-self-employment contracts. The precarious nature of work can also create a willingness to accept OSH risks, just to be able to work.

The workforce is dispersed and rarely engaged in a traditional employer/employee relationship. For example, most are self-employed, with precarious employment contracts (zero-hours contracts, on-call work, online-platform work), often taking multiple and/or short-term jobs. This has a detrimental impact on OSH outcomes. One example of this is the lack of implementation and enforcement of any OSH legislation or health surveillance.

Social media are used to form collectives, which attempt to use their combined power to improve working conditions, with occasional and often limited success. AI 'assistants' are also provided by the better online work platforms, to promote OSH information to workers. As a result, there is a considerable contrast between the good and bad jobs, in terms of OSH.

Increasing levels of robotics and automation remove many people from physical, chemical and biological hazards in working environments. However, workers generally have to adjust their speed or position in order to work effectively with collaborative robots. This pressure to perform at the same level as robots can cause stress and MSD issues from poor ergonomics or working too fast.

The combination of new technology and older technology can lead to OSH risks, for example if an individual comes across an older robot and expects it to behave in the same way as an intelligent, sensing collaborative robot.

Some OSH issues are offshored along with the work. However, there is still a need for 'dirty' work in some areas that are currently too difficult to automate fully or where human workers are still cheaper. For those working in these environments, there is the potential for exposure to a wider range of, and more chemically complex, materials, for example during manufacture or recycling. New materials are also being used for 3/4D printing and bio-printing in small shops and start-ups by owners and their workers, who may have little training in the risks of exposure to toxic particles/fumes or explosion/fire hazards.

Technology is increasingly complex and brought to market quickly, which can lead to potentially hazardous design flaws that are difficult to spot. A lack of investment in cyber-security and internet infrastructure also means that work equipment is susceptible to malfunctioning due to hacking in ways that can cause hazardous situations in the workplace; for example, the shutting down of cooling systems for exothermic chemical processes.

Human-machine interfaces are ubiquitous and some are personalised to the user. However, many are not adapted to the cognitive level or other needs of workers. New ways of interfacing may also reveal new cognitive and MSD risks as well as possible harm to the voice or vision.

Overall, work-related stress, anxiety and depression are common because of the precarious nature of most jobs, job insecurity, work intensification, working for multiple employers, continual monitoring, working alongside robots and pressure to increase productivity from AI systems (known as the 'digital whip'). Cyber-bullying is also common in many workplaces, across many sectors.

Lots of people, despite their self-employed status, feel 'owned' by their 'employers', are expected to be available for work at very short notice and suffer from conflicting employer demands. It is easy for individuals to overwork, and many workers burn out.

Scenario 4 – Fragmentation

Europe in 2025

Europe has endured a decade of low growth and low technological development for most sectors of the economy. There are low levels of social cohesion and most people are motivated by self-interest. The economy is typified by short-termism, low wages, low tax revenues and high inequality. Only the 'fittest' businesses and workers survive. There are high levels of informal work in the 'grey economy', often based on local or personal relationships, often facilitated by social media.

Ethics have come under pressure, as tax avoidance becomes the norm, and governments' ability to regulate new working patterns has diminished. Both businesses and individuals working in the 'grey economy' see avoiding tax as 'smart' or, at least, sensible. The concept of loyalty to one's company or workforce has virtually disappeared. Traditional models of hierarchical command-and-control management and HRM have generally broken down. The lack of tax revenues means there is limited government spending on social welfare and health. Deregulation pressures have led to a 'small state' ethos. There are high levels of unemployment, at least in the formal economy, and many of those in work need at least two jobs to sustain themselves. Job insecurity is widespread, with zero-hours contracts common. The ageing population has no choice but to remain in work longer and tend to have to accept lower value jobs as their previous jobs disappear.

Governments have done little to support innovation. Businesses have exploited developments in technology with a narrow focus on short-term profit, and 'productivity' in the form of the replacement of labour, or by using AI 'supervisors' to drive increased efficiency. In some cases, industrial disputes against automation have actually resulted in its implementation being speeded up to restore reliable services to customers. Some well-paid, high-status roles remain, so there is still a segment of society that can afford high-quality personalised services.

