

FORESIGHT ON NEW AND EMERGING OSH RISKS ASSOCIATED WITH DIGITALISATION BY 2025

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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 digitalisation by 2025 (EU-OSHA, 2018a). The workshop was organised together with EU-OSHA's Focal Point in Romania, the Romanian National Research and Development Institute on Occupational Safety (INCDPM 'Alexandru Darabont'), on 7th February 2019 in Bucharest, and was delivered by the UK Health and Safety Laboratory and SAMI Consulting Limited.

Digital technologies, including Information Communication Technology 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) was made one of the European Commission's (EC) 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 Commission strategic documents (EC, 2017; EC, 2014) 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 digitalisation and 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, trades unions and employers with information on digitalisation, its impact on the nature and location of work, and the emerging challenges to OSH that it may bring. This project 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 digitalisation in 2025 that will allow policy-makers to consider a range of potential future OSH implications.

The final report (EU-OSHA, 2018a) and summary report (EU-OSHA, 2018b) with an explanation of how the scenarios were developed and tested along with a description of the OSH issues identified during

the project and are available on the EU-OSHA website at: <https://osha.europa.eu/en/emerging-risks/developments-ict-and-digitalisation-work> .

Objectives of the workshop

The objectives of the dissemination workshop were to:

- Present the foresight project, the scenarios developed and the new and emerging challenges and opportunities 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 is likely to include elements from each of the four scenarios developed during this foresight project, (given in the Appendix of this summary), in a mix that cannot be predicted. They should not therefore, 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 challenge 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 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 about the issues raised by the different potential futures and reach consensus on what should be done.

Description of the workshop

The workshop consisted of a blend of presentations, group exercises and plenary discussions over the course of one day. Ioana Georgiana Nicolescu (INCDPM "Alexandru Darabont") opened the workshop and gave the floor to Emmanuelle Brun (EU-OSHA) who informed the participants the background to EU-OSHA's foresight study. The plan for the workshop was then introduced by Michael Owen (SAMI Consulting). An initial presentation by Huw Williams (SAMI Consulting) explained some key developments in digital technologies that could be present 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 five years from now (McLeod and Fisch, 2018). Huw explained that the time taken to reach 50 million users worldwide has accelerated; whilst it took 75 years for the telephone it now takes a little over a month for popular smart phone 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 and the miniaturisation of ICT-ETs such as wearables, monitoring of worker performance and the use of the human body as an IT platform.
- A description of key technologies and the impact of how they could be used in the future. These included Artificial Intelligence (AI), Augmented and Virtual Reality (AR/VR), 3D printing, autonomous vehicles including drones, advances in robotics and androids.

This was followed by a presentation by David Lye (SAMI Consulting), on how the four OSH scenarios of the future, shown in the 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.

After the first exercise a presentation was given by Nicola Stacey (HSL) about the impact of ICT in 2025 on OSH and the potential influences of the differences between the scenarios.

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

Exercise Two, done in the same groups with the same scenarios as for the first exercise, involved considering how jobs might have changed by 2025 and the possible OSH implications. Participants were encouraged to discuss the OSH challenges and opportunities, the sectors and workers most affected and comment on the potential impacts. The findings were recorded in a table format as shown in Tables 1, 4, 7 and 10.

Exercise Three, again done in the same groups with the same scenarios, consisted of reviewing the OSH challenges and opportunities identified during Exercise Two 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 to focus on a few things that they felt would have the most impact.

A record of the main points from Exercise Three is captured for each scenario in Tables 2, 5, 8 and 11.

The final exercise was done in plenary. Each group was asked to describe a policy that they thought was particularly important or novel to their scenario. All the other groups were then asked to consider to what extent that policy would work in their scenario 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 anticipated. 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'. A record of the main points from this plenary exercise is captured in Tables 3, 6, 9 and 12. At the end of the wind-tunnelling exercise all participants were asked to vote, by a show of hands, which scenario they would most like to see happen and which they thought was most likely to happen.

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.

Results of discussions

Scenario 1: Evolution

Exercise 1: OSH news headlines in scenario for 2025

Top choices: “Technology Gaps Fracture Europe and Romania.”
“People Face New Industrial Revolution.”

Key points made / alternative headlines:

- A challenging new era is beginning.
- Technology could be like a scary movie.
- Need to improve and develop technology in sectors that are not moving forward in this scenario.
- Opportunities to use technology in OSH.
- Dreams of workers – veering between fear and hope for the future.

The group engaged constructively with the scenario, and there was general agreement about the final headlines – one looking at the scenario from a business/government perspective, the other looking at it from a workers’ point of view.

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.)
Relations and interactions between workers and robots/other technology (e.g. IT and AI).	Challenge: unavoidable need to address OSH implications of the roll-out of new technology.	Administration. ICT. Distribution.	Slower progress in this scenario, but still some progress.
New technologies beginning to appear in old, established sectors.	Challenge: workers’ inability (mainly, but not exclusively, older workers) to adapt to changes in their workplaces and sectors.	Most sectors but particularly agriculture and mining.	Loss of jobs, necessitating retraining, which older workers may be reluctant to do.
Growing ICT Sector.	Challenge: investment needed to safely develop the sector and realise the OSH opportunities.	ICT.	An economic opportunity.
Growth of e-trading/retail.	Challenge: remote working, psycho-social effect of isolated working, impact of sedentary working on the one hand; also falls and other injuries in warehouses.	Distribution trades/storage.	An economic opportunity.
Safety of workers in heavy industries.	Opportunity: use of technology should improve worker safety. Challenge: providing appropriate OSH training.	Mining. Metallurgy.	In Romania, a potentially important area for OSH investment, bearing in mind limited funds.

The group reached a clear consensus about the above challenges and opportunities, and the relative priority between them – they are listed in order of priority and importance.

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
<p>Opportunity: Encouraging the safe development of new sectors – IT and E-Trading.</p>	Anticipation of risks affecting new sectors.	<p>Possible use of tax exemptions to encourage investment and uptake of training.</p> <p>Focused OSH training aimed at IT and distribution workers.</p>
<p>Challenge: Programmes to improve training, focused on particular sectors. Because money is short – clear prioritisation and focus on online training.</p>	Focused online training, and clear prioritisation will maximise the OSH gain from very limited resources.	OSH professionals and labour regulators working on a sector-by-sector basis (and sub-sector basis, where needed).
<p>Surprising/novel: Media, trades unions and government working together to help workers adapt to changes in their job or retrain for new jobs.</p>	Overcoming worker resistance to change (which will be a major issue in Romania) will allow the development of a more flexible and educated workforce with a better OSH awareness. This will also help deal with job losses in traditional industries and build trust in government.	<p>Trades unions have a key role to play – will need to improve dialogue between them and government.</p> <p>Media has a role in explaining and informing people about changes that are happening.</p> <p>OSH and employment professionals need to provide training to enable people to transfer existing skills, learn new skills, and enable themselves to move between sectors and work safely in different sectors.</p>

Table 3: Record from plenary wind-tunnelling of policies from other scenarios for Evolution scenario

Scenario	Policy	Ranking	Reasons	Implementation
2	Government policy that requires all workers to have a personal consultant that is responsible for supporting workers and ensuring workers are suitably qualified and competent through advice and evaluation.	+3	The group liked the idea, but thought it would not be affordable in the “Evolution” Scenario	Affordability is a big problem.

