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

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 Norway on 8th November 2018, Oslo, and 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 organisation of work over the next 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 Community 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 rapid developments associated with digitalisation.

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 digitalisation, their impact on the nature and location of work, and the emerging challenges to OSH that they 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 ICT 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 are available on EU-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. Annick Starren (EU-OSHA) opened the workshop and informed the participants about the background to this foresight study. The plan for the workshop was then introduced by John Reynolds (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 John Reynolds (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.

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 choice: "Cyber-attack – no mobile phones for over 10 hours"

Key points made:

- Local is the new global.
- Good quality of life.
- Loss of autonomy.

The group felt that this was a realistic scenario and that many of its features reflected aspects of Norway.

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.)
Stress from the close regulation of time.	ICT will increase the impact of this. Monitoring of health workers is already causing major stress issues.	Raised during discussion of caring sector but also issue across all sectors.	In caring there are important issues on the balance between technology and 'warm hands.'
Mechanical handling and lifting.	Mainly an opportunity as MSDs can be reduced by monitoring workers and using technology to assist handling.	All sectors dealing with physical goods.	Risk may increase in new local enterprises.
Workers' lack of experience.	AI can give workers the necessary knowledge, but a lack of experience can lead to OSH risks not being appreciated. In construction, technologies such as Building Information Modelling (BIM) will require new skills and reduce the value placed on experience.	Particularly in more hazardous sectors, such as chemical processing and construction.	Increasing issue of operators' loss of situational awareness due to automation. Increasing risk for manual workers
Local energy production.	Reduced experience and supervision if local communities go 'off grid.'	Power.	Rural communities.
Reduced migration due to relatively high unemployment and protectionist trade and migration policies in this scenario.	Although many low-skilled workers may not be replaced by robots if investment costs are high, less of them will be migrants. Opportunity to improve accident rates as migrant workers are statistically three times more likely to have an accident.	Mainly lower skilled sectors.	Fewer low-skilled migrant workers at risk.

OSH issue	Describe: OSH challenge or opportunity?	Sector(s) of the economy	Comments (new or increasing, who most affected, nature of impacts etc.)
Image recognition and automation reduces the use of chemicals	Reduced occupational and environmental exposure to chemicals.	Agriculture.	
Tax incentives are increasing use of electric cars and electric and hydrogen ferries.	Reduced occupational and environmental exposure to chemicals, fire and explosion risks associated with production, storage and transport of oil based fuels.	Transport. Oil and gas.	
Reduced personal interaction.	AI and new ways of working will result in stress from isolation having an increasing impact.	Across all sectors but a particular issue in the gig economy.	Remote and self-employed workers at most risk.

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: Collection and use of sensor data on workers, to support design of better work processes.	Reduced stress, fewer physical hazards and increased efficiency.	Implement through legislation.
Challenge: Reducing risk of physical hazards.	Reduction of risk from physical processes.	Regulations requiring the analysis of physical processes, to enable the use of technology and revised processes to reduce the hazard. This would be similar to the current regulations for the use of chemicals.
Surprising/novel: Employees must monitor the work environment, to identify potential loneliness problems.	Reduced health problems, absenteeism and disability.	Regulations to define the monitoring requirements, including the required survey methods and quality standards.

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

Scenario	Policy	Ranking	Reasons	Implementation
2	Government funded collaborative working spaces designed to foster face to face interaction and informal knowledge sharing.	+2	This was viewed as a useful policy but it would not be a high priority for the limited government funding available.	Would seek broader engagement in the policy and encourage local initiatives.
3	Use of variable sickness and accident insurance premiums to drive better behaviour and ownership of risks by workers.	+3	It was felt that this would not be effective with just an economic driver. Insurance premiums related to OSH are already implemented in some countries but are not effective for OSH prevention. Also difficult to implement for the self-employed.	Stronger regulation of the insurance industry and premiums would have to be used to reinforce this policy.
4	"Smart regulation" based on Big Data and AI: requires monitoring and surveillance statistics to be submitted and uses Big Data and AI to analyse them for health and safety outcomes.	+4	This would help to prioritise the limited funds available for inspections to those areas where it would be most effective.	The historically high levels of investment. Would need to clarify who will own worker data, whether the worker would have data portability, and whether/how the data can legally be shared with regulators.

Scenario 2: Transformation

Exercise 1: OSH news headlines in scenario for 2025

Top choice: "Spending on mental health higher than ever: everything is better so why are workers so anxious?"

Key points made:

- The loss of understanding of how systems work so that when they go wrong we would not know what to do.
- Dependency on ICT systems would lead to increasing anxiety; in this scenario this would lead to a big new government initiative.
- Skills and training would be top priorities as well as life-long learning.
- The need to protect people from falling outside the system and losing access to jobs and services.
- Those who have influence may not be representative of all workers.
- The blurring of work and private life would make it difficult to know who was responsible for OSH and raise ethical issues around regulatory inspection.

