FORESIGHT ON NEW AND EMERGING OCCUPATIONAL SAFETY AND HEALTH RISKS ASSOCIATED WITH DIGITALISATION BY 2025

Summary of dissemination workshop in Slovenia
September 2018, Ljubljana

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, 2018 a). The workshop was designed for the Republic of Slovenia Ministry of Labour, Family, Social Affairs and Equal Opportunities and delivered to them and various invited stakeholders on 20th September 2018 in Ljubljana. The workshop was delivered by the Health and Safety Laboratory and SAMI Consulting Limited.

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

A connected Digital Single Market (DSM) 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 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, trade unions and employers with information on digitalisation and changes in ICT-ETs, their impact on the nature and location of work, and the emerging challenges to OSH that they may bring. It should help them to:

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

This foresight project was carried out in two distinct work packages. The objective of Work Package One was to identify key trends and contextual drivers of change that could contribute to creating new and emerging OSH risks associated with digitalisation (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 are available on EU-website at: https://osha.europa.eu/en/emerging-risks/developments-ict-and-digitalisation-work .

1   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 will include elements from each of the four scenarios developed during this foresight project, 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.

2   Description of the workshop

The workshop consisted of a blend of presentations, group exercises and plenary discussions over the course of one day. Mrs Katja Rihar Bajuk (Director General, Labour relations and labour rights. Ministry of Labour, Family, Social Affairs and Equal Opportunities) opened the workshop. This was followed by some background information to EU-OSHA's foresight study given by Emmanuelle Brun (EU-OSHA). 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 ICT-ETs 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 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, 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 influence 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. The nature of the plenary discussion and the conclusions that could be drawn from the workshop are included in this summary.

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.

3 Scenario descriptions

Scenario 1 — Evolution

(Low levels of economic growth and technology application / High levels of governance and supportive public/worker´s attitudes)
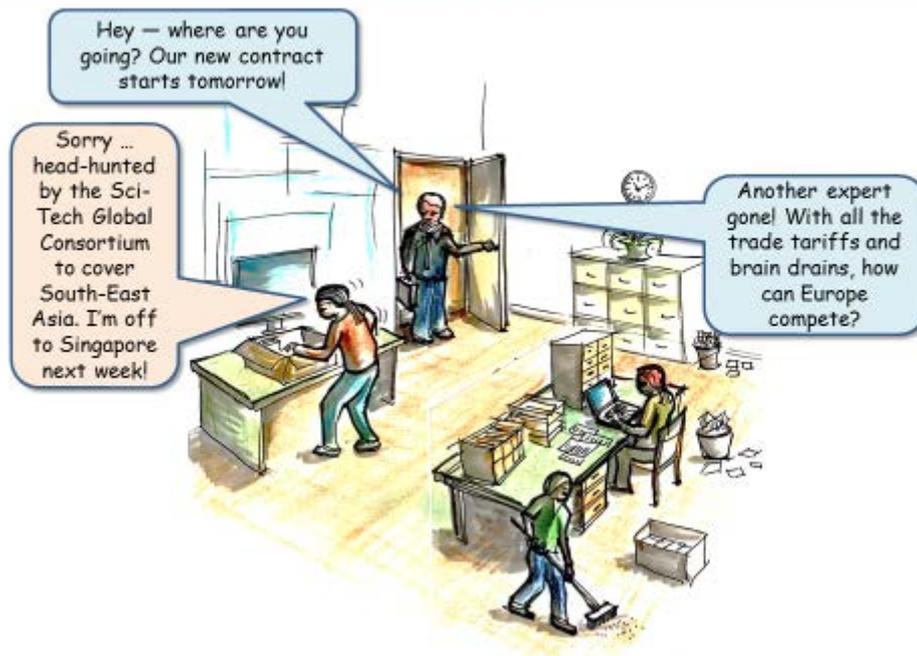
Europe in 2025