Scenario	Policy	Ranking	Reasons	Implementation
3	Use monitoring devices to gather evidence on health risks, which is made available to workers so that they can use it to influence employers and government to improve the situation.	-3	The group were concerned about affordability, and the use of surveillance data.	Would not be able to implement due to affordability and privacy concerns.
4	Reducing the instances of psychosocial issues and stress by using a range of digital, interactive means of communication to persuade businesses that a healthy workforce is a profitable one.	+2	Addressing psychosocial issues and stress was something the group had also identified as a challenge.	The low-cost approach would be suitable for the "Evolution" scenario.

Scenario 2: Transformation

Exercise 1: OSH news headlines in scenario for 2025

Top choice: "Man accused of crime he didn't commit because his monitoring device was hacked."

Key points made/other headlines:

- When something goes wrong it may be difficult to decide or agree whether a person or the AI is responsible.
- Due to the dependence on self-learning AI, its complexity and failure to understand it, it may be impossible to explain why an accident happened which would also mean that lessons cannot be learnt.
- Information can be lost in translation between what a human worker or designer wants or has specified, and how the AI interprets it.

Table 4: 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.)
Workers need to have the qualifications to cover all types of changes related to digitalisation including in OSH.	<p>Challenge: All workers will need to adapt and restructure their jobs to take account of digitalisation.</p> <p>Challenge: ensuring enough workers have ICT and OSH training.</p> <p>Opportunity: Good training to enable workers to adapt and give them the self-confidence in the new ways of working.</p>	All sectors.	<p>Workers need to be spread across jobs/work sites according to their competence to ensure all sites have sufficient workers with relevant competence.</p> <p>Older workers may find adaptation and retraining more difficult.</p>

OSH issue	Describe: OSH challenge or opportunity?	Sector(s) of the economy	Comments (new or increasing, who most affected, nature of impacts etc.)
Monitoring devices can be used to prevent accidents.	Opportunity: drones, cameras and other devices could work together so that the worker is warned of danger.	Construction was the first focus of the discussion but this could also apply to most sectors.	Would need to match the monitoring approach used according to workers skill levels and attitudes.
Work processes can be redesigned to remove or reduce OSH risks.	Opportunity: use of automation, robotics, 3D printing to do all the main construction or manufacturing activities, which are typically hazardous.	Construction was the focus but this could also apply to most heavy industries such as manufacturing, oil and gas, and energy generation.	Manual workers would be most affected in terms of reduced risk but also loss of jobs.
Workers having multiple jobs in a fast changing job market.	Challenge: Evaluation of worker capability to do jobs correctly and safely. Challenge: workers will need to take more responsibility for OSH.	All sectors.	May require new jobs dedicated to worker evaluation and monitoring.

Due to the size of this group (18 participants) they worked in two sub-groups, one sub-group was made up of OSH service providers in the construction sector so they chose to focus on this sector. However many of their ideas could equally apply to other sectors and this is reflected in how the results have been captured in Table 4. The other sub-group was mostly made up of labour inspectors. One idea in one sub-group complemented an idea in the other sub-group so the two ideas have been merged.

Table 5: Exercise 3 - OSH policies and actions to achieve the best OSH outcome in Transformation scenario

Description of action/policy	Expected OSH benefits	Implementation
Opportunity: More investment in training that is tailored to the skills of each individual to ensure workers have the necessary qualifications.	If workers are qualified to do the new jobs this will reduce the risk of accidents. Healthy life expectancy will increase. Workers will have better work-life balance.	Employers would be required to train workers and support or set up schools. Government would oversee this policy and make decisions where it needs to be improved for the benefit of society.
Challenge:	Better society that is structured to make the most of the new digital age, higher	Employers and governments would be responsible to survey

Description of action/policy	Expected OSH benefits	Implementation
To ensure that there are sufficiently qualified workers to cover all workplace demands.	quality personal life, development of finance sector.	the qualifications and health of workers.
Surprising/novel: Government policy that requires all workers to have a personal consultant that is responsible for supporting workers and ensuring workers are suitably qualified and competent through advice and evaluation.	Increased wellbeing as workers are doing jobs that they are suited to and employers are getting good quality work delivered. Reduced accidents as a result of a more competent workforce. Increased wellbeing thanks to personal contact with consultant.	Introduce personal consultants for everyone to quality assure worker's competence, improve qualifications, personal skills, and resilience for multiple jobs, and make people aware of opportunities.

Table 6: Record from plenary wind-tunnelling of policies from other scenarios for Transformation scenario

Scenario	Policy	Ranking	Reasons	Implementation
1	Media, trades unions and government working together to help workers adapt to changes in their job or retrain for new jobs.	+3	This would already happen in this scenario.	A clear strategy would need to establish what steps are required, by whom and how they would be done. Implementation would need to be carefully evaluated and monitored. Legislation would need to be flexible as well as clear so that it does not have to be continuously updated.
3	Use monitoring devices to gather evidence on health risks, which is made available to workers so that they can use it to influence employers and government to improve the situation.	+4	Whilst not needed to influence employers and government in this scenario, it would help detect and deal with problems before they happen and cause harm.	This policy would build on how OSH is already managed in this scenario. In this scenario it would also be well funded and organised with cooperation between social partners.

Scenario	Policy	Ranking	Reasons	Implementation
4	Reducing the instances of psychosocial issues and stress by using a range of digital, interactive means of communication to persuade businesses that a healthy workforce is a profitable one.	0	This is already well understood and managed in this scenario so this policy would have no impact.	Already implemented.

Scenario 3: Exploitation

Exercise 1: OSH news headlines in scenario for 2025

Top choice: "Growing Demand for Robot Unions!"

Key points made/other headlines:

- Imbalance of power between AI and HR.
- Friction between robots and humans.
- Vacuum of legislative organisational framework.
- Polarisation of social classes.
- Latest measure of social class divide shows the widest ever.

The group responded well to this exercise and discussed the dynamics and frictions within the scenario.