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.)
Monitoring of workers.	Potential negative psychological impact. There could be motivation to fool the monitoring if there were negative social or financial implications. Being monitored all the time may give people a false sense of security.	All sectors, particularly transport, oil and gas, admin, finance and agriculture.	What are legal implications for regulators/employers of monitoring workers whilst at home/not working?
Lots of data.	Opportunities to: predict OSH issues before they occur; gather information on best-practice/compliance in a more dynamic, real-time and less rigid way that is more tailored to situation.	Any sector where work is fairly routine.	There could be lots of noise in the data. It could produce a power asymmetry and advantage to big companies that have more expertise to gather and use the data.
Skills and expertise.	How would quality of training be assured? How would client be assured that supplier has necessary expertise when workers are responsible for their own training?	Self-employed workers.	Regulators would need to invest in training so that they can keep up with innovation in working practices.
Loss of personal interaction at work.	This can make it difficult to manage OSH and also cause mental health issues for workers.	Any sector where work can be done remotely.	Human workers could become more like robots.
Majority of people work remotely for many different employers.	Challenge to how worker organisations represent members in relation to OSH and collect fees.	Any sector where work can be done remotely or by self-employed.	Worker organisations would need to change fundamentally how they deliver services and collect fees.
Robotics doing difficult dirty jobs.	Free up people to do more rewarding jobs.	Manufacturing, oil and gas, chemical processing, agriculture, construction.	Low-skilled may be negatively affected, although good quality re-skilling opportunities should be available in this scenario.
Division between public and private sectors.	Loss of wellbeing if people are not cared for by people. Children may not need to go to school to access learning but social interaction is a key aspect of education. If public services are delivered remotely or by robots or AI instead of people it could damage national core values and identity.	Education, police, health care, public services.	Need to ensure that there are sufficient opportunities for people to interact in person. Also that people have sufficient 'down-time'.

OSH issue	Describe: OSH challenge or opportunity?	Sector(s) of the economy	Comments (new or increasing, who most affected, nature of impacts etc.)
AI could exacerbate human biases and mistakes. Alternatively AI could become confused by human biases and frailties.	How to prevent or spot and correct these before they cause OSH problems.	All sectors where work can be codified.	May need robot therapists.
People who are unable or don't want to conform to new social norms or ways of working.	Wellbeing of people who are excluded. Benefits not enjoyed by all.	All.	These people may have a role to play in ensuring others have sufficient social interaction and down-time.

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: To deliver important values for Norway in terms of providing a good working life and avoiding dangerous work.	Increased wellbeing, significant reduction in number of injuries and occurrence of occupational ill-health by removing workers from hazardous environments and where this is not possible providing tailored real-time, dynamic personal protection and advice.	Provide training to workers to ensure that they can understand the issues sufficiently to actively participate in public dialogue to agree the principles / design standards to safely deliver automation, autonomous vehicles / robotics and AI for the benefit of all workers.
Challenge: To ensure that no part of society is excluded.	The real benefits presented by this world would be enjoyed by all. Improved mental health.	Ensure that public services are designed so as to not exclude people who are less comfortable with the new ways of working. Workers should be given a sense of having a regular job, despite the fact that they are working for many different employers. This could be introduced by regulations that require work to be done through umbrella organisations. These organisations would take responsibility for OSH and making sure that workers receive a reasonable wage. It may also be necessary for government to set expected fees for different types of work to ensure workers are not undercutting one another.

Description of action/policy	Expected OSH benefits	Implementation
Surprising/novel: Ensuring people have sufficient opportunities to interact in person whilst at work.	Better mental health and wellbeing.	Create collaborative workplaces for people to use. Design these so that they encourage and foster interaction and informal knowledge sharing. It would not be a requirement for people to use these workplaces (in particular certain professions, when concentration or confidentiality is needed) but they would be designed in such a way that they encourage people to use them.

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

Scenario	Policy	Ranking	Reasons	Implementation
1	Regulation of physical hazards that require lowest risk process to be used, as per existing EU Framework Directive – i.e. the use of automation or robotics if they would remove workers from hazardous environments even if this would be more expensive than using low skilled workers.	+4	Commercial drivers will make this happen anyway when people are more expensive.	Continuation of regulation requiring use of best available technology. Public procurement specifying technologies that do this. Design standards will be needed to specify good practice.
3	Use of variable sickness and accident insurance premiums to drive better behaviour and ownership of risks by workers.	-2	The positive core values/culture in this scenario would be damaged by putting too much onus on individual.	Wouldn't implement.
4	"Smart regulation" based on Big Data and AI: requires monitoring and surveillance statistics to be submitted and uses AI to analyse them for health and safety outcomes.	+3	Would enable dynamic real-time less rigid advice and risk reduction.	Would need public dialogue to agree the principles under which this would be allowed, including rules to protect privacy and safeguards against stress.

Scenario 3: Exploitation

Exercise 1: OSH news headlines in scenario for 2025

Top choice: "Intelligence pill now available again."

Key points made:

- Other proposals were "Robot Babies for Rent".
- And "Last Trade Union Member Identified".

The group readily worked with the features of the world as described in this scenario, and focussed on its high-tech/social alienation dynamics.

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.)
Rapid technological advances.	Opportunity for developing sensors to monitor workers' vital signs (e.g. fatigue).	Sectors involving high-risk processes (e.g. construction).	This will be a big growth area; and is in the interests of both workers and employers.
Individualisation of responsibility	Challenge to reach the stressed self-employed in the absence of a sound regulatory framework. Opportunity to use market mechanisms to appeal to the self-interest of workers.	Mainly involving the provision of personal services, either directly or virtually.	Scope for education to help the self-employed to be better informed and aware of OSH issues.
Cyber security	Challenge to prevent risks to employees from hacked/malfunctioning software affecting processes. Opportunity for employees and workers to take more control of their private data.	Affects all sectors of the economy.	Skilled workers will be at a premium in this scenario; and they will be motivated to take a personal interest in their own data. Issues such as 'digital erasure of history' will become increasingly important.
Robotics and automation	Challenge to keep abreast of the speed and penetration of new systems and processes. Opportunity to build in upgraded OSH features when new processes are being developed.	Almost all sectors of the economy will be affected to some extent, but especially factory/ construction environments.	The control and monitoring systems will be generating a big digital footprint, which is both a challenge and an opportunity.
Who is responsible for OSH?	Challenge of highly-automated processes diffusing and blurring lines of responsibility for OSH. Opportunity to use the insurance market to give workers more control over the liabilities.	All economic sectors are involved.	Employers would need to recognise the legal and reputational damage of failing to take OSH seriously. Workers, especially skilled, would see health and risk insurance as providing a private OSH framework.

