

Priorities for occupational safety and health research in Europe for the years 2013–2020

Summary report – (updated Jan 2014)

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Foreword

In 2012, the European Agency for Safety and Health at Work (EU-OSHA) prepared a report to define the priorities for occupational safety and health (OSH) research for 2013–2020. The aim was to provide input into the preparation of a possible European Union (EU) OSH strategy and into the EU Research Framework Programme Horizon 2020, as well as to promote OSH research coordination and funding in the EU. The report is an update of the EU-OSHA working paper ‘Priorities for occupational safety and health research in the EU-25’, published in 2005, taking into account the latest developments in scientific knowledge in the field, changes in the world of work and recent trends that have an impact on safety and health at work.

The report’s objective was to identify priorities for OSH research in the coming years in accordance with the Europe 2020 strategy and the Horizon 2020 programme and their priorities and key objectives of ‘smart, sustainable and inclusive growth’ and ‘excellent science — competitive industries — better society’.

The report is structured around four major themes:

- demographic change — sustainable work for healthier and longer working lives;
- globalisation and the changing world of work;
- OSH research for safe new technologies;
- new or increasing occupational exposures to chemical and biological agents.

These themes reflect the global economic, social and technological challenges that the EU is facing and links the reports priorities for OSH research to the targets set by the Europe 2020 strategy

The seminar ‘Moving towards 2020: Priorities for OSH research for the years 2013–2020’ was held on 8–9 October 2013 in Brussels as a follow-up to the report and aimed to validate the findings of the report and to discuss the priorities for OSH research for 2013–2020 in view of the broader challenges Europe is facing. The aim was also to provide a platform for discussing the ways in which to foster OSH research coordination and funding and promote mainstreaming OSH research in other policy areas. The participants of the seminar included research directors and representatives of funding bodies (PEROSH, former NEW OSH ERA Members), representatives from Member States, representatives of the European Commission (DG EMPL, DG SANCO, DG RTD, DG ENTR) and European social partners.

The first day of the seminar was chaired by Ms Maria Teresa Moitinho, Head of Unit, B3 (Health, Safety and Hygiene at Work), DG EMPL, and was mainly dedicated to providing feedback on the report. Directors and research directors of major European OSH research institutes and funding bodies commented on the four thematic areas of the report and the session was followed by a discussion. The first day of the seminar also included a round table discussion moderated by Ms Moitinho.

The second day was chaired by Dr Christa Sedlatschek, Director of EU-OSHA, and it focused on the ways in which to foster OSH research and promote research coordination and mainstreaming OSH research in other research and policy areas. The programme included presentations by representatives of the European Commission, DG RTD, DG SANCO and DG ENTR. The international perspective was provided by Jukka Takala, the Executive Director of Workplace Safety and Health Institute, MOMSC, Singapore. Examples of OSH research cooperation were also presented. The seminar was concluded by Dr Christa Sedlatschek.

This publication contains the executive summary of the EU-OSHA report ‘Priorities for occupational safety and health research in Europe: 2013–2020’; the list of priorities identified in the report; and the main findings of the seminar ‘Moving towards 2020: Priorities for OSH research for the years 2013–2020’ held on 8–9 October 2013 in Brussels. A summary of the seminar and the presentations are available at <https://osha.europa.eu/en/seminars/moving-towards-2020-priorities-for-occupational-safety-and-health-research-for-the-years-2013-20>

Executive summary

1.1 The economic, societal and policy contexts

In June 2010, the European Council adopted the new 10-year Europe 2020 strategy for smart, sustainable and inclusive growth; a strategy for delivering high levels of employment, productivity and growth and, at the same time, social cohesion ⁽¹⁾. The strategy identifies the major challenges that Europe faces: demographic change, globalisation and rising global competition for natural resources, which all put pressure on the environment. The strategy is proposing five measurable EU targets for 2020 that will steer the process, which include targets for employment, research and innovation, climate change and energy, education, and combating poverty. The key goals, set out in the strategy, are reflected in the seven flagship initiatives, the digital agenda and the agenda for new skills and jobs. All EU policies, instruments and legal acts, as well as financial instruments, should be mobilised to pursue the strategy's objectives. The importance of mainstreaming priorities across policies is emphasised in many policy documents. The optimal achievement of objectives in some policy areas — including climate action, environment, consumer policy, health and fundamental rights — depends on the mainstreaming of priorities into a range of instruments in other policy areas ⁽²⁾. These policy goals have a clear relevance for safety and health at work and related research.