Table 7: 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.)
Weak regulation of workplaces.	Challenge: unsafe and harmful workplaces, owing to reduced prevention.	Manufacturing. Distribution trades/storage. Construction.	Increasing problem as weak regulation fails to match technology advances.
Increased monitoring and evaluation; often via online platforms.	Challenge: psychological issues, stress and neuro-psycho-sensory overload. Challenge: cyber-bullying.	Manufacturing. Distribution trades/storage. Administration.	Critical overload has led to growth of "accommodative astenopy" (weakness or fatigue of the eye, with pain in the eyes, headache, and dimness of vision resulting from refractive error and excessive contraction of ciliary muscle) now recognised as a condition in the professional literature.
Increased use of mobile ICT.	Challenge: exposure to electro-magnetic fields.	Professional science and technology sectors. Administration.	An increasing problem, closely linked to the growth of ICT.

OSH issue	Describe: OSH challenge or opportunity?	Sector(s) of the economy	Comments (new or increasing, who most affected, nature of impacts etc.)
Efficiency of fail-safe technological processes and decision-making algorithms.	Opportunity: lowering of risk to workers through reduction of human errors and improved decision-making.	Manufacturing. Distribution trades/storage. Construction.	Increases with technology advances.
Use of databases.	Opportunity: facilitates improved knowledge-sharing and professional communications.	Applies to most sectors of the economy.	ICT technology gives easier access to databases and the opportunity to leverage data to improve OSH outcomes.

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

Description of action/policy	Expected OSH benefits	Implementation
Opportunity: Using fail-safe technological processes to improve decision processes and reduce human error.	Reduction of physical risks; less work accidents; less musculoskeletal disorders; safer workplaces.	Employers and trades unions would agree on new standardised procedures which would be recognised as being of benefit to all sides.
Challenge: Tackle the growing psychosocial risks and the neuro-psycho-sensory overload through greater health and psychological surveillance.	Reduction of work-related stress through ability to use evidence and data to educate both employers and workers of the need to introduce safer, more enlightened and productive working environments.	Needs support of employers and trades unions to recognise the long-term dangers of sensory overload by implementing monitoring, surveillance and treatment protocols.
Surprising/novel: Introduce annual ophthalmological surveillance to monitor and advise on risks and evidence related to electro-magnetic fields.	Early awareness of the risks to individuals and the opportunity to intervene and advise on prevention.	Needs support of medical profession in conjunction with the Occupational Health System providing advice and support.
Opportunity: Use monitoring devices to gather evidence on health risks, which is made available to workers so that they can use it to influence employers and government to improve the situation.	Improvement of workers' health and well-being; empowerment of workers.	Employers, trade unions and government to agree on implementation and use of the technology and data collected respecting worker's privacy and rights, for the benefit of all sides.

Table 9: Record from plenary wind-tunnelling of policies from other scenarios for Exploitation scenario

Scenario	Policy	Ranking	Reasons	Implementation
1	Media, trades unions and government working together to help workers adapt to changes in their job or retrain for new jobs.	-3	Such an interventionist role for government is incongruous in "Exploitation" scenario.	Would not be feasible to implement.
2	Government policy that requires all workers to have a personal consultant that is responsible for supporting workers and ensuring workers are suitably qualified and competent through advice and evaluation.	+2	Good as it emphasises the ultimate human responsibility.	There is some question mark on implementation as to how this would be financed.
4	Reducing the instances of psychosocial issues and stress by using a range of digital, interactive means of communication to persuade businesses that a healthy workforce is a profitable one.	+4	Has the advantage of using business self-interest rather than government intervention.	Despite its attractiveness, there was some feeling that this proposal is an outcome rather than a policy.

Scenario 4: Fragmentation

Exercise 1: OSH news headlines in scenario for 2025

Top choice: "Out of control robot chooses to kill inefficient workers."

Key points made / alternative headlines:

- Government cuts R&D funding; business cuts jobs.
- Mr Big finally arrested for tax fraud. The point made was that tax fraud is already common - FINALLY getting someone important arrested would be news.
- 'Out of sight' people organise resistance, but fail. This reflects powerlessness of the majority in this scenario.
- Riot attacks robots.

The top choice headline began just as "out of control robot kills", but it was pointed out that this could happen now. The key thing in this future was the CHOICE, to select inefficient workers to "get rid of".

Table 10: 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.)
Increasing psychosocial issues and stress.	<p>Challenge: many causes, growing substantially in this scenario:</p> <ul style="list-style-type: none"> - Zero hours contracts. - Poor work/life balance. - Sub-contracting. - Short term contracts. - Job insecurity. - Financial insecurity. - Lack of autonomy. - Violence. - Excessive monitoring. <p>All lead to lack of OSH control.</p>	<p>Most.</p> <p>Less so in professional jobs where flexibility may be welcomed.</p>	<p>Already starting to happen.</p> <p>Impacts seen in increasing stress and mental health issues.</p> <p>Action needed to address both the causes and the impacts.</p>
Failing culture of OSH.	<p>Challenge: in this scenario people are likely to become more accepting of risk, and less educated about OSH.</p>	Most.	Sub-contracting and (pseudo-) self-employment undermine OSH structures.
Poor quality control of materials.	<p>Challenge: 3D printing and use of low-cost/counterfeit materials increases hazards.</p>	Manufacturing.	Includes biological and chemical hazards.
Equipment is poorly maintained and older, maybe second-hand.	<p>Challenge: cost-cutting puts pressure on OSH.</p>	Manufacturing. Transport.	Self-employment drives cost-cutting.
3D printing highly repeatable.	<p>Opportunity: only need to design something once – get it right and all copies are safe.</p> <p>Challenge: get design wrong and all copies are unsafe.</p>	Manufacturing.	
Cheaper and better communication about risks.	<p>Opportunity: use digital technology to produce images, actors, games to communicate about OSH.</p>	All.	<p>Hard to keep up to date in this scenario.</p> <p>Hard to motivate government or business to do this.</p>

Finding opportunities was harder than finding challenges, which is not surprising in this scenario.

Table 11: Exercise 3 - OSH policies and actions to achieve the best OSH outcome in Fragmentation scenario

Description of action/policy	Expected OSH benefits	Implementation
Opportunity: Use cheaper digital means of communication more creatively to explain OSH.	Greater awareness of OSH issues.	Encourage participation and creativity. Exploit greater digital skills of young (cheaper) people.
Challenge: Reducing the instances of psychosocial issues and stress by using a range of digital, interactive means of communication to persuade businesses that a healthy workforce is a profitable one.	Improved workers' health Greater personal responsibility for OSH.	Low cost communication campaigns.
Surprising/novel: Develop safer 3D printing through approved exemplars.	Fewer poorly designed products.	Selective central design.

Table 12: Record from plenary wind-tunnelling of policies from other scenarios for Fragmentation scenario

Scenario	Policy	Ranking	Reasons	Implementation
1	Media, trades unions and government working together to help workers adapt to changes in their job or retrain for new jobs.	+2	Good idea but hard to do when social structures are weak.	Keep trying, there will be some successes.
2	Government policy that requires all workers to have a personal consultant that is responsible for supporting workers and ensuring workers are suitably qualified and competent through advice and evaluation.	+0.5	Can't afford to do this in this scenario, even though it's a good idea.	Could try using AI or other ICT for some limited areas.
3	Use monitoring devices to gather evidence on health risks that is made available to workers so that they can use it to influence employers and government to improve the situation.	+2	As for the policy in scenario 1, a good idea but hard to implement. Also there would be cyber-security risks in this scenario.	Could encourage employers to do it if the message of health = profit gets through.