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: Harness technology/automation to create a safer, better-monitored work environment, utilising machine learning and feedback on OSH parameters.	Fewer accidents through better analysis of working conditions. Automation of dangerous work. Sensors for early hazard detection – and hence prevention.	Employers should recognise the benefit of implementing this, both for themselves and their workers; but it requires mutual co-operation as well as training. There needs to be a clearing house to analyse data.
Challenge: Self-employed workers' sickness and accident insurance, to encourage and empower 'gig' workers, especially in home-working environments.	Responds to the 'Individualisation' of work by addressing needs of workers and unions. Spreads 'best practice' among insurance companies.	Insurance companies to take the lead, as implementation is in their own commercial interests. Risk assessment will generate the necessary insurance premium; and risk reduction will result in lower premiums.
Surprising/novel: Sensors to monitor the health and welfare of workers prior to accessing/ undertaking higher-risk environments. This could include fatigue, stress, and other medical conditions that would make it unsafe for e.g. driving or operating machinery.	This would be in the interests of the individuals and would achieve good OSH outcomes through the anticipation and prevention of exposure to higher-risk work environments where the worker is not in a fit state to perform.	This should have the support of both employers and employees. It could be offered by employers as an employment benefit.

The group considered that there were many opportunities in this scenario to harness technology in pursuit of better OSH outcomes. For instance, testing of new technologies would be of benefit to manufacturers to avoid negligence litigation. In the face of inadequate regulation, the challenge was to focus on skilled workers, who would be more highly-valued; and also on the atomised self-employed, who could be mobilised in their own self-interest.

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

Scenario	Policy	Ranking	Reasons	Implementation
1	Regulation of physical hazards that require lowest risk process to be used, as per existing EU Framework Directive – i.e. the use of automation or robotics if they would remove workers from hazardous environments even if this would be more expensive than using low skilled workers.	0	Existing technical solutions already in place.	The policy is over-regulation and would not be implemented.

Scenario	Policy	Ranking	Reasons	Implementation
2	Government funded collaborative working spaces designed to foster face to face interaction and informal knowledge sharing.	+2	The concept is good, but central funding is not available.	Would not be implemented by government funding; but could be implemented in a different way, e.g. with insurance industry support.
4	"Smart regulation" based on Big Data and AI: requires monitoring and surveillance statistics to be submitted and uses AI to analyse them for health and safety outcomes.	+1	Scope for misuse of personal data. Post hoc, rather than anticipatory. Our scenario has better ideas on monitoring.	In principle, a possibility, but would require further discussion. A more positive score might well result from further negotiation on implementation.

Scenario 4: Fragmentation

Exercise 1: OSH news headlines in scenario for 2025

Top choice: "Govt press release: "OSH is YOUR responsibility" (sub-text: we're not doing it)".

Key points made/other headlines:

- Huge budget cut for Arbeidstilsynet (The Norwegian Labour Inspection Authority); CEO says "We're going to have to work smarter"
- LO (Confederation of Norwegian Trade Unions) closes (union membership is falling, and is already below 50%)
- Illegal protests and demonstrations challenge cuts
- Major accident, with loss of life, caused by cyber-attack.

The group was at first reluctant to accept that the scenario could happen in Norway with its strong institutions, but gradually they accepted that it could happen in some sectors to begin with and then spread.

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.)
Monitoring and surveillance; working for an AI manager.	Psycho-social stress of being monitored all the time and of being given tasks by unsympathetic management. Better monitoring should result in fewer accidents and opportunities to impart skills at a relevant time.	Knowledge work; management; all work at ICT terminals. Most sectors to varying extents.	As people are rated, some may be excluded from the workforce. Opportunities for skills checks and re-training. Could be intrusive (less "democratic") but safer. Will be more depressing and with less trust.

OSH issue	Describe: OSH challenge or opportunity?	Sector(s) of the economy	Comments (new or increasing, who most affected, nature of impacts etc.)
Hazardous environments.	Drones (and other technology) reduce exposure and could also be cheaper.	All heavy industries.	
Technology facilitates a broader range of work opportunities being made available to disabled workers, and removes people from dangerous situations.	An opportunity, particularly for knowledge work.	As above.	
Awareness of OSH issues declines; number of inspections declines.	Increasing risks or occupational accidents and ill-health.	All.	Could affect all levels, as more is automated.
Mix of old and new technology.	Lack of understanding of risks of different systems.	Mainly manufacturing.	
Work insecurity (or flexibility) caused by self-employment/ sub-contracting.	Psycho-social stress due to lack of job security and income; fear of missing out on opportunities. Some people like the chance to choose what work they do and when.	Service sector.	Can be OK for the more dynamic and younger workforce, for a while at least. But others will need income security.
Sedentary work.	Increasing sedentary work-can reduce accidents and some MSDs but cause other non-communicable diseases such as obesity and diabetes, MSDs, cardio-vascular disease and psychosocial disorders.	Knowledge workers and increased automation with sitting, supervising operators.	Already an issue for professional drivers
Decline in skills as technology takes over.	Informal learning is lost as people work in isolation. Also causes loss of social skills and depression. Socio-technical stress of keeping up with new technology. Could be opportunities for education through social media.	All.	Already seeing this with reliance on Google Maps for navigating, or phone memories for telephone numbers. Could potentially negatively affect those towards the end of their working life. Self-employed will need social skills to sell their services.

OSH issue	Describe: OSH challenge or opportunity?	Sector(s) of the economy	Comments (new or increasing, who most affected, nature of impacts etc.)
Larger number of artists and other creatives as unemployment increases.	Only the best or best-connected survive; will demand from the well-off be sufficient?	Creative sectors and those that supply them.	
Cuts in publicly-funded OSH research.	Lack of knowledge of new hazards.	All.	Private sector not likely to finance or if they do could introduce bias into conclusions ("fake research").