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.
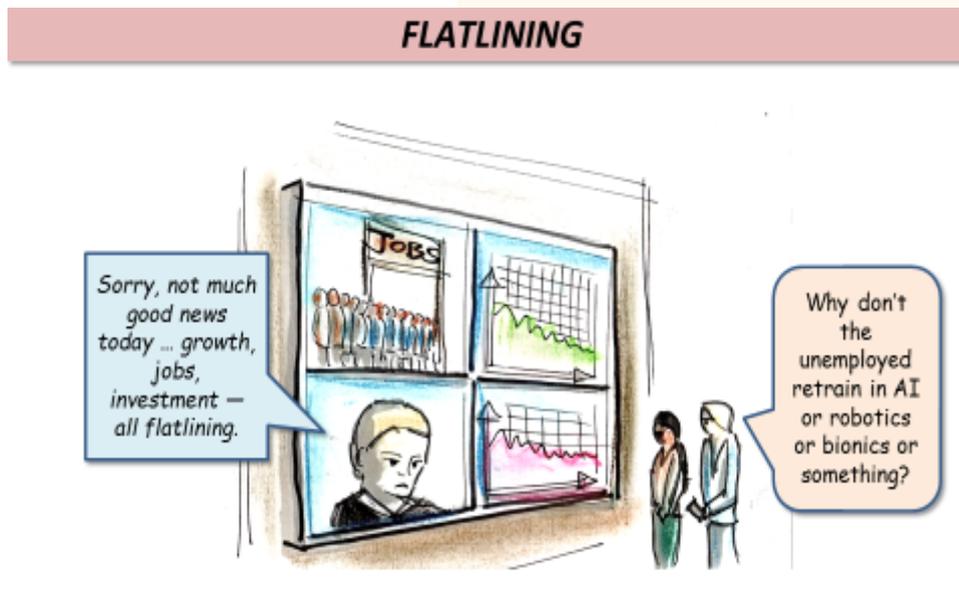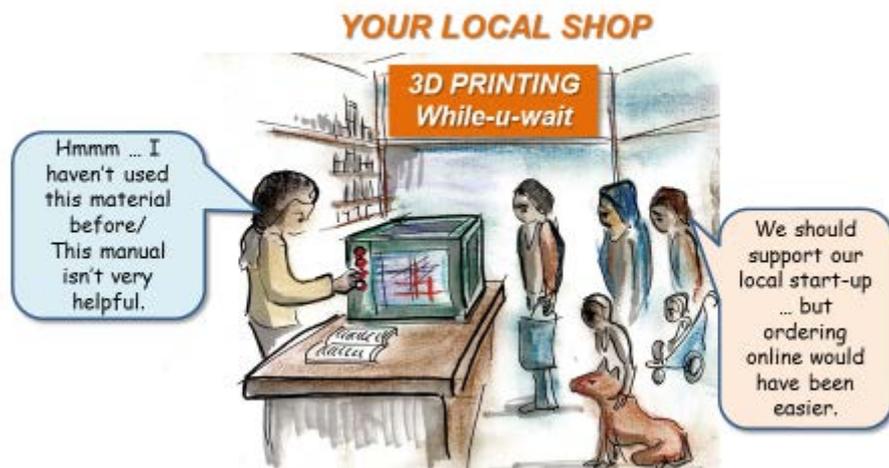

There have been continuing levels of relatively high unemployment and a loss of confidence in the benefits of international trade. In response to popular concerns, Europe seeks to protect its economies through strict trade and migration policies. However, there is global competition for highly skilled 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

Hey — where are you going? Our new contract starts tomorrow!

Sorry ... head-hunted by the Sci-Tech Global Consortium to cover South-East Asia. I'm off to Singapore next week!

Another expert gone! With all the trade tariffs and brain drains, how can Europe compete?

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

YOUR LOCAL SHOP

3D PRINTING
While-u-wait

Hmmm ... I haven't used this material before/ This manual isn't very helpful.

We should support our local start-up ... but ordering online would have been easier.

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.
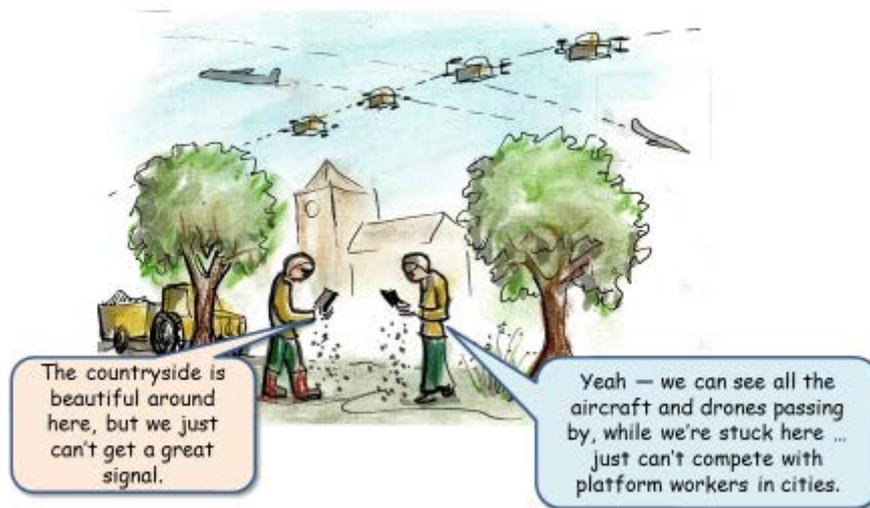
There has been relatively slow development in cutting-edge technologies, such as AI, that drive the Internet of Things (IoT). 'The use of basic AI and voice control interfaces has increased moderately, but more advanced AI and human-machine interfaces (e.g. eye-tracking, gesture and direct brain to computer 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.
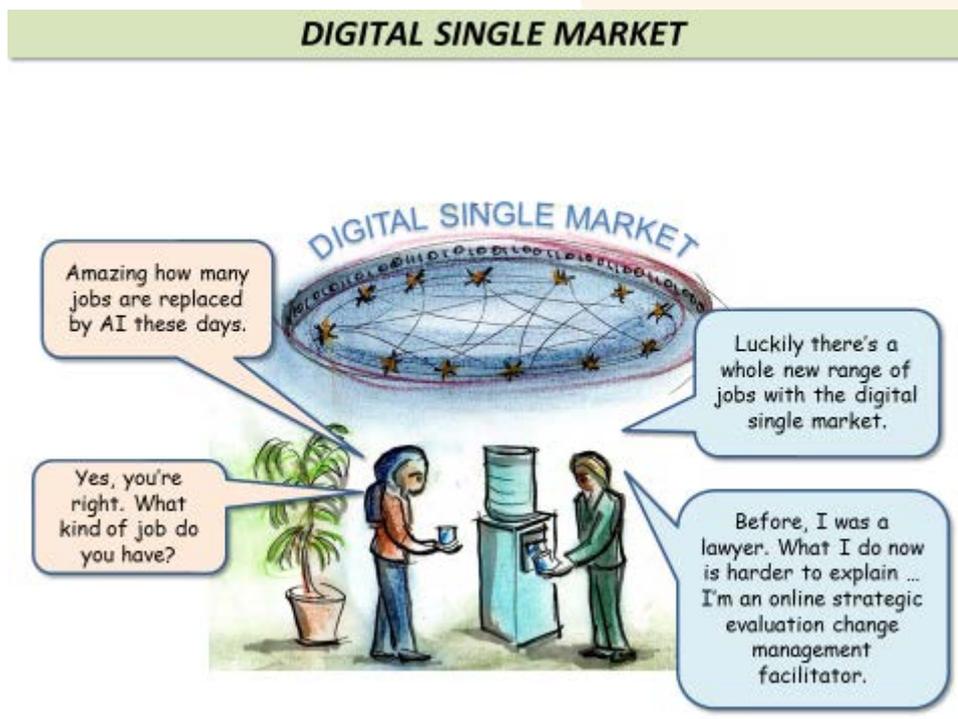
Unemployment remains generally low owing to widespread good-quality skills among workers, innovative job search tools and new jobs replacing lost ones. Workers' disposable income is generally good, with less disparity between most people. This has created high levels of migration into Europe.