Plenary discussion and conclusions

The summary report of the foresight study had been circulated to participants before this workshop so participants had been given an opportunity to familiarise themselves with the nature of the project, the scenarios and the main findings. This may have contributed to participants being quickly able to engage with and work constructively with the scenarios that they had been allocated. All groups were able to follow the guidance to accept the world as described, although there was some evidence that discussions were occasionally influenced by issues of the present.

The discussions that took place during the workshop indicated that it met the objectives of: raising awareness of the foresight project, the scenarios developed, the new and emerging challenges and opportunities identified, and understanding how the scenarios could be used to discuss how potential new and emerging OSH challenges could be met.

The groups comprised people from a wide range of backgrounds, who were able to bring a considerable variety of expertise and professional know-how to the discussions. There was a supportive spirit and the facilitators felt that everyone's opinions and ideas were communicated and fully taken on board within all the groups. The group held discussions in both English and Romanian, with the latter discussions then being helpfully translated so they could be shared with the facilitator.

Participants seemed to have found the exercises a rewarding and worthwhile experience, from which they had learned a lot. However, 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.

All groups quickly recognised both the challenges and opportunities presented by the scenarios. A good number and variety of OSH issues were identified and discussed. Only one issue, the interaction between workers and new technology, was discussed across all four scenarios. Training or qualifications was discussed in three of the four scenarios and the need for workers to adapt was discussed in two scenarios.

The discussions, during Exercise Three on policies and actions followed quite naturally from the challenges and opportunities identified in Exercise Two. However, some groups found the development of policies a bit harder than the identification of the OSH issues. While there was enthusiasm about the task, some found it difficult to formulate policies that fitted their specific scenario, rather than the current world. This is not unusual when the time allowed is limited in such a workshop. Nonetheless, participants applied their minds with a dedicated focus and warmed to the process indicating that with more time they would in all likelihood have produced more fully developed policies.

Participants engaged particularly well with final wind-tunnelling exercise, where groups considered one policy from each of the other three scenarios. None of the policies scored highly in all four scenarios and all four policies scored low or negatively in at least one scenario. This demonstrated the value of using scenarios to test the robustness of policies or strategic decisions to consider what may happen in the future. Only two policies were scored negatively, once each by one other group, and only one policy was given a zero by just one group. 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. Should the scenarios be used to develop actual policy, strong facilitation would be needed to ensure that groups look at policies from other scenarios, if appropriate, in a critical way.

The Transformation scenario was the one that most participants, who voted, would like to happen and the next most popular was the Evolution scenario. However, the Evolution scenario was the one that most participants, who voted, thought was the most likely to happen with the next most popular being the Transformation scenario. Both the Evolution and Transformation scenarios were ones where government and the public were both supportive of digitalisation and one another.

The facilitators felt that there were indications, during the discussions, of the scenarios stretching participants' thinking, creating new insights and challenging current assumptions. Whilst the objective of the workshop was not to agree policy, the participants were able to propose possible policy options that had the potential to achieve the good 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 addressing the OSH challenges identified in the project. 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.

Acknowledgements

The authors are grateful for the positive engagement of all the workshop participants in the exercises, which provided a valuable opportunity to validate the scenarios and test their use for OSH.

Please contact a member of the project team if you would like further information or support to use the scenarios or any other of the outcomes of this project.

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Appendix: Scenario descriptions

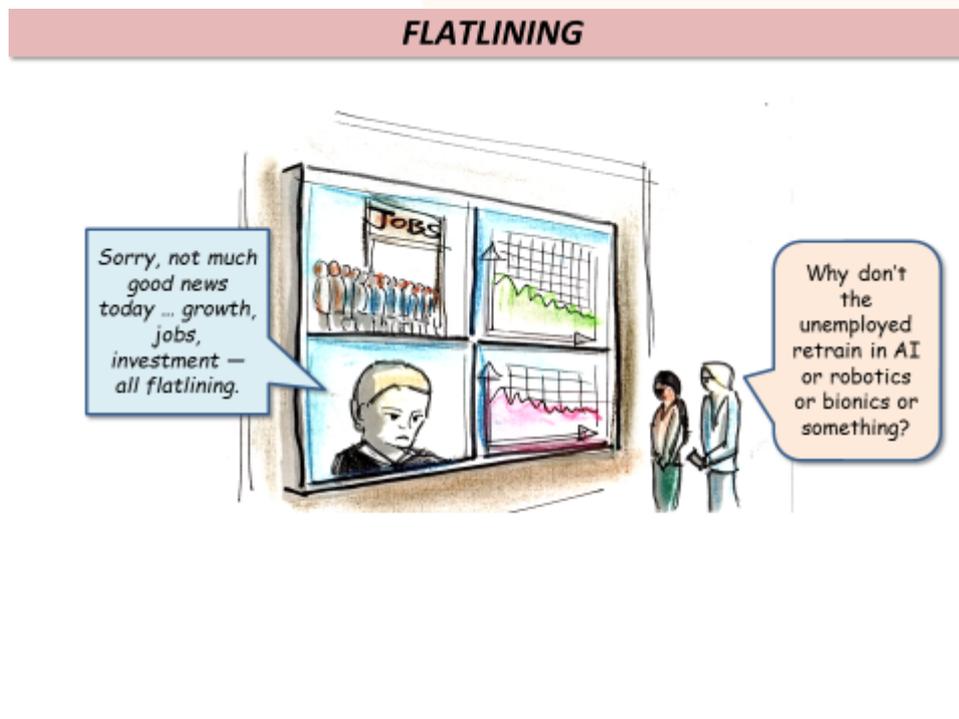
Scenario 1 — Evolution

(Low levels of economic growth and technology application / High levels of governance and supportive public/worker's attitudes)