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: "Smart regulation": requires monitoring and surveillance statistics to be submitted and uses big data, machine learning/AI to harvest data and to analyse them for health and safety outcomes such that regulators can use algorithms to achieve compliance.	Better safety monitoring at lower costs than an inspection regime.	Introduce new regulations on information sharing that specifies who will own worker data, data portability, and how the data can legally be shared with regulators. Needs new AI/IT system, (though lack of money means using something standard).
Challenge: To overcome loss of informal learning and corporate memory, redevelop education system to focus on social skills and "learning to learn".	More flexible workforce able to keep up to date with safety procedures.	Work with educators (some of this is already happening).
Surprising/novel: a) "Power to the Consumer": require consumer to take responsibility for using safe equipment/procedures – insurance invalid otherwise. (Recent law on cleaning agencies does something similar). b) Intellectual Property of the Natural Environment – if people visiting Norway sell the photos they take, they should be taxed.	Better monitoring of safety procedures at no cost to government. Gets value from increasing creative market.	Work with insurers (it is a win-win). PR/publicity campaign probably needed. Difficult – may need AI.

Other ideas included:

- A system where workers could carry credits for safe working from organisation to organisation; the worker owns the data from monitoring systems; link this to online courses and requirements for monitoring algorithms. Should result in better safety at lower cost
- Mandatory "corporate memory" of safety incidents (to address old and new tech issue)
- Basic universal income to address insecurity/flexibility issue (but probably couldn't afford this in Scenario 4)

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

Scenario	Policy	Ranking	Reasons	Implementation
1	Regulation of physical hazards that require lowest risk process to be used, as per existing EU Framework Directive – i.e. the use of automation or robotics if they would remove workers from hazardous environments even if this would be more expensive than using low skilled workers.	+2	It's cheap and will change behaviour. But only followed in our scenario if there is some reward or win-win.	Combine with our insurance idea.
2	Government funded collaborative working spaces designed to foster face to face interaction and informal knowledge sharing.	-2.5	Not feasible in Scenario 4 because of lack of funding and lack of trust.	Could encourage people to do it themselves.
3	Use of variable sickness and accident insurance premiums to drive better behaviour and ownership of risks by workers.	+5	Similar to car insurance with black-box assessment, so very feasible. Cheap.	Could link with smart regulator and our insurance idea encouraging self-employed to conduct risk assessments.

Plenary discussion and conclusions

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 exercises appeared to be well-received and appreciated by the participants, with some commenting that they felt it had given them new insights into how such a process could be used to develop an agenda for action. 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.

A draft of the foresight project summary report 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. Participants were able to engage and work with the scenarios that they had been allocated. Despite some initial reluctance to accept that some of the features described

in some of the scenarios could happen in Norway, all groups were able to follow the guidance to accept the world as described.

All groups appeared to recognise quickly both the challenges and opportunities presented by the scenarios. Despite some aspects of some scenarios being very different to the current nature of work and how it is regulated in Norway, participants continued to be positive and look for ways to address the issues raised. A good number and variety of OSH issues were identified and discussed. The discussions, during Exercise Three, on policies and actions followed quite naturally from the challenges and opportunities identified in Exercise Two.

Some common themes (monitoring, social interaction, skills and expertise) were discussed across all scenarios. However, these were approached from different perspectives depending on the scenario. All groups identified a variety of potential psychosocial issues reflecting the fact that these are high on Norway's agenda at the moment. Other themes were quite different for each scenario, such as the extent and impact of individualisation, polarisation and inequality - including health inequality - which is a function of occupations, income and education and driven by technology and the increased polarisation of jobs in high skill/high income versus low skill/low income.

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 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 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.

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. Four distinctly different policies were 'wind-tunnelled' during the last exercise. None of the policies scored highly in all four scenarios and two 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.

The Transformation scenario was the one that most participants liked and also the one that most participants thought was the most likely to happen. A few participants liked the Evolution scenario and thought it was the one most likely to happen. No participants liked or thought either of the other two scenarios was likely for Norway, but they thought that they were likely in other European countries. This strong bias towards the Transformation and Evolution scenarios of the future suggests that there could, in Norway, be a danger of policy and decision makers not taking a sufficiently wide view of what may happen. This could lead to confirmation bias such that policy and decision makers actively seek for reasons to confirm that their preferred vision of the future will happen but early indications of aspects of the other scenarios becoming likely are missed. The use of scenarios could, therefore, be essential to help policy makers consider different possibilities and not take the economic environment or alignment of public attitudes with those of the government for granted. Moreover, the scenarios could be used to help in the consideration of possible policies that could be implemented now in order to prevent unwanted aspects of any of the scenarios of the future from actually happening. Another way to counteract biases is to include participants who have different views and backgrounds and who would challenge the views of others so that a wider range of possibilities and options are more fully explored.