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.
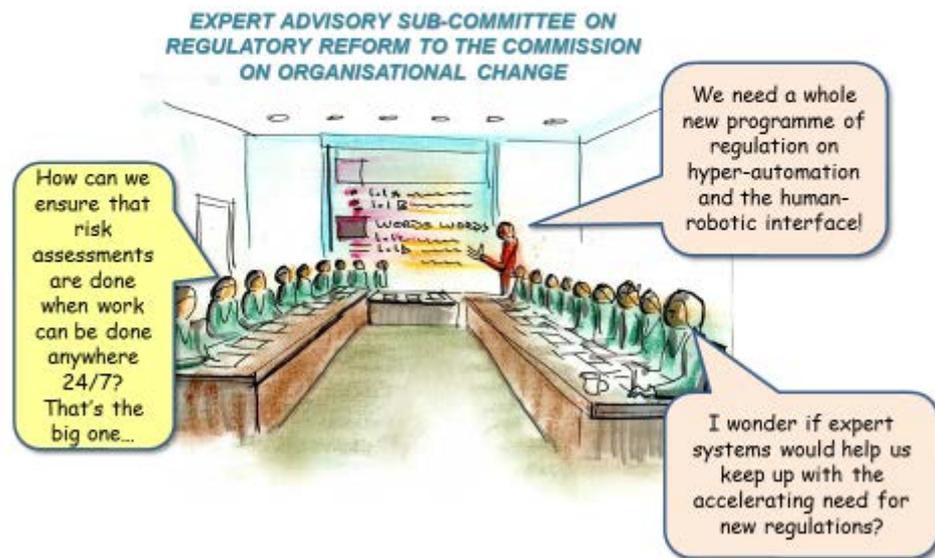

There is an expectation that people will comply with social norms driven (in part) by insurance and employment implications. Most workers are comfortable with this. For those who are not, it has led to a feeling that they have lost their sense of identity, as they are rarely completely free from being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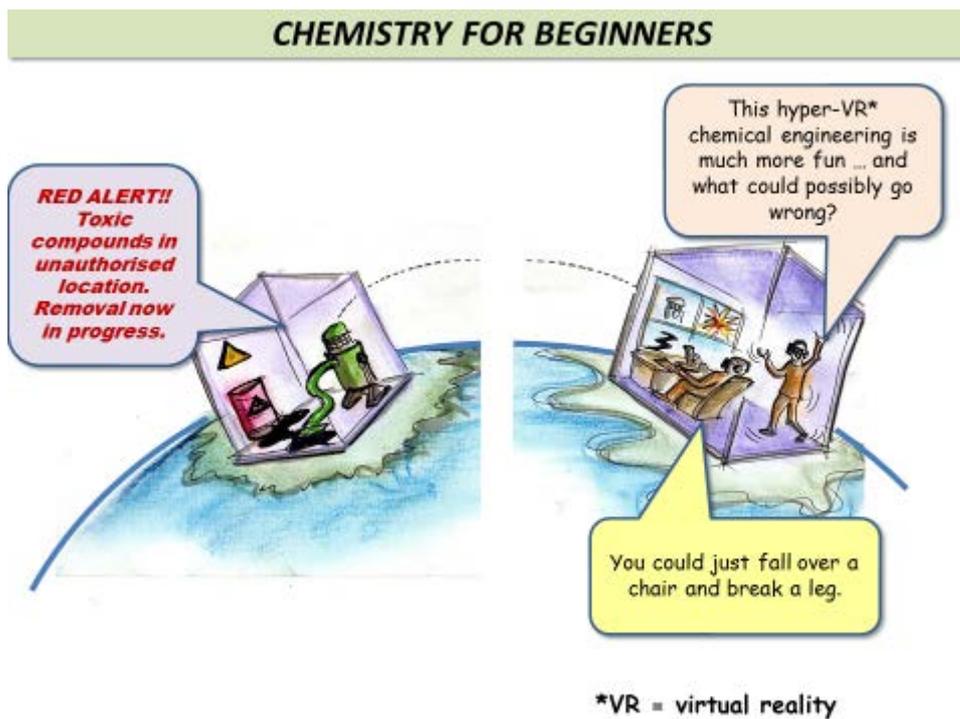
OSH environment