Europe in 2025

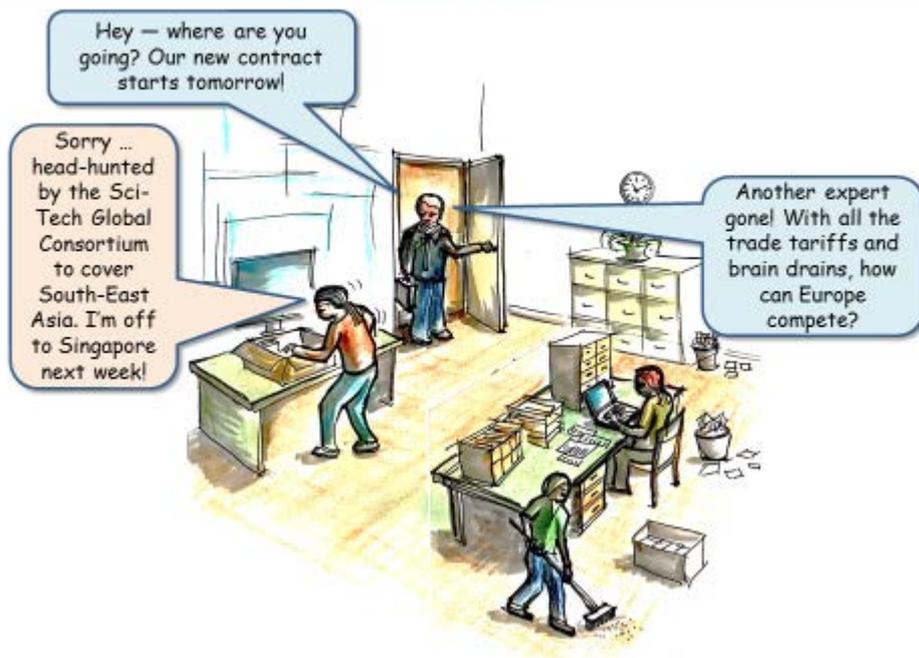
During a decade of low economic growth, the governments of Europe have sought to regain the trust of the voters and maintain social cohesion by focusing on workers' rights, social welfare, health and social care, and education. Employees, workers' representatives, business leaders and governments have worked together through social dialogue to build a consensus on the benefits of the exploitation of ICT-ETs at work. There is a mix of participation and trust management on the one hand and command and control on the other. This approach has been successful insofar 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.



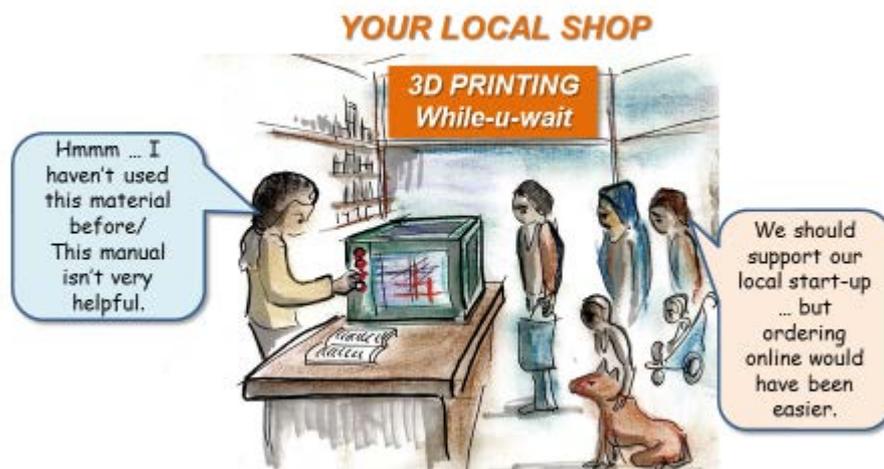
There have been continuing levels of relatively high unemployment and a loss of confidence in the benefits of international trade. In response to popular concerns, Europe seeks to protect its economies through strict trade and migration policies. However, there is global competition for highly skilled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

BRAIN DRAIN



There is a mix of workplace innovation and more traditional work organisation, human resource management 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.

GDP growth remains low throughout the period, 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 lowest 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 to 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 sectors.

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, to motivated individuals or to local initiatives. The low levels of GDP growth and governments' focus on protecting 'old' jobs and maintaining social cohesion mean that a relatively low priority is 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.

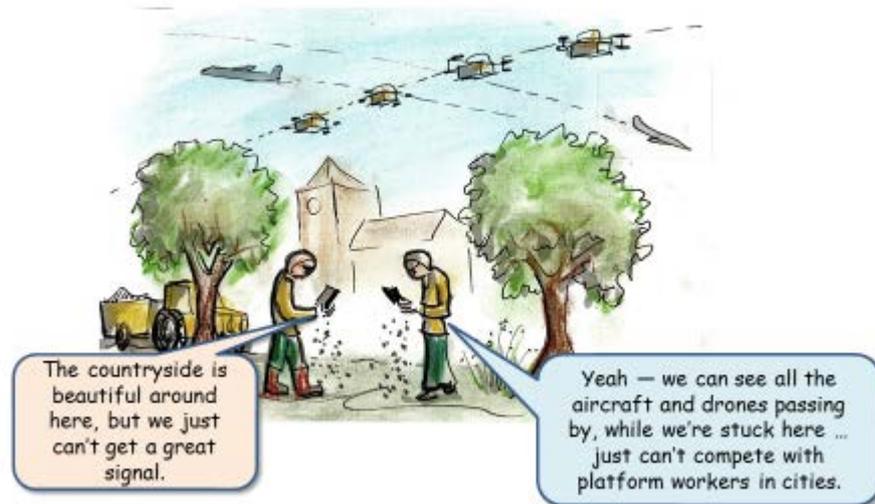
There has been relatively slow development in cutting-edge technologies, such as AI, that drive the Internet of Things (IoT). The use of basic AI and voice control interfaces has increased moderately, but more advanced AI and human-machine interfaces (e.g. eye-tracking, gesture and direct brain to computer interfaces) 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 across 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.

RURAL BYPASS



OSH environment

The priority for the private sector is staying in business and for the public sector it is reducing and dealing with the issues associated with unemployment. Governments support workers' rights and work with the social partners to ensure that OSH is seen as important, 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 for existing technologies to be widely diffused, rather than for new technologies to be rapidly adopted, 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 for best practices to be shared before the technologies to which they apply are in widespread use. Social media is also used to disseminate information on OSH issues.

A gradual but patchy increase in levels of automation, use of robotics and use of AR and VR removes some people from hazardous working environments. However, some of these technologies may not be well maintained owing to businesses' constrained finances and/or understanding of the risks. Connected robots/machines could also be vulnerable to cyber-attacks that could cause 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 or, in some sectors, job insecurity. However, wearable technology is also used to help individuals monitor and manage stress.