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.
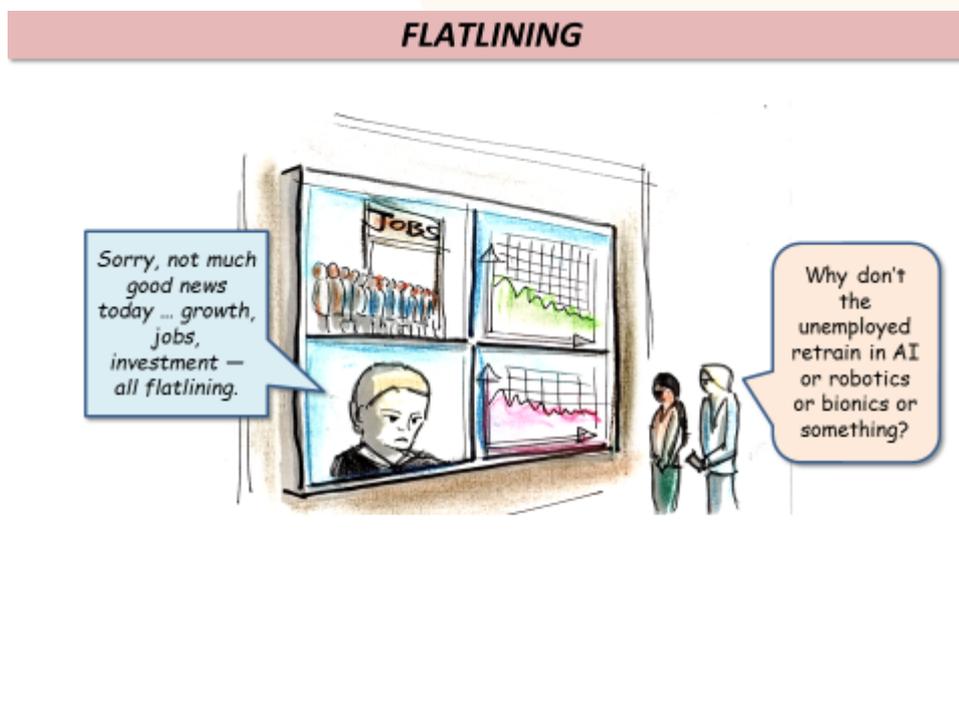
There have been continuing levels of relatively high unemployment and a loss of confidence in the benefits of international trade. In response to popular concerns, Europe seeks to protect its economies through strict trade and migration policies. However, there is global competition for highly skilled 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.
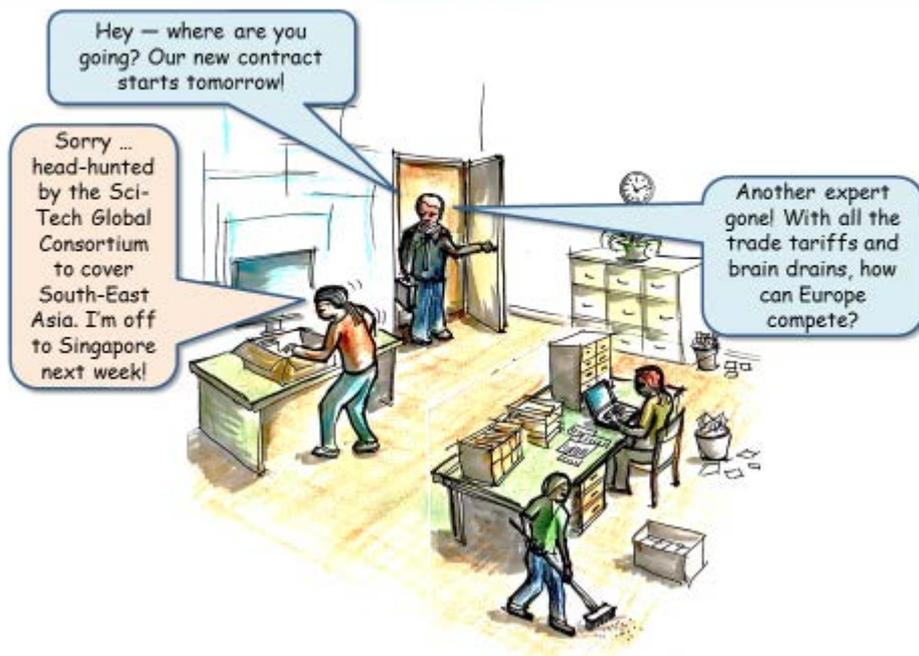
There is a mix of workplace innovation and more traditional work organisation, human resource management and labour relations. In some places, groups of people or local governments have formed their own micro-economic communities of interest and local enterprises. This is patchy, but where it has happened it is a positive response to the problems affecting Europe as a whole, and offers potential examples for others to follow.

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.
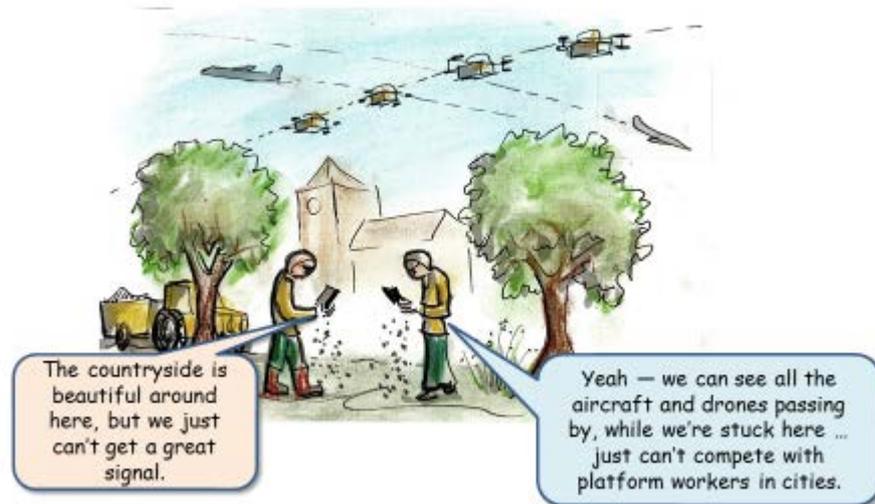
Technological change

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

The countryside is beautiful around here, but we just can't get a great signal.

Yeah — we can see all the aircraft and drones passing by, while we're stuck here ... just can't compete with platform workers in cities.