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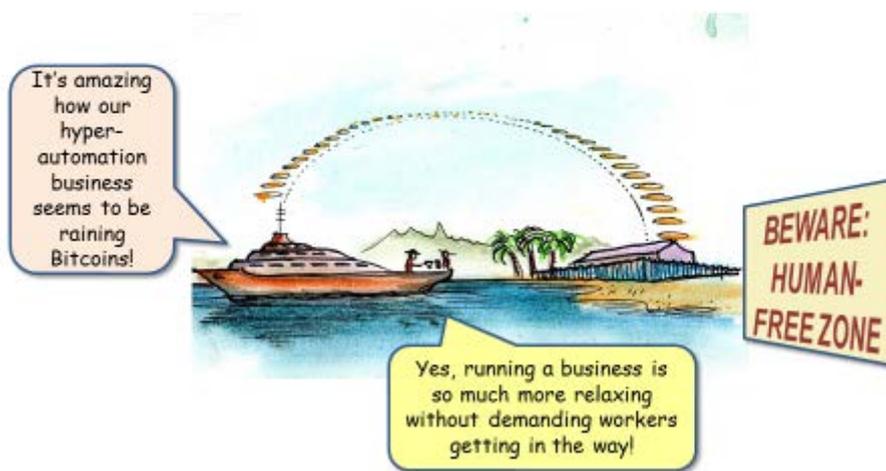
There is a 'digital divide' between the 'haves' (highly skilled individuals who compete for the best jobs) and the 'have-nots' (unemployed or in precarious employment). There has been a decline in public trust and workers' rights, and a lack of government leadership. Those still in work feel threatened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

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


PRODUCTIVITY PROBLEMS
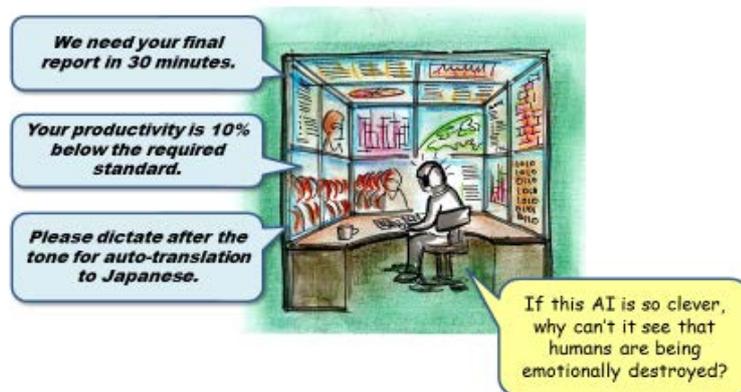
Robots and computer algorithms now carry out the majority of routine and repetitive tasks. Skilled professional jobs have also been significantly affected. Robots commonly work collaboratively with humans and can undertake increasingly complex and powerful tasks. Biomechanical devices, such as exoskeletons, 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).
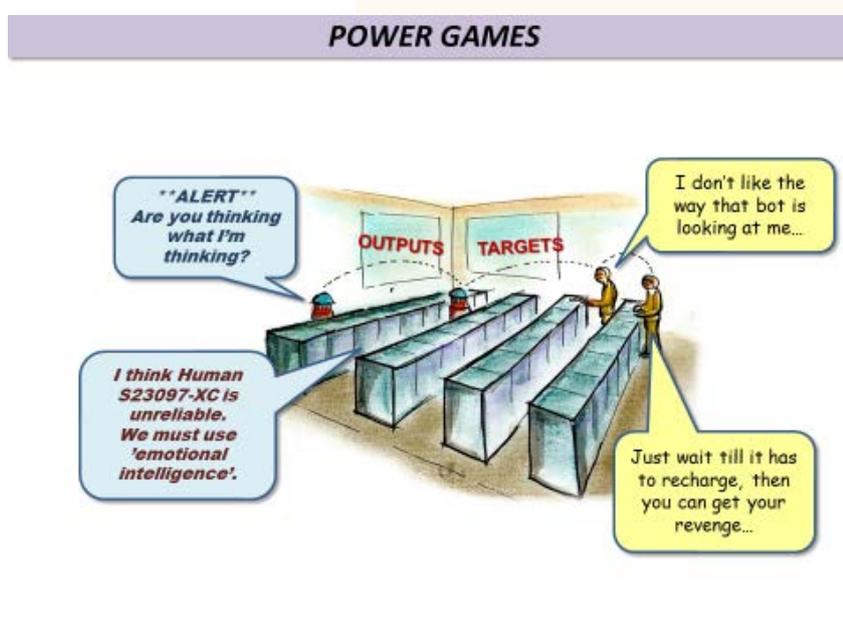
Throughout the decade, cyber-attacks have been increasingly common, because of the lack of a robust, coordinated response to the threat from both governments and businesses. This has resulted in a greater loss of public trust. Infrastructure, power and utilities have all been disrupted by cyber-attacks, 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.
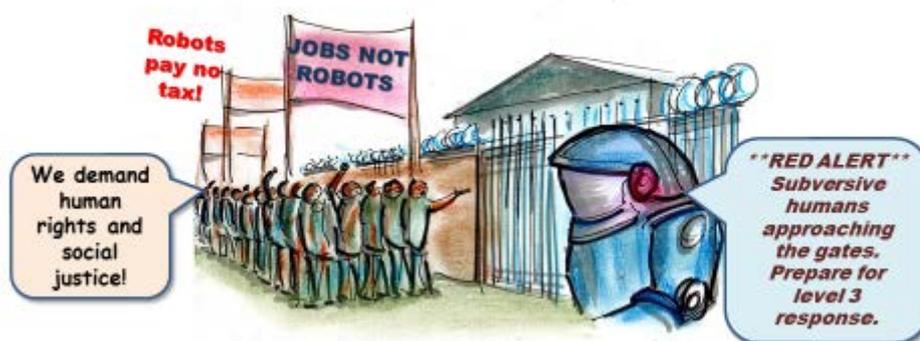
Around 20 % of jobs have been lost during the decade, mainly to the automation of low-skilled, repetitive work. Few new (formal) jobs have been created. Most people change jobs frequently as they are pushed out. New job opportunities tend to be lower paid and short term.