Scenario 2 — Transformation

(High levels of economic growth and technology application / High levels of governance and supportive public/worker's attitudes)

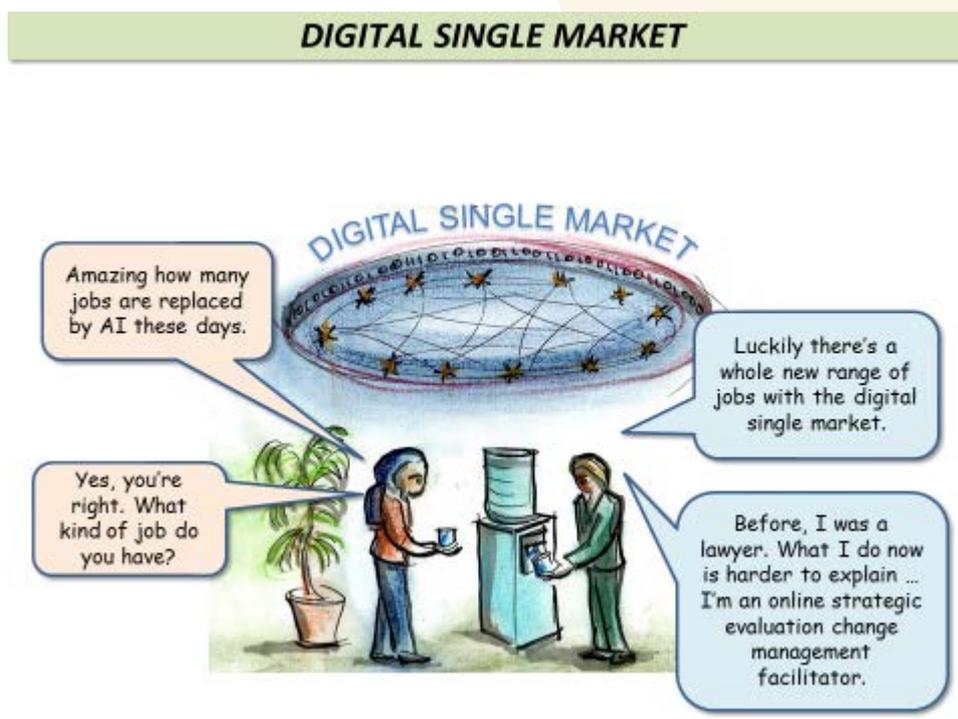
Europe in 2025

The political and social landscape of Europe has undergone a transformation, becoming 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 and sustainable work practices and care for the environment. This creates, among most, a high level of trust in policy-makers, and, in general, an acceptance of new technology. Society is also less discriminatory and more equal, as ICT supports workers irrespective of their demographic (e.g. age or class).

Political alliances, established during the successful implementation of the European Digital Single Market, have resulted in governments across Europe working well together. Governments have embraced the efficiencies offered by ICT-enabled technologies and have 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 past 10 years, 50 % of jobs have fundamentally changed or disappeared, with many new jobs being created. It is common for workers to have several jobs that fit around their 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 Artificial Intelligence (AI) supervisory algorithms built into work interfaces. People also change jobs frequently and with ease, and often continue to work healthily into their 80s. Average life expectancy is 100.



Unemployment remains generally low owing 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 increasingly 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 widely available. Quality is assured through accreditation by online worker cooperatives, employment associations and trade 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.

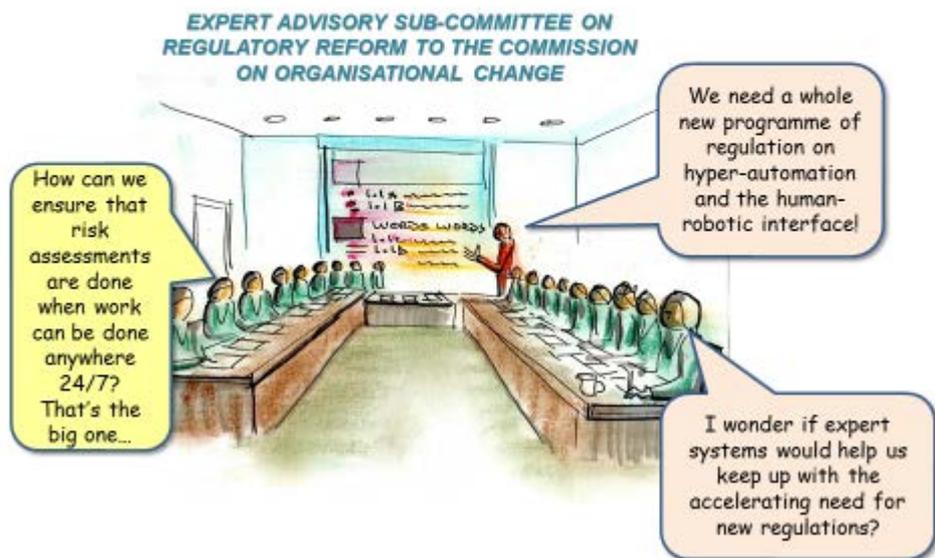
TARGET PRACTICE



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 don't 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 change and changes in ways of working) is moderated by the need to reach consensus among 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 Internet of Things (IoT) is widespread, such that most devices at work and at home are smart and connected.

The use of basic, narrow 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 to 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 learning AI systems, which help to manage stress, promote well-being 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 AGI machines now make decisions and act upon them without human supervision or intervention. However, there are some concerns around how much control AGI machines 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.

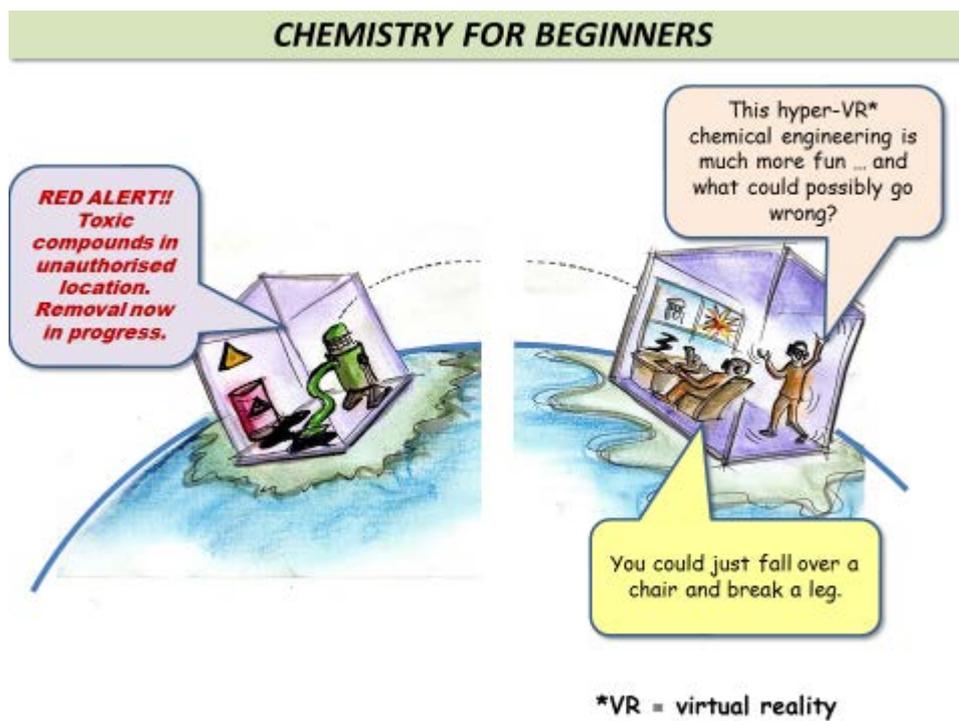
Interfacing with ICT (and other people remotely) is more natural and immersive. There is widespread use of voice recognition, eye tracking and gesture control. The use of direct brain-to-computer interfaces, while not widespread, is no longer seen as niche.