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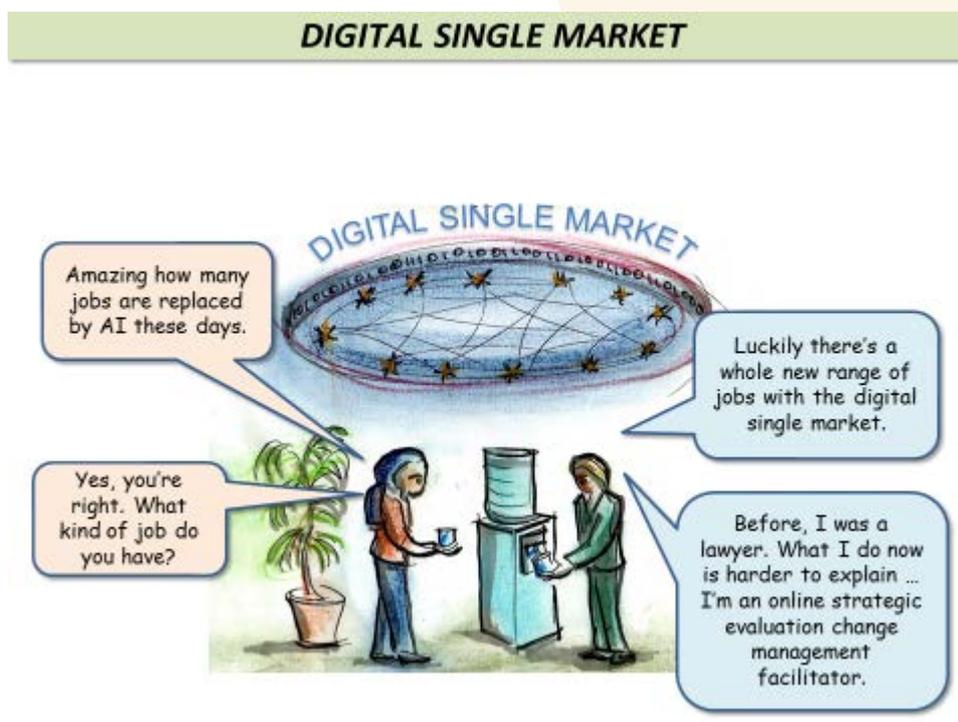
Unemployment remains generally low owing to widespread good-quality skills among workers, innovative job search tools and new jobs replacing lost ones. Workers' disposable income is generally good, with less disparity between most people. This has created high levels of migration into Europe.

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.
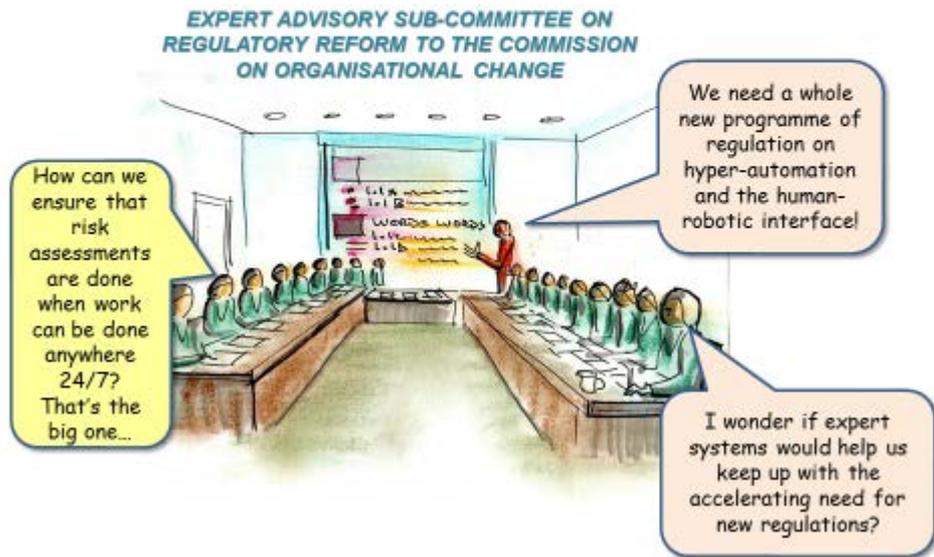

There is an expectation that people will comply with social norms driven (in part) by insurance and employment implications. Most workers are comfortable with this. For those who are not, it has led to a feeling that they have lost their sense of identity, as they are rarely completely free from being 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

EXPERT ADVISORY SUB-COMMITTEE ON REGULATORY REFORM TO THE COMMISSION ON ORGANISATIONAL CHANGE

How can we ensure that risk assessments are done when work can be done anywhere 24/7? That's the big one...

We need a whole new programme of regulation on hyper-automation and the human-robotic interface!

I wonder if expert systems would help us keep up with the accelerating need for new regulations?

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.