Promoting good health is an integral part of the smart and inclusive growth objectives of Europe 2020. Keeping people healthy and active for longer has a positive impact on productivity and competitiveness ⁽³⁾. Thus, safety and health at work and OSH research have a role to play in delivering smart, sustainable and inclusive growth.

Reaching the high-level goals of Horizon 2020 and the overall EU policies for the next decades will depend on the success of new enabler technologies such as those needed for new energy policies, climate adaptation and future manufacturing. However, new technologies will succeed only if the benefits are clearly visible and the potential risks are regarded as acceptable by society. This requires identifying and addressing stakeholder and public expectations and responding to their concerns in order to build trust and confidence and to show that the new technologies are 'well under control' ⁽⁴⁾. This in turn requires identifying and assessing the safety and health risks associated with new technologies and integrating OSH aspects in the development of new technologies and processes, as well as strengthening risk communication and OSH communication.

▪ The economic dimension of occupational safety and health

Work is an economic activity and occupational injury and illness are also matters of economics. Understanding the role of economic factors in the aetiology of workplace ill health and the effects this has on the economic prospects for workers, enterprises and society is crucial for policy development and to support decision-making at enterprise and society levels.

According to the International Labour Organization (ILO), some two million people worldwide die every year from work-related accidents and diseases. An estimated 160 million people suffer from work-related diseases and there are an estimated 270 million fatal and non-fatal work-related accidents per year. The

⁽¹⁾ Europe 2020: A strategy for smart, sustainable and inclusive growth. Available at: <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2010:2020:FIN:EN:PDF>

⁽²⁾ A Budget for Europe 2020 /* COM/2011/0500 final */. Available at: <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2011:0500:FIN:EN:HTML>

⁽³⁾ A Budget for Europe 2020 /* COM/2011/0500 final */. Available at: <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2011:0500:FIN:EN:HTML>

⁽⁴⁾ European Emerging Risk Radar (E2R2) Initiative: 'Matching the technology challenges of 2020' European Parliament/Science and Technology Options. Available at: <http://www.europarl.europa.eu/stoa/cms/cache/offonce/home/events/workshops/integ;jsessionid=4A9AAC6D54988A0292C1192038303A57>

economic cost of these injuries and deaths are colossal at individual, enterprise and societal levels (ILO, 2007)⁽⁵⁾, inhibiting economic growth and affecting the competitiveness of businesses.

Research on the economic dimension of OSH, including an estimation of the socioeconomic costs of the consequences of poor or no OSH and an analysis of the costs and benefits of OSH prevention, is necessary to support evidence-based policies and decision-making at society and enterprise levels.

▪ **Transversal issues**

The impact of OSH research on workers' safety and health will depend on how research findings are translated into practical and accessible workplace solutions. It is paramount that OSH research is focused on the transfer and translation of scientific knowledge into practical and accessible workplace solutions and interventions.

It is widely recognised that there is a lack of good-quality intervention research in OSH. There is an urgent need for studies that evaluate the feasibility, effectiveness, and costs and benefits of interventions in the workplace, in occupational health service settings and at a policy level.

It is equally important to integrate OSH research in the development of new technologies and processes (prevention through design).

Risk communication and OSH communication in general are closely related to the transfer and dissemination of research results. Risk communication is particularly important in the context of new technologies, where there are uncertainties regarding potential risks. There is a need to strengthen *risk communication* research to identify efficient ways of delivering timely and appropriate information on OSH to various target audiences.