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; many factories are fully automated with no or minimal remote human supervision or 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 on the part of workers.

The new social contract means that there are trust, transparency, shared values and openness between governments and social partners, which encourages 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 by social partners. Work organisation mirrors this, generally following a participation and trust management regime. This has allowed innovative partnership, 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 as a result of the widespread use of wearables and from the IoT. Consequently, OSH tends to be built into ICT enabled technology and work processes. Therefore, on the whole, there is resilience to the moderately rapid pace of change (technological change and changes in 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.

Social norms can cause stress/anxiety from the pressure and/or need to conform; some individuals worry that they are not able to perform or behave well enough to meet societal expectations. 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 because of 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', and many are supervised, assessed, coached managed and monitored by AI. This can put excessive cognitive load 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 mean that most people work from home, in shared communal spaces or in public places. Most work meetings are held in virtual reality 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 result in new cognitive, voice, visual and MSD risks.

Increasing levels of automation and use of robotics remove many workers from hazardous physical, chemical and biological working environments. AR and VR are used for immersive training and to support maintenance tasks, which can often be done remotely; this 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 PPE 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; if hacked, these systems 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 can 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 can be exacerbated by the fact that many work processes are 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 due 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 intensely; 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, for example not having enough to do, their job being monotonous or their job not requiring them to use their cognitive skills.

Scenario 3 — Exploitation

(High levels of economic growth and technology application / Low levels of governance and resistive public/worker's attitudes)

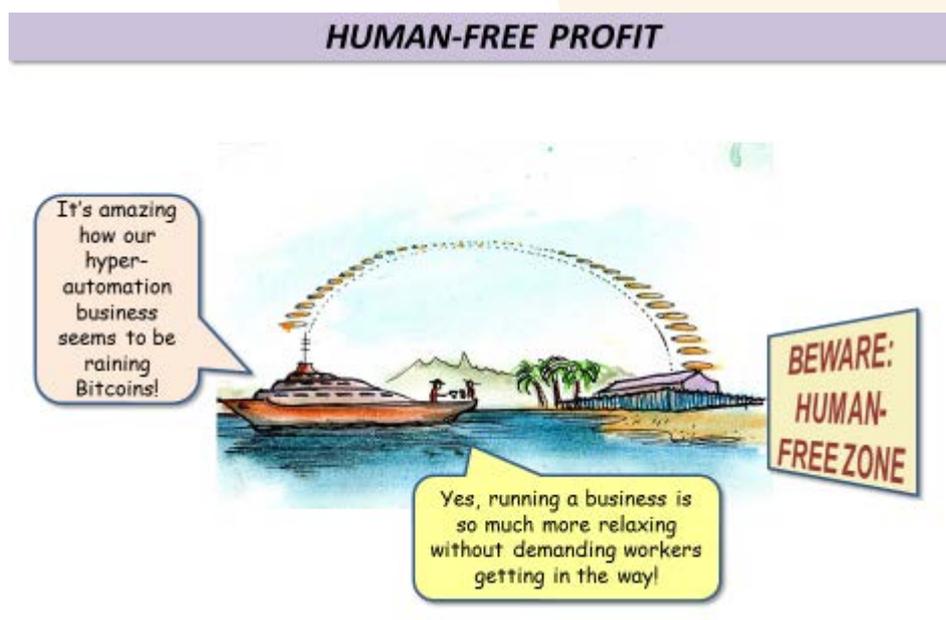
Europe in 2025

Annual 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 and governments have generally failed to work together and have lacked the resources to ensure that regulatory frameworks keep up with the rapid pace of changes in ICT-ETs and the changes they have triggered in relation to (flexible) employment, working arrangements, the nature of work and work location. This has 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 profits. 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 fundamentally changed or been lost. Of these, around 40 % of jobs have been lost because 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. The available work is primarily unskilled, with only a small proportion of partly standardised high-skilled work.

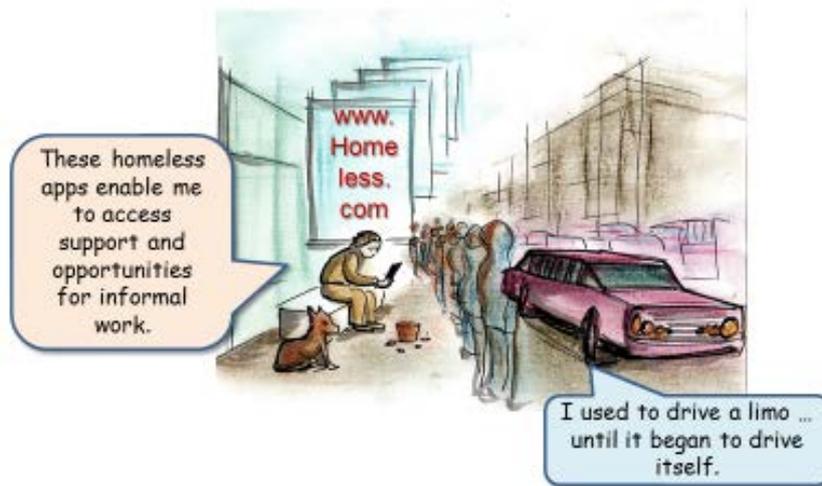
There are very high levels of unemployment and much greater inequality between the high and low paid. Workers' interests and their training are lower priorities, as it is easy to buy in skills as required. What jobs there are are generally unstable and insecure in nature, and work is often challenging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



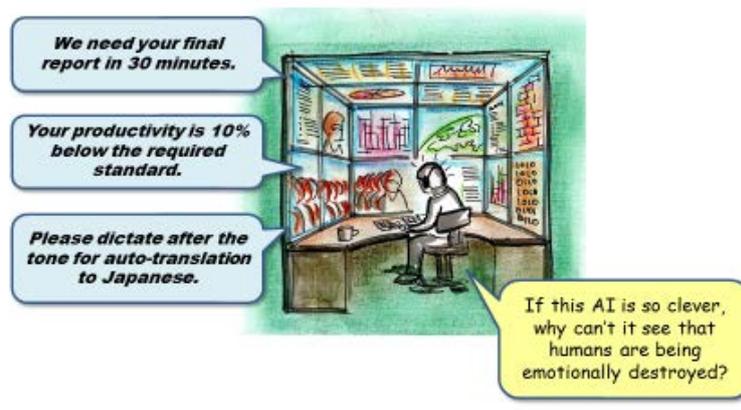
As a result of significant ICT skills gaps towards the beginning of the decade, businesses attempted to upskill the workers needed to use advanced ICT-ETs. This means that there are opportunities for less wealthy EU countries to benefit from the ICT revolution. Increasingly individuals use widely available Massive Open Online Courses (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 wider 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'.