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.

SMART CITY FUN
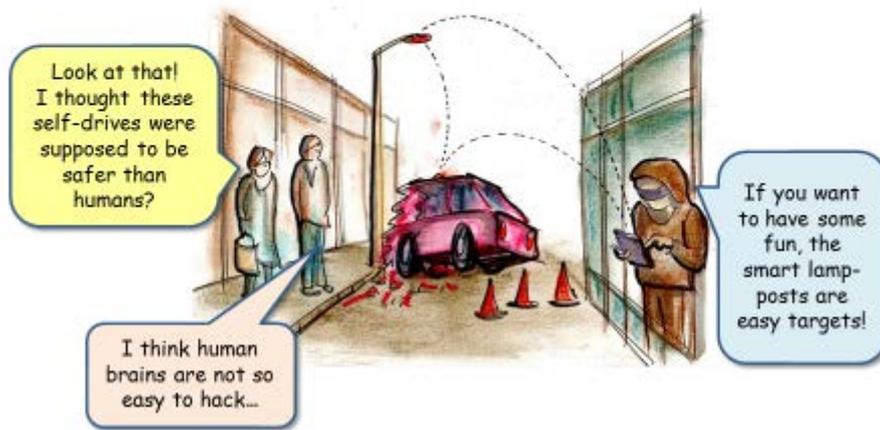
#There has been a large increase in online work platforms that provide a wide variety of work, from highly skilled professional work to small, routine tasks. Work is carried out online or offline (but managed online), in varied work locations, and most workers are (pseudo) self-employed. Numerous individuals 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 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.
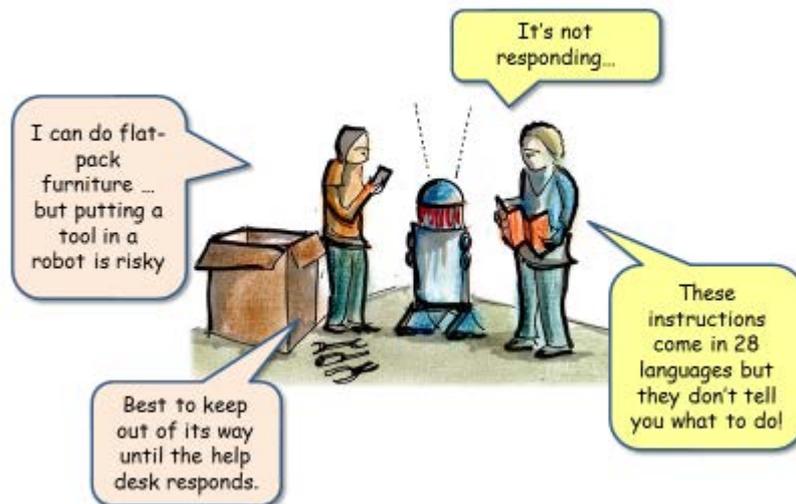
A make-do-and-mend culture, with a mix of old and new assets, creates OSH risks arising from the integration of the new with the old, and at the interfaces between the two. The tendency to run old systems until they break down also increases OSH risks.

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.

4   Results of discussions

4.1   Scenario 1: Evolution

Exercise 1: OSH news headlines in scenario for 2025

Top choice: "New Government Policies for Hybrid Workers".

**NB – hybrid workers are people working for a number of different employers at a time, or part employed and part self-employed

Key points made:

- Government Aims to Win Back Brain Drain Workers.
- Government Incentives for Skilled Migrants.
- Employers Demand Greater Flexibility.