In order to find sustainable solutions to complex issues, it is necessary to build bridges between OSH research and other disciplines. In particular, the links between OSH and economic, general health and environmental issues have to be considered. Closely connecting OSH research with these and other relevant fields will help to mainstream OSH, so that it will be considered when important decisions are made at societal and company levels.

▪ **Demographic change — sustainable work for healthier and longer working lives**

The EU's population is becoming older: the number of people aged 60 years and over in the EU is increasing by more than two million every year. The working population is also ageing, as the proportion of older workers in employment is increasing in comparison with the proportion of younger workers. In the 27 Member States of the EU, the 55- to 64-year-old working-age population is expected to increase by about 16 % between 2010 and 2030. Policies that address the ageing of the population and its workforce focus on enabling older workers to remain active and productive for longer.

Given current policy directions, which are focused on preventing premature retirement and prolonging workforce participation, identifying the factors affecting retirement decisions is crucial. Research on the employability of older workers has identified that the low participation of older people in the labour market is the result of a combination of wage conditions, rigidity in workplace organisation, inadequate skills and competencies, and poor health status, rather than the wish to retire early.

It is obvious that prolonging working careers strongly depends on the adaptation of workplaces and the organisation of work. Workplace accommodations are likely to benefit workers of all ages. Several studies acknowledge that more research is needed into how workplaces should be designed and how work should be organised to meet the needs of older workers. Further research is also needed on the effects of specific workplace exposures on the trajectory of normal ageing. Workplace interventions

⁽⁵⁾ ILO (International Labour Organization), GB.300/LILS/10: Project on economic dynamics of international labour standards, 2007. Available at:

http://www.ilo.org/wcmsp5/groups/public/ed_norm/relconf/documents/meetingdocument/wcms_084831.pdf

targeted at older workers, including improving work organisation, training and workplace accommodations, deserve the highest level of attention.

Over the past 10 years, female employment rates have increased throughout Europe (EU-27), from 57.9 % in 2001 to 62.3 % in 2011. As the Europe 2020 strategy envisages a 75 % total employment rate in the EU by 2020, involving more women is seen as one of the major factors in meeting this target. The goal of higher female employment underlines the need to more effectively address the safety and health issues that affect women.

Taking into account the different safety and health risks to which female and male workers are exposed to at work, the different effects of those risks on men and women (in terms of exposure to hazardous substances), the impact of those risks on reproductive health, the physical demands of heavy work, the ergonomic design of workplaces, the length of the working day and domestic duties (ILO, 2009)⁶, a more targeted gender-sensitive approach to research and prevention is needed. It is necessary to integrate the gender aspect into all work-related research topics.

Over the past decade, unprecedented levels of immigration, both from third countries and within the EU-27, have substantially increased the proportion of EU-27 inhabitants who do not live in their native country. As most migrants are relatively young, they contribute to the size of the EU-27 labour force. In the future, the labour force will increasingly include people with a migration background. By 2060, close to one-third of the EU-27 workforce will be of foreign descent. These trends imply that additional efforts are needed to enable immigrants to integrate into their host society and contribute to the labour market by making full use of their potential.

In the coming years, more than has previously been the case, the labour market will be characterised by increasing diversity. As a consequence of the diversification of the labour supply, there is an increasing need to engage with a more demographically diverse workforce (females, migrants, younger and older workers and workers with disabilities). These demographic groups are disproportionately represented in precarious employment arrangements and non-standard working times. There is a lack of information and research on these groups of workers and the jobs they occupy. As the proportion of these groups in the workforce increases, monitoring and research of the changing scale and nature of the risks to which they are exposed is critical.

There is a considerable body of evidence showing that health has strong effects on the participation in the labour market in general and the labour supply of older workers in particular. Ageing leads to an increase in the risk of developing disorders and diseases, and health issues are the most common reason for leaving the workforce before the statutory retirement age. Musculoskeletal disorders (MSDs) and the growing incidence of mental ill health are the primary diagnostic causes for disability retirement. Therefore, it is crucial to organise work and to design workplaces in such a way that the manifestation (or at least the aggravation) of these illnesses can be prevented and more employees are able to work until the regular retirement age.