Advances in AI and robotics are ubiquitous in the workplace. Businesses have realised the improvements AI can bring to productivity and efficiency, and systems have now been widely adopted

PRODUCTIVITY PROBLEMS



to direct, monitor and assess worker performance and productivity. Management is usually of a command and control nature, overseen by AI supervisors.

Robots and computer algorithms now carry out the majority of routine and repetitive tasks. Skilled professional jobs have also been significantly affected. Robots commonly work collaboratively with humans and can undertake increasingly complex and powerful tasks. Biomechanical devices, such as exoskeletons, are commonly used in workplaces, for example in 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 Internet of Things (IoT).

Interfaces using voice recognition, eye tracking and gesture control are common in some sectors, and there has been early adoption of direct brain-to-computer interfaces. Traditional large manufacturing activities have been significantly disrupted by additive manufacturing; small and medium-sized enterprises and start-ups increasingly provide 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 their leisure time, is routine (to monitor for a healthy lifestyle, valued because of the link to productivity benefits).

POWER GAMES



Throughout the decade, cyber-attacks have been increasingly common, because of the lack of a robust, coordinated response to the threat from both governments and businesses. This has resulted in a greater loss of public trust. Infrastructure, power and utilities have all been disrupted by cyber-attacks, and this is now 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 falling trade 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 quality training, and experience extended periods of unemployment. Employers commonly transfer responsibility for OSH management onto their workers through 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 workers are self-employed, with precarious employment contracts (zero-hour 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 is used to form collectives, which attempt to use their combined power to improve working conditions, with occasional but 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 good and bad jobs in terms of OSH.

Increasing levels of robotics and use of automation remove many people from hazardous physical, chemical and biological 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 as a result of 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 3D and 4D printing and bio-printing in small shops and start-ups by owners and their workers, who may have little training in the risks posed by 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 owing to hacking in ways that can cause hazardous situations in the workplace, for example the shutting down of cooling systems used in 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 result in new cognitive, voice, visual and MSD hazards.

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 from AI systems to increase productivity (known by some 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 over-work and many workers burn out.

Scenario 4 — Fragmentation

(Low levels of economic growth and technology application / Low levels of governance and resistive public/worker's attitudes)

Europe in 2025

Europe has endured a decade of low growth and low technological development in 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 those businesses and workers who are the 'fittest' 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 has become 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 human resource management 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 older workers 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 sped 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

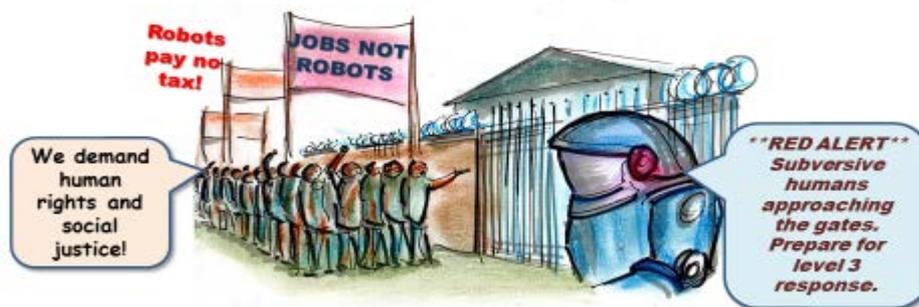


GDP growth throughout the period remains low, at about 1 % per annum at best. Investments by both business and government in research, infrastructure and skills development are generally very low, and incremental improvements are seen as the most cost-effective way of reducing labour costs. However, there have been some significant examples of the successful application of ICT, particularly by the owners of online work platforms to support 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 will 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 (e.g. engineering, 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 governments' 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 the maintenance of both equipment and software, leading to more frequent 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. Massive Open Online Courses (MOOCs) are available, but they are of variable quality, so they improve skills only to some extent. Use of online training also means that wider skills, for example social skills, can be poor. All this has combined to hold back innovation in many businesses. The 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.

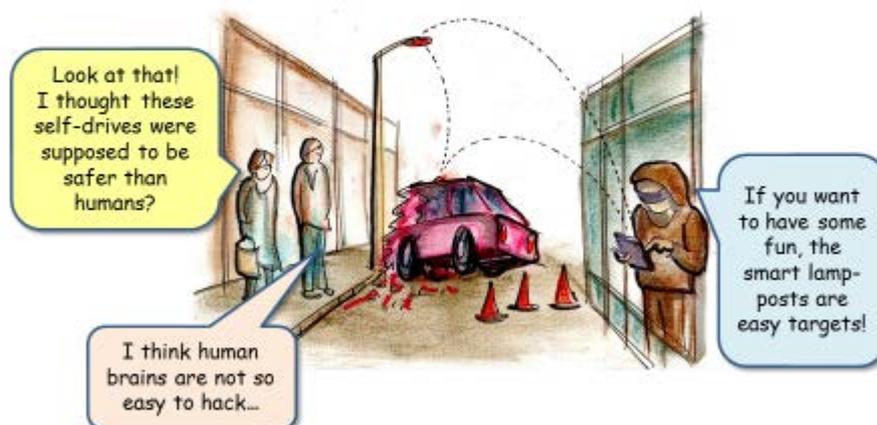
Investment in mobile networks has been limited and 5G is focused on profitable areas, generally industrial areas and cities. The Internet of things (IoT) is now part of many aspects of our daily lives, including work, so we are almost never free from 'supervision.' However, limited investments in networks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

Monitoring technologies, including through 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. Robots working collaboratively with humans are 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.

SMART CITY FUN



There has been a large increase in online work platforms that 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 (e.g. with workers being called to jobs on a just-in-time basis) means that many suffer from stress and anxiety. Work is often intense, which contributes to both psychosocial and physical disorders. A large amount of the available work is computer-based, which has led to an increase in physical disorders such as MSDs. Some of the online platform work available is in typically dangerous occupations such as forestry. Because most individuals are (pseudo) self-employed, the responsibility for safety and health is transferred from the employer to the worker. Many lack employment benefits such as sick pay.

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

OSH environment

Despite 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 cybersecurity 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 the 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. In addition, 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 arising from the 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.

INSTRUCTIONS NOT INCLUDED



The use of AR and VR has increased for training and to improve productivity. However, there is little new innovation in the underlying technology. The use of these technologies has primarily been to improve the productivity of online platform workers, so instantaneous translation and human interfaces using gestures 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 in 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 and ergonomic hazards. However, there are also hazards associated with workers interacting with automated equipment, particularly collaborative robots, such as collisions, increased work pace and increased cognitive load. Improved electronic monitoring makes it possible to alert workers to the presence of hazardous substances.

Work-related stress is widespread as a result 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.