CHEMISTRY FOR BEGINNERS

*VR = virtual reality
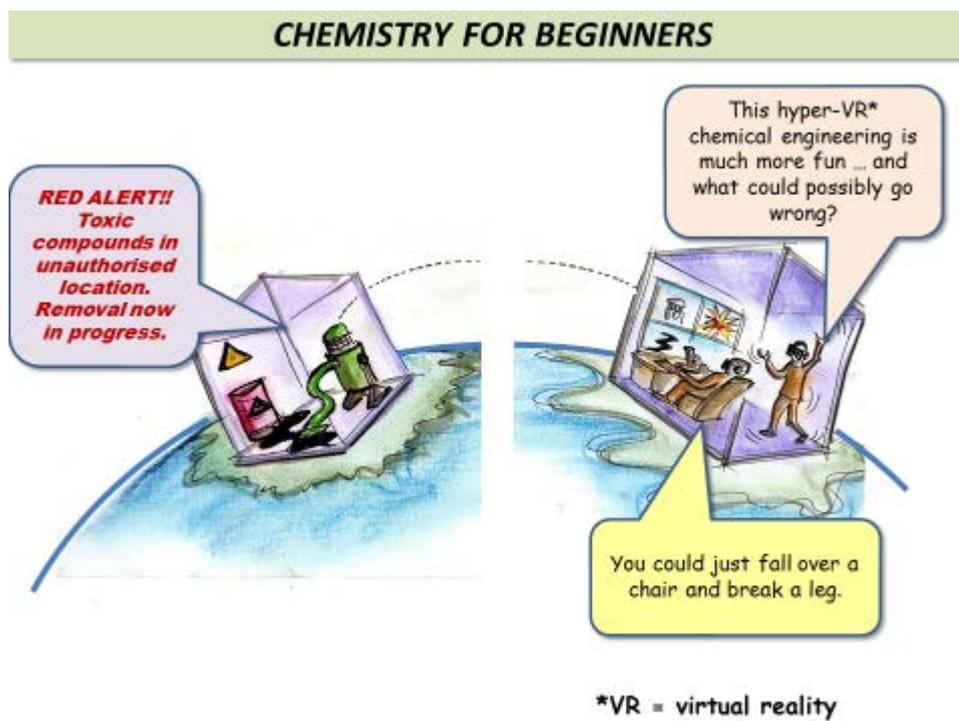
OSH environment

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.
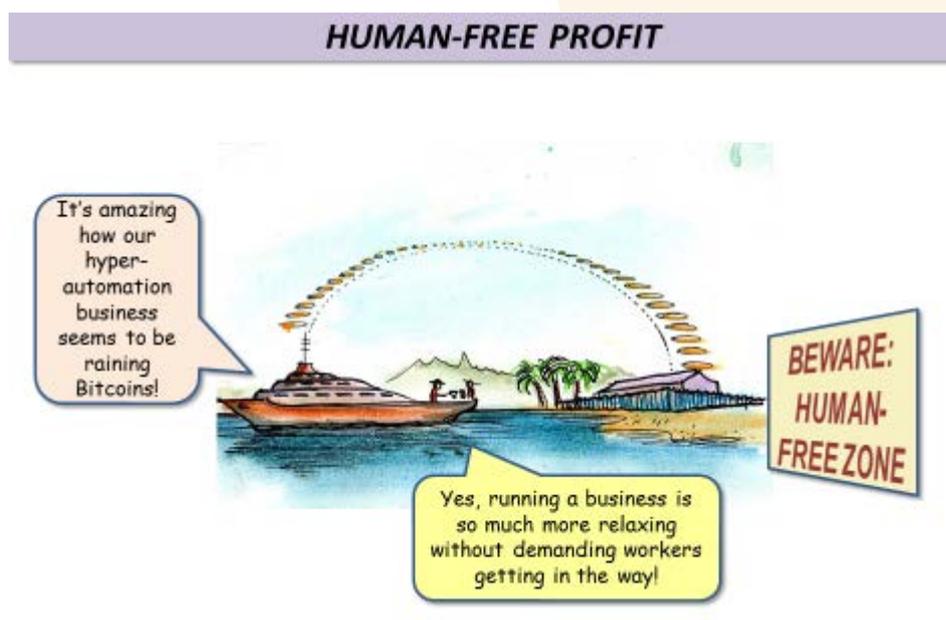
There is a 'digital divide' between the 'haves' (highly skilled individuals who compete for the best jobs) and the 'have-nots' (unemployed or in precarious employment). There has been a decline in public trust and workers' rights, and a lack of government leadership. Those still in work feel threatened 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.


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

PRODUCTIVITY PROBLEMS
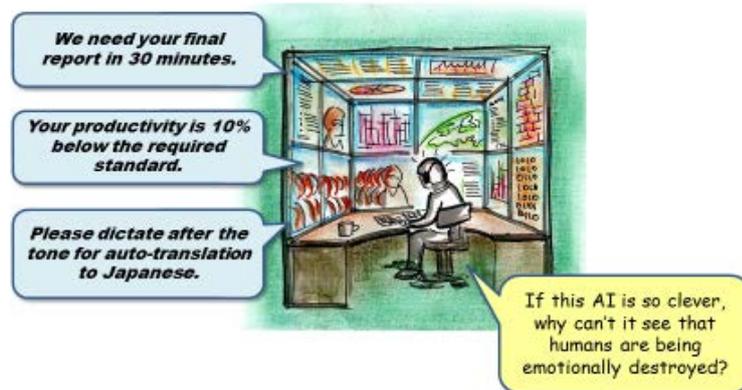
Robots and computer algorithms now carry out the majority of routine and repetitive tasks. Skilled professional jobs have also been significantly affected. Robots commonly work collaboratively with humans and can undertake increasingly complex and powerful tasks. Biomechanical devices, such as exoskeletons, 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
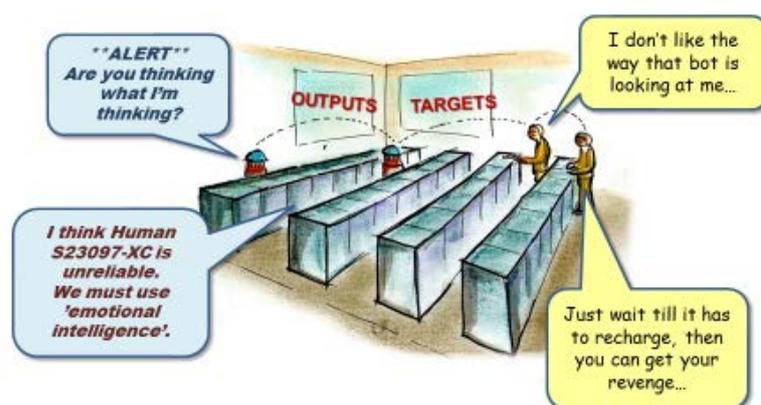
Throughout the decade, cyber-attacks have been increasingly common, because of the lack of a robust, coordinated response to the threat from both governments and businesses. This has resulted in a greater loss of public trust. Infrastructure, power and utilities have all been disrupted by cyber-attacks, 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.