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 among workers.	Challenge	All, but mostly sectors affected by ICT, e.g. service sector.	Increasing numbers of isolated, lone and co-workers. Increasingly blurred lines between work and non-work life.
Regulation of OSH.	Challenge Opportunity	Private sector, especially distributive and administration.	How to raise awareness among isolated, self-employed and hybrid workers. What powers does OSH need to intervene and inspect isolated, self-employed and hybrid workers. Who is responsible? Refocus OSH resources on new, hybrid workers.
Change to the Classical (pre-existing) workforce.	Challenge.	Professional & ICT. Support & Administration.	What is a workforce, when people work from home, or the local coffee bar? How to reach them and interest them in OSH?
More self-employed, dependent, and co-workers.	Challenge Opportunity	Professional & ICT. Support & Administration.	Precariousness of work. Different methods of engagement and conversations about OSH. New jobs may allow greater flexibility and easier reconciliation of work/life balance.

OSH issue	Describe: OSH challenge or opportunity?	Sector(s) of the economy	Comments (new or increasing, who most affected, nature of impacts etc.)
New Ways of Delivering Public Services.	Opportunity	Professional and ICT.	Emergence of local communities of interest sees innovative approaches to delivering integrated local services, encompassing nursing and social care, as well as other services, e.g. repairs & maintenance. Use of block-chain underpins local economy/systems of credit for such services.
Loss of Skills.	Challenge	Professional & ICT.	Slovenia loses skilled people in a "Brain Drain" to Asia/USA, and to other parts of Europe.

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: Development of Local Communities of Interest.	Better OSH – so fewer injuries, less stress & better social inclusion. Better Quality of local services. Promotion of values of social responsibility and community.	Legal Framework needs creating. Incentives – whether financial (this is a low-growth scenario) or other forms of reward and recognition, e.g. honours, medals ceremonies. Support and training to encourage people to participate, maybe some refocusing of benefits system.
Challenge: OSH for hybrid workers.	Protection for vulnerable hybrid workers (some will be happy, but others will be at risk of exploitation and need protection).	Legal Framework (although this will not easily reach the grey economy). Target workers at key times, e.g. when registering as self-employed/filing tax returns. Compulsory OSH, but beware of making it too officious and bureaucratic – which will have the perverse incentive of making people avoid OSH.
Surprising/novel: Integrated Local Services.	Better quality nursing, social care, cleaning, gardening, repairs and maintenance. Healthier, happier people. Satisfied workers.	Government encourages and rewards/recognises. Local communities organise and innovate.

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

SCENARIO	POLICY	RANKING	REASONS	IMPLEMENTATION
2	Tailored education as a pan-Government initiative.	+4	Prevention is good; this would help prepare the workforce we would need; good to spread education through working life.	Low growth in our scenario would mean readjusting existing education funding from current system to this one.
3	Platform owners are required to take out mandatory insurance.	-5	Our scenario lacks a strong economy. This could drive jobs away, making a difficult situation worse. Employers would resist	We would not do this
4	Increase OSH awareness via private sector and civil society.	+5	Low cost option would be worth doing, and fit with our local communities of interest.	Government to encourage and recognise achievement.

4.2 Scenario 2: Transformation

Exercise 1: OSH news headlines in scenario for 2025

Top choice: "Where AI fears to go – boundaries set to limit use of AI".

Key points made:

- Danger that AI will do all the thinking so that we will forget how to.
- Workers are being monitored but not AI.
- Empathy algorithms could give AI too much power/influence with the danger that we will become its 'slaves'.
- Who/what is making decisions and how?
- It is not healthy if the public does not retain some scepticism/ability to challenge those making decisions. People need not only to be allowed to challenge but also be motivated and have the skills and knowledge to do so.
- If routine jobs are all replaced there will be no low skilled labour so there may need to be a universal guaranteed income and also a different system of taxation.
- Life is good but only if there are clear boundaries, you can stay in charge and disconnect when you want to.

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.)
Time management.	Opportunity: to be able to manage own career and work-life balance. Challenge: stress if not able to cope with pace of change	All however likely to particularly affect middle management and those will low self-	Sectors in this scenario will tend to merge into one. Workers will need good interpersonal skills and middle

OSH issue	Describe: OSH challenge or opportunity	Sector(s) of the economy	Comments (new or increasing, who most affected, nature of impacts etc.)
	or get work-life balance right.	management skills.	managers will need good resource management skills.
Worker and workplace diversity.	Opportunity: Better collaborative working including sharing of resources at collaborative workspaces. Challenge: no simple standard solutions for organising work or managing OSH. Loss of low-skilled jobs.	All sectors.	Peer support will be important. Due to high pace of change and longer working life workers will have many different ICT preferences – i.e. the one that existed when they first began to use ICT.
Availability of data and means to analyse it.	Opportunity: Better evidence based decisions. Challenge: who/what owns the data / makes the decisions, knowing too much. Losing ability to think as AI does it all for us so do not know how to fix things if they go wrong or AI preferences do not match ours.	All sectors but particularly the designers of systems and those who operate them.	Important to teach safe sharing of data and ability to cope with lots of information. Need to be clear about when AI should only be allowed to provide advice and when it can make decisions and when it can act on decisions.
Loss of human identity and curiosity.	Challenge: mental health problems, sudden cessation of human driven progress.	All but particularly those who design and use system.	
Workers will become more autonomous and even less easy to reach (hidden).	Opportunity: to provide OSH services directly via self-sufficient working communities or collaborative workspace. Challenge: if workers have many employers and change employers frequently will need new mechanism to fund OSH services.	All	Increasing number of self-employed if they can't access OSH services.
Increasingly sedentary work.	Opportunity: less exposure to hazardous environments and MSDs. Challenge: unfit and unhealthy workforce.	All.	