OUT OF SIGHT

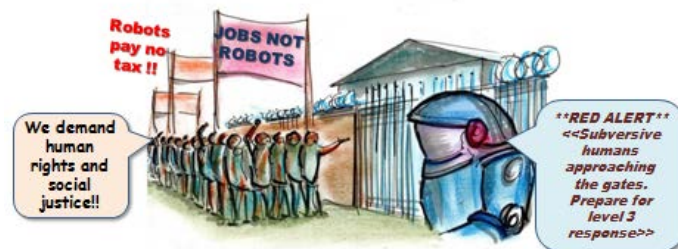


GDP growth throughout the period remains low at about 1 % per annum at best. Investments by both business and government in research, infrastructure and skills development are generally very low, and incremental improvements are seen as the most cost-effective way of reducing labour costs. However, there have been some significant examples of the successful application of ICT, particularly by the owners of online work platforms supporting the 'gig' economy.

Around 20 % of jobs have been lost during the decade, mainly to the automation of low-skilled, repetitive work. Few new (formal) jobs have been created. Most people change jobs frequently as they are pushed out. New job opportunities tend to be lower paid and short term.

Lack of trust that the benefits of new technologies would benefit workers or be spread evenly across the population has led to a high level of resistance to change. While technological change has continued, the rate is, in most cases, steady rather than rapid. More traditional industries (such as engineering and retail) continue to exist, but with decreasing profitability. Limited innovation is focused on greater exploitation of both human and environmental resources.

LOCKED OUT



Faith in government's ability to shape the future has all but vanished and ever fewer people vote or participate in civic society. An 'every person for themselves' attitude prevails, particularly in the formal economy. However, there is still a place for personal contacts and relationships to provide mutual support in some parts of the 'grey economy'. Some see the greater personal freedom and limited state intervention as a positive development.

There is low investment in maintenance of both equipment and software, leading to increased failures, greater numbers of cyber-attacks and consequently even greater loss of public trust.

Low investment in education and training has also created a workforce where only some have the skills to fully exploit advanced technologies. MOOCs are available, but these are of variable quality so they allow skills to be improved only to some extent. Use of online training also means that broader skills, for example social skills, can be poor. All this has combined to hold back innovation in many businesses. Polarisation of society, therefore, continues to increase, with rich individuals and a few successful businesses able to sequester greater shares of national wealth, and a growing underclass turning to increasingly illicit ways of surviving.

Technological change

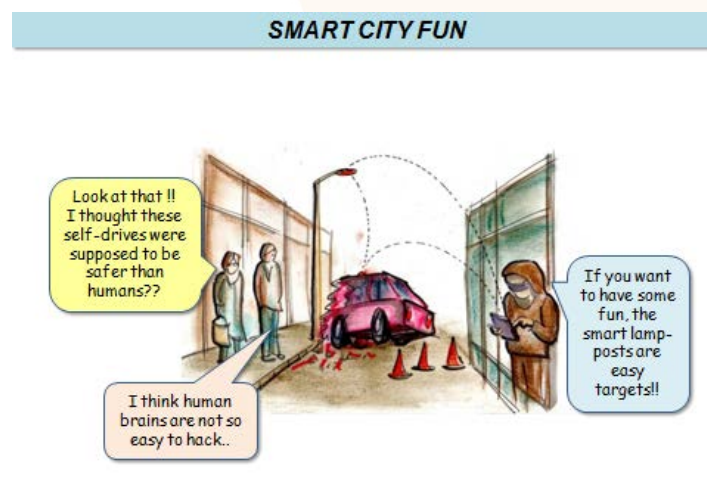
The wave of technological developments that was in the pipeline at the beginning of the decade has been harnessed for short-term profit but innovation has been limited. Automation has replaced significant numbers of routine repetitive jobs, particularly manual ones in the manufacturing and construction sectors. Drones and autonomous vehicles are becoming fairly common.

The investment in mobile networks has been limited, and 5G is focused on profitable areas, generally industrial areas and cities. The IoT now covers many aspects of our daily lives, including work, so we are almost never free from 'supervision'. However, the limited investments in networks and cyber-security have led to increased cyber-crime and restricted data sharing.

Monitoring technologies, including use of mobile devices, are increasingly used to ensure workers are working as hard as possible, and to remove those seen as not performing well enough.

Additive manufacturing is beginning to disrupt traditional manufacturing industries and create new business models, including small start-ups.

The development of robots undertaking more complex tasks that require greater dexterity has continued but is not widespread. The use of robots working collaboratively with humans is more widespread and the use of bionics has increased where productivity gains can be made. The effective use of big data has enabled fairly widespread use of basic 'narrow' AI, which has significantly changed some jobs and replaced routine clerical ones.