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.
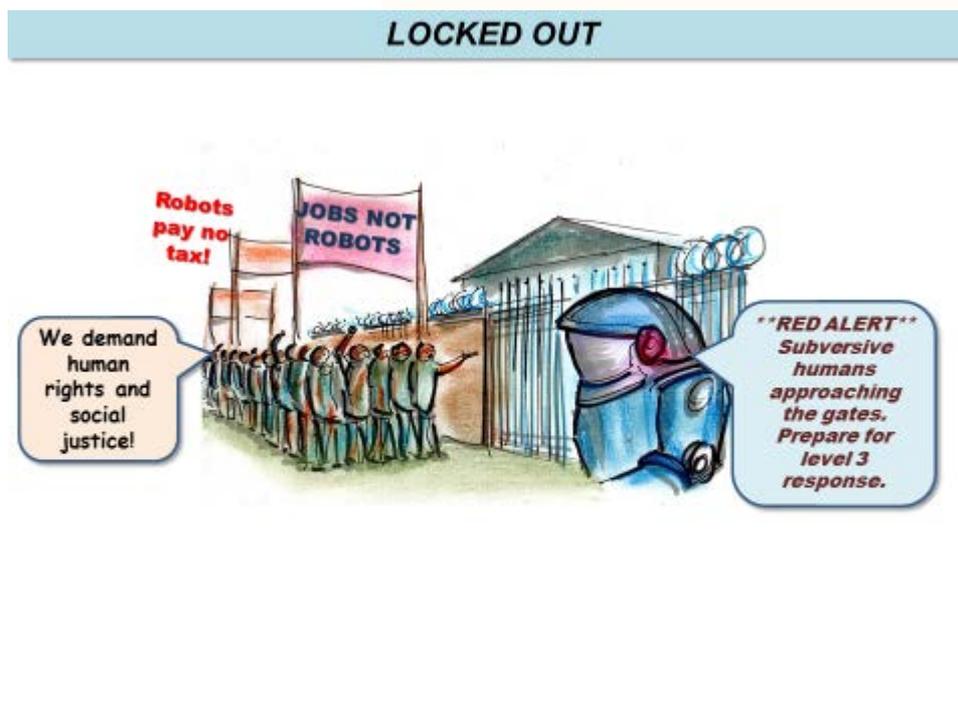
Faith in governments' ability to shape the future has all but vanished and ever fewer people vote or participate in civic society. An 'every person for themselves' attitude prevails, particularly in the formal economy. However, there is still a place for personal contacts and relationships to provide 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.
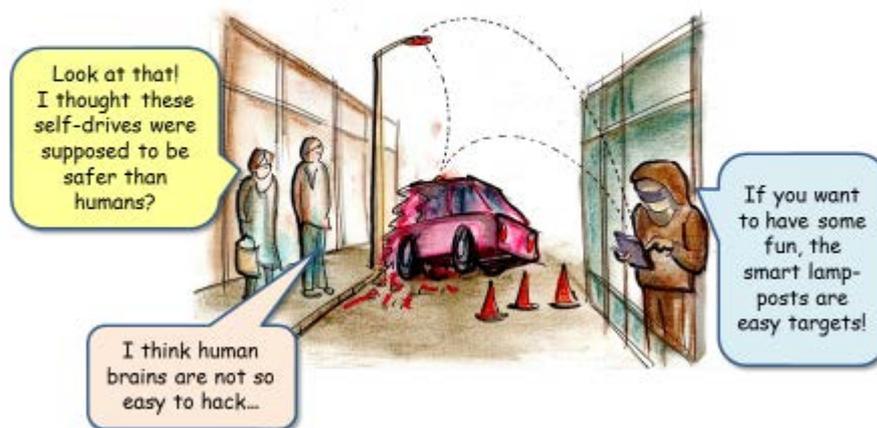
There has been a large increase in online work platforms that provide a wide variety of work, from highly skilled professional work to small, routine tasks. Work is carried out online or offline (but managed online), in varied work locations, and most workers are (pseudo) self-employed. Numerous individuals 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 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 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.
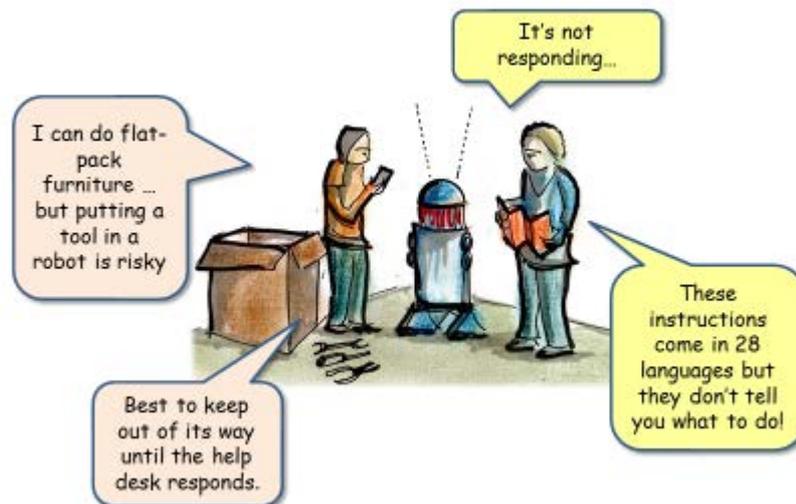
The use of AR and VR has increased for training and to improve productivity. However, there is little new innovation in the underlying technology. The use of these technologies has primarily been to improve the productivity of online platform workers, so instantaneous translation and human interfaces 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.