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: Tailored education and coaching from initial education throughout working life to enable everyone to meet their potential, have the skills to cope with the nature of work/- pace of change and do jobs that they are best suited to.	Better overall wellbeing, less ill-health or stress.	Would need collaboration across different parts of government and input from experts outside of government to develop and deliver. Would need government leadership and societal support. It would be important that it empowered rather than dictated to people. Community activities that support this policy e.g. parenting needed to be recognised in same way as work. Credits for this should be given that could be exchanged for income or other benefits.
Challenge: Loss of individualism and ability to innovate. Clear boundaries need to be set about when AI can make decisions and act upon them.	Mental health problems.	Permission to disconnect and law requiring all AI to have an off button.
Surprising/novel: Collaborative workspaces, whether physical or online required to provide work-life coach and other OSH services to all workers who use those spaces.	Better OSH outcomes in all areas.	Pass a law and enforce it. Due to changing nature of work will also need a new system of taxation to fund enforcement.

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

SCENARIO	POLICY	RANKING	REASONS	IMPLEMENTATION
1	Encourage local communities.	+5	This is in line with the nature of society in this scenario and in this scenario there would be the money to fund such an initiative.	Provide through collaborative workspaces. Give credits for community activities. Incorporate parenting, cultural events, first aid and early education at the same time.
3	Platform owners are required to take out mandatory insurance.	+2	Could undermine culture in our scenario and encourage people to hide accidents. However accidents will still happen so it would be good to protect workers through insurance.	Pass a law and enforce it. Would also need new system of taxation to fund enforcement.

4	Increase OSH awareness via private sector and civil society.	0	Not relevant in this scenario as this is already dealt with in a different way and workers already have access to good quality OSH information, education and training.	Implemented through long life learning support and coaching.

4.3   Scenario 3: Exploitation

Exercise 1: OSH news headlines in scenario for 2025

Top choice: "New 'burnout' pill developed".

Key points made:

- Social conflict threatens economic future.
- Excessive focus on profit, with high level of accident rates.
- Technological divide leading to widespread skill shortages.
- High-stress environment causing worrying levels of individual burnout.

Most of the group felt that this was a realistic scenario; indeed, there was evidence that many of the trends were already apparent.

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.)
Lack of – or inadequate – regulation of e.g. working hours.	Challenge	Most sectors of the economy, where workers are directly employed.	This was a main factor behind the growing stress/burnout among the working population.
No supervision in the face of fast pace of technology.	Challenge	High-technology sectors of the economy.	Leading to increased accident rates. Need to develop new rules to deal with new materials and new dangerous wastes.
Who is the employer?	Challenge	Self-employment; Independent service providers, e.g. telemedicine.	Arises from re-configuration of traditional forms of employment from organisations to more individually-based.
Who takes responsibility for Health and Safety in the world of high automation?	Challenge	Most sectors of the economy, especially the high-tech sectors.	The issue concerns how OSH strives to interact with the forces controlling the world of AI/technology/robots.

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 Big Data	Opportunity to harness technology to help workers and companies to get better results for all sides. Challenge to protect workers from the abuse of personal data of all kinds – e.g. medical, work performance, profiling.	Most sectors of the directly-employed economy.	The growing issue is the challenge to protect workers from abuse of e.g. their DNA profiles. The longer-term opportunity is to achieve more enlightened use of the data to benefit the interests of the wider society.

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: Integrate OSH awareness and knowledge into all levels of education programmes.	Creates a positive, informed and enlightened OSH framework for the future.	It would seem to be a totally reasonable proposal. It would still require endorsement and support from government and the public; therefore, some lobbying and out-reach activities would be a pre-requisite for implementation.
Challenge: Use legal and economic incentives so that platform owners take responsibility for regulatory deficiencies through mandatory insurance on all risks, including emerging risks.	Improves OSH outcomes without additional bureaucratic structures. Gives OSH the opportunity to work with employers and insurance companies for better risk management.	While the proposal has the merit of using the scenario's preference for "free-market" mechanisms, its implementation would require a groundswell of political and legal support .
Surprising/novel: Harness Big Data to programme robots to be OSH aware and to act as Robot Inspectors.	Rigorously-improved outcomes. Would overcome the funding gap that prevents the use of more OSH human inspectors	Implementation must await the development of the assured technology – which will undoubtedly come.

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

SCENARIO	POLICY	RANKING	REASONS	IMPLEMENTATION
1	Encourage local communities.	+3	Fits in with the non-bureaucratic philosophy although still requires some government sponsorship.	Requires some driving forces to stimulate the movement in a scenario of stress and distraction.

SCENARIO	POLICY	RANKING	REASONS	IMPLEMENTATION
2	Tailored education as a pan-government initiative.	+4	Many similarities with a Scenario 3 proposal.	Would be no public funds for large recruitment of new specialist teachers
4	Increase OSH awareness via private sector and civil society.	+5	Consistent with lack of strong government intervention.	Needs an organising to champion, but not necessarily governmental.

4.4   Scenario 4: Fragmentation

Exercise 1: OSH news headlines in scenario for 2025

Top choice: "New IT billionaires create AI systems doing the work of 100's".