There has been a large increase in online work platforms, which provide a wide variety of work, from highly skilled professional work to small, routine tasks. Work is carried out online or offline (but managed online), in varied work locations, and most workers are (pseudo-)self-employed. Numerous individuals are on zero-hours contracts and the insecure nature of work (for example being called to jobs on a just-in-time basis) means many suffer from stress and anxiety. Work is often intensive, which contributes to both psychosocial and physical disorders. A large amount of available work is computer-based, which has led to increasing physical disorders such as MSDs. Some of the online platform work available is in historically dangerous occupations, such as forestry. Because most individuals are (pseudo-)self-employed, the safety and health risk is transferred to the worker, rather than the employer. Many lack employment benefits such as sick pay.

In addition, a wide range of new online jobs has also been created, such as crowdfunding specialists and personal digital curators.

OSH environment

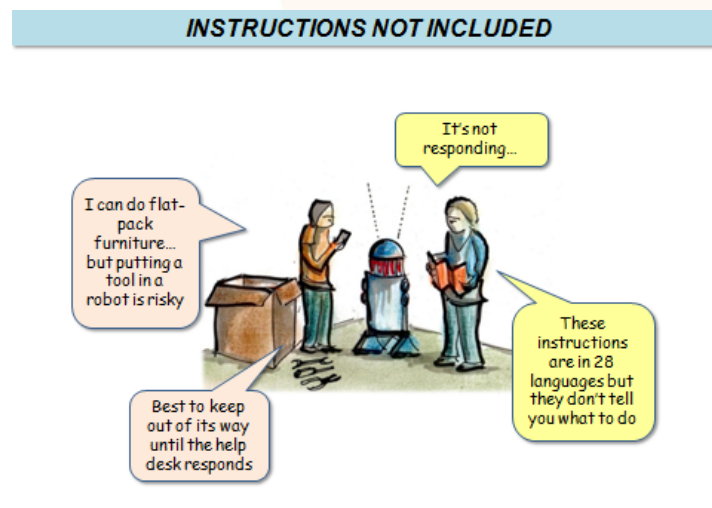
Despite the occasional public outcry at disasters, governments struggle to impose or enforce regulations, not least because there are limited tax revenues available to fund enforcement. Indeed, in the name of 'cutting red tape', some regulations have been relaxed and OSH is not well viewed generally. The effects often have a delayed impact, so are not seen for a number of years.

The overall slow pace of change means that in most areas OSH regulation is adequate and little changed but it can struggle to keep up with pockets of high innovation. This variation across and within sectors makes the transfer of OSH knowledge from one workplace to another more difficult.

The unregulated 'grey economy' is fraught with potential OSH risks and is very difficult to monitor and control. The safety of work processes and the quality of products or advice services cannot be assured, as corners are cut in an attempt to make profits or keep prices low enough to be viable. Extensive sub-contracting also blurs responsibility for compliance with OSH regulations, and responsibility for OSH is transferred to the worker in some sectors. Under-investment, by governments and businesses, in cyber-security has led to more cyber-crime, which can shut down or compromise safety systems.

Companies focusing on short-term profits have consistently under-invested in OSH systems, so the number of equipment failures and incidence of injuries and work-related ill-health remains high. Organisations invest little in OSH training, and many workers have poor access to good-quality OSH information. Additionally, workers often experience extended periods of unemployment. Overall, this means that many individuals lack adequate OSH knowledge and work experience and as a result are at greater risk of harm at work.

A make-do-and-mend culture, with a mix of old and new assets, creates OSH risks during integration of the new with the old, and at the interfaces between the two. The tendency to run old systems until they break down also increases OSH risks.



The use of AR and VR has increased for training and to improve productivity. However, there is little new innovation in the underlying technology. This has primarily been to improve the productivity of online platform workers, so instantaneous translation and human interfaces via gesture and eye tracking are fairly widespread.

Small-scale use of additive manufacturing, often outside regulation in the 'grey economy', increases the numbers of flawed products on the market. Untrained operators are exposed to particulates and hazardous chemicals, for example backstreet 3D printing operations.

Robotics and automation, commonly in manufacturing but also in the care industry, have improved OSH through reduced exposure of workers to hazardous environments or ergonomic hazards. However, there are also hazards associated with workers interacting with automated equipment, particularly collaborative robots, such as collisions or increased work pace, and cognitive load. Improved electronic monitoring provides the capability to alert workers to the presence of hazardous substances.

Work-related stress is widespread because of extensive job and financial insecurity, poor work/life balance, the lack of predictability in the 'grey economy', work intensification in some jobs and task deprivation in others. Intrusive workplace electronic monitoring leads to stress and overwork. Some workers may also suffer from stress due to a lack of autonomy and job variation.