Although there is growing evidence that, in addition to mechanical load, psychosocial risk factors play a role in the development of MSDs, more research is needed to clarify this influence in the context of multifactorial causation. More high-quality intervention studies are needed to evaluate the effectiveness of interventions that apply a multi-risk approach in order to promote evidence-based practice in the prevention of MSDs.

Although there is evidence that the prevalence of common health problems does increase with age because of the normal and inevitable ageing process, this does not necessarily hinder work performance and is not a valid reason to exclude an individual from the workforce. More research is needed into how workplaces should be designed and work should be organised to meet the needs of people with chronic diseases and health conditions. In addition, modifiable factors and possible interventions need to be identified in order to prevent work disability and unnecessary job loss.

⁶ ILO (International Labour Organization), Providing safe and healthy workplaces for both women and men . 2009. Available at: http://www.ilo.org/wcmsp5/groups/public/@dgreports/@gender/documents/publication/wcms_105060.pdf

Too many workers leave the labour market permanently as a result of health problems or disability, and too few people with reduced work capacity manage to remain in employment. The amount of money spent on disability benefits has become a significant burden on public finances and hinders economic growth, as it reduces the effective labour supply. Although the main factors predicting disability are, to a large extent, known, there is only scattered information available from workplace intervention studies aimed at preventing disability in long-term settings. Irrespective of diagnosis-related issues, further research on the determinants of return-to-work outcomes, based on longitudinal data, is required. This research must take into account more thoroughly the complexity of processes related to the development of long-term sickness absence and disability, as well as successful reintegration after illness.

▪ Globalisation and the changing world of work

In the past, globalisation has often been seen, more or less, as an economic process. Nowadays, it is increasingly perceived as a more comprehensive phenomenon that is shaped by a multitude of factors and events that are quickly changing our society. It has created more opportunities for economic development, but it has also intensified competition and increased economic pressure, resulting in companies restructuring and downsizing and business activities being outsourced and offshored. The consequences for workers include job insecurity and work intensification.

Restructuring — company reorganisation, closures, mergers and acquisitions, downsizing, outsourcing, relocation, etc. — is necessary if companies are to remain competitive. Restructuring is now becoming permanent and tends to occur in all Member States. In operation since 2002, the European Restructuring Monitor (ERM) recorded over 14,000 cases of large-scale individual company or organisation restructuring from 2002 to mid-2012 (Eurofound, 2012)⁷.

Before the global economic crisis, restructuring had already become a permanent structural component of the economy. In this difficult context of the economic crisis, anticipating, managing, limiting and cushioning job losses, however they are caused (from mass redundancies following the closure of large companies to sporadic lay-offs in small and medium-sized enterprises (SMEs) and the termination of contracts of casual workers), is increasingly challenging. The issue of restructuring has been placed at the top of the political agenda of governments and social partners in the EU since the economic crisis began.

Data relating to health and restructuring are lacking and fragmented at both national and European levels. Collecting and evaluating data on workers' health in restructuring processes, including in SMEs, is important for assessing the real-life situation and planning future activities in this area.

There is empirical evidence of the negative health impact of restructuring both on the direct victims, that is those who lose their jobs, and on the survivors of restructuring. Given the evidence of the potentially negative health effects of restructuring, occupational health services should promote prevention and workplace health intervention before, during and after restructuring.

Increased competition, economic pressure and restructuring owing to globalisation, the rapid spread of information and communication technology (ICT) and the Internet and the shift from manufacturing to services have all affected the world of work. Employment and working patterns have undergone significant change, resulting in increased exposure of workers to psychosocial hazards. In the context of organisational changes, and of restructuring in particular, job insecurity and work intensification appear to be major OSH risk factors.

Globalisation and increasing competition have had a large impact on production methods and work organisation, resulting in a gradual transition from relatively standardised work organisation and working time patterns to more complex and diversified structures. Since the early 2000s, the number of workers employed under atypical arrangements (fixed-term contracts, self-employed, temporary agency workers) has risen significantly, while there has been a relaxation of legislation governing dismissal in various

⁽⁷⁾ Eurofound, ERM report 2012 - After restructuring: Labour markets, working conditions and life satisfaction Publications Office of the European Union, Luxembourg. Available at: <http://www.eurofound.europa.eu/pubdocs/2012/61/en/1/EF1261EN.pdf>

countries. Studies on the OSH effects of precarious employment found there is a negative association with OSH; it was also found that the higher the instability of employment, the more it is associated with morbidity or mortality.

Globalisation is closely linked to the development of new technologies, in particular of ICT. The rapid spread of ICT and the Internet is changing the way in which companies organise production and is also modifying working conditions and work organisation. ICT has contributed to the development of the 24/7 economy, which requires flexible work organisation, high flexibility in working hours and quasi-continuing availability. The growing use of computers and automated systems at work has also led to an increase in fixed body postures and physical inactivity at work. Physical inactivity is associated with increased health risks such as coronary heart disease, certain types of cancers and psychological disorders such as depression and anxiety.

Structural, organisational and technological changes in the work environment increase the pressure on work–life balance. Sources of pressure include factors such as advances in ICT, information load, the need for speed in response, the importance attached to the quality of customer service and its implications for constant availability, and the pace of change. Research is needed on the impact of new working patterns, different types of flexibility and the implementation of new technologies (e.g. mobile ICT-supported work) on work–life balance and on health and well-being at work.

The ongoing shift towards a service- and knowledge-based economy underlines the importance of the services sector. This sector provides an increasing number of high-skilled jobs, for example in ICT and marketing, but also provides an increasing number of low-skilled and low-wage jobs, often characterised by non-standard working conditions and unsociable working hours. Particularly in the education and health and social sectors, employee's experience distressing working conditions with high emotional load and may be exposed to violence and harassment at work. The potential health hazards in the services sector include growing psychosocial pressures to increased availability demand and frequent and new human contact. It is likely that this phenomenon will become more important as the services sector continues to grow.

Those affected by violence and harassment in the workplace tend to report higher levels of work-related ill health. Victims of violence and harassment experience, among other problems, depression, anxiety, nervousness, sleeping problems and concentration difficulties. Organisational consequences include absenteeism, accidents and impaired performance. Commonly accepted definitions and classifications, as well as systematic strategies, are needed to better assess the prevalence of work-related violence at the European level. There is a lack of intervention evaluation research in relation to harassment and violence at work; therefore, too little is known about the most effective measures of preventing harassment and violence at different levels.

Psychosocial and organisational risk factors such as high workloads, tight deadlines, long and/or non-standard working times (shift work, night work), precarious or isolated work — whether or not these factors are combined — are likely to contribute to the development of certain chronic disorders and diseases. The nature of many of the complex interactions between work-related psychosocial risk factors, risk behaviours and chronic diseases and health conditions, including occupational diseases and disorders, is not well studied or understood. A better understanding of the links between work-related psychosocial risk factors and morbidity and mortality is needed for the development of evidence-based policies and effective prevention strategies.

Traditionally, occupational health psychology has focused on risk factors in the workplace and their adverse health effects. The vast majority of intervention research concerns the detection and management of occupational health problems, rather than the reinforcement of positive aspects of work. The mechanisms that underlie employee ill health and malfunctioning, however, are not the same as those that constitute employee health and optimal functioning. Positive occupational health psychology advocates an integrated approach that balances positive and negative aspects of work and well-being. This positive approach in occupational health psychology research needs to be strengthened.

As new technologies and globalisation reduce the importance of economies of scale in many activities, and larger firms downsize and outsource more functions, the weight of SMEs in the economy is

increasing. In 2008, two-thirds of the EU-27's non-financial business economy workforce was active in an SME.

The potential of small enterprises has been recognised and it is appreciated that employment and economic growth to a large extent depend on these enterprises. Both political and scientific interests in OSH in small enterprises have, therefore, grown considerably during the last decade.

In terms of OSH, small businesses present a challenge: they are difficult to regulate, as they are typically heterogeneous, geographically scattered, lack cohesive representation and have a short life cycle. The need to focus OSH research on small businesses is now recognised, but effective mechanisms to reach, assist and impact these companies continue to be a challenge. To date, most OSH research and interventions have been primarily focused on large companies.

In order to develop effective OSH strategies and policies targeted at small businesses, it is important to understand their organisational and cultural realities and to know their specific needs and motivations. Moreover, knowledge is needed on the specific success and obstacle factors in the different stages of the enterprise life cycle, on the one hand, and during different economic cycles (growth, recession), on the other.

The quality of research on small and micro-enterprises needs to be improved. Innovative support schemes adapted to the realities and needs of small and micro-enterprises need to be developed, implemented and evaluated.

▪ **Occupational safety and health and new technologies**

OSH research has a key role to play in contributing to the development of safe, new technologies. A global shift towards a greener and more sustainable economy results in the development of new technologies and processes. As with any new and developing technology, workers in 'green jobs' will also be exposed to new hazards, which probably have not been previously identified. These 'green' challenges can be met only by developing safe working processes together with workplaces that fully exploit new processes and technologies. In addition to new hazards, workers in green jobs are also exposed to traditional OSH hazards in new settings and conditions; the challenge is how to deal with this exposure to a combination of old risks within new settings and conditions. Means by which to transfer existing knowledge to new applications and working environments need to be identified. Furthermore, the current rate of expansion in green jobs will also lead to a skills gap and a reliance on a large number of inexperienced and/or under skilled workers who will be handling and interacting with new or unfamiliar technologies.

The need to decrease greenhouse gas emissions by 2020 has contributed to the development of renewable energy technologies such as wind, solar and waste-to-energy applications. These new technologies are needed to be able to move towards a greener economy; however, their implementation brings about occupational exposure to biological agents, chemicals and new materials, generating potential health risks that have to be assessed and managed.

The need to resolve environmental protection issues has encouraged and developed the industrialisation of waste treatment and large-scale waste disposal systems such as incineration and recycling. As raw materials such as rare elements are becoming scarcer and more valuable, their recovery and recycling by landfill mining may become economically viable. Waste management and recycling is one of the fastest growing green economy sectors in terms of employment. However, the OSH issues associated with them have not yet been adequately addressed. Workers are exposed to injuries, biological agents that are able to provoke infections, allergies or toxicity and dangerous chemicals (e.g. heavy metals, flame retardants, rare earth elements or nanomaterials) present especially in waste electrical and electronic equipment or associated with their treatment. The health risks related to these activities need to be identified, assessed and brought under control.

The implementation of ICT has the potential to change the nature of how work is carried out and to affect the working environment. However, it is these ICT-related changes in the world of work, rather than the technology itself, that bring about not only great opportunities, but also a certain number of safety and health risks.

Ambient intelligence (AMI) refers to the extension of the working or living environment with intelligent functions that adapt to the needs and tasks of the user. AMI-based working assistance systems include head-mounted devices equipped with information displays and other vision-based or tactile systems. The possibilities of using AMI solutions for creating tailored support systems to adjust workplaces to the changing abilities of older people or to the needs of people with disabilities need to be explored.

The rapid development of ICT has enabled the development of flexible work forms and virtualisation of the working environment (virtual offices, teleworking), which can contribute to well-being at work. On the other hand, certain OSH risks related to ICT-supported work, including mental workload, permanent accessibility and human–computer interactions, have increased. Research is needed to find prevention solutions to these issues. Furthermore, usage and usability of ICT should be studied to also take into account the specific needs of, for example, migrant workers or older and disabled workers. Research in cognitive ergonomics concerned with mental processes is necessary to ensure that OSH aspects are effectively integrated into the development of new technology applications.

Intelligent but