Key points made:

- Highest ever rates of suicides, cyber-bullying, unemployment, stress and drug-taking.
- Grey economy creates high levels of tax avoidance.
- Rich own most of the wealth - society polarised.
- Social groups mutually support each other under the radar (online barter economy).
- Brain drain.
- Governments cut jobs and benefits.
- This scenario was entirely possible or even quite likely.

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.)
Remote workplaces, home-working.	Challenge: who is responsible for OSH? Who does risk assessments? Can't inspect people's homes Domestic risk includes cables, electro-magnetic exposure, quality, chemicals (e.g. from 3D printing), stress/social isolation/depression.	Knowledge work; management; all work at ICT terminals. Most sectors to varying extents.	Significant increase from today with lack of control and personal risk.
Sick leave/insurance.	Opportunity: lower premiums if you meet OSH standards (like car insurance approach).	As above.	Verification schemes that work in devolved settings needed.
Skills in safety.	Challenge: informal person-to-person learning is undermined	As above.	

OSH issue	Describe: OSH challenge or opportunity?	Sector(s) of the economy	Comments (new or increasing, who most affected, nature of impacts etc.)
	Opportunity: new online education systems		
Lack of investment	Challenge: Old technology, poorly maintained; poor cyber-security	Manufacturing. Online services.	Significantly increasing, generating a vicious circle with lack of trust in institutions.
Ageing population	Challenge: How to provide working environments that can accommodate older workers; dealing with older people excluded from the workforce; harder for elders to work in multi-tasking workplaces.	ALL	
Innovative ideas on OSH from entrepreneurs	Opportunity: could possibly create new bottom-up approaches to OSH that are more suitable in a devolved environment; lack of central control provides opportunity to invent or choose a better way.	Mainly knowledge workers, but could apply to e.g. scaffolding.	Clearly risks too, but perhaps it could be supported in some way.
Self-help, mutual groups, skills advisors	Opportunity: new market for OSH advice and accreditation; market in education for "how-to" guides; new roles for Trades Unions and civil society.	All.	OSH could be bundled into wider "how to run your business" guides.
Lack of funding for research into OSH.	Challenge	All.	
Accumulation of health problems over time puts pressure on the health system.	Challenge: cost Opportunity: independent clinics, insurance.	All.	Changing role of the state.

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: Utilise civil society.	Bottom-up awareness and personal responsibility for OSH.	Persuade Trades Unions to focus on OSH not just wages and jobs Encourage Consumer groups to include OSH in product/business reviews; rating systems similar to those used on various Internet sites to rate quality of services.
Challenge: Remote working/home-working.	Bottom-up awareness and personal responsibility for OSH.	Awareness raising approaches: - Re-train OSH inspectors as OSH advisors, and send out into community. - private "how-to" services, part of wider "how to run your business"; authenticated by state. - complete OSH-awareness quiz to get lower insurance premiums. - mobilise medics. - provide a library of incidents as educational tool.
Surprising/novel: Educate children from an early age.	Builds OSH into general culture as something good entrepreneurs do naturally.	Difficult, needs to mobilise teachers who are not incentivised to do this.

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

SCENARIO	POLICY	RANKING	REASONS	IMPLEMENTATION
1	Encourage local communities.	+3	We don't have the same trust in government, but this is a cheap policy, similar to ours.	Difficulties in motivation.
2	Tailored education as a pan-government initiative.	+2 (minority view -4)	Education is a good idea, but in Scenario 4 there is no funding or central direction for this.	Mobilising teachers would be necessary which is difficult.
3	Platform owners are required to take out mandatory insurance.	+5	As this just requires issuing an edict, this is easy to do, and though there may be some resistance and enforcement could be an issue, we could get on with it.	Just do it.

5 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 risks 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, particularly the wind-tunnelling which they felt was super. 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.

Participants were, on the whole, able to engage with the scenarios and follow the guidance to accept the world as described in the scenario that they had been allocated. To achieve participants 'living their scenarios', it is important to explain, at the beginning of the workshop and also in the joining instructions, the purpose of scenarios and what to expect during the workshop. In addition it is necessary to allow participants time to become familiar with the scenarios and express their concerns about the issues they raise. Participants had received the four scenarios in English and in Slovenian ahead of the workshop to give them the possibility to read them before the workshop.

The discussions, during exercise three, on policies and actions followed quite naturally from the challenges and opportunities identified in exercise two and the groups engaged well with the exercises. The facilitators felt that there were indications during the discussions of the scenarios stretching participants' thinking and creating new insights and in some cases 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.

There was quite a similarity in overlapping policy proposals among the four groups. Only one proposal was considered to be strongly inappropriate in just one scenario, otherwise the groups tended to support each other's policies. It should be pointed that it is quite an unusual outcome in such a workshop for so many policies to score so highly in all scenarios. This might be due to everyone being from the same country, similar disciplines or a reluctance to challenge one another's ideas, or that, with more time a wider range of policies could have been wind-tunnelled. The wind-tunnelling process is used to facilitate cross scenario consideration of policies and if stakeholders are engaged in this process it can provide a good framework for facilitating a strategic discussion. It is, therefore, important to ensure that sufficient time is allowed at the end of the workshop for this exercise.

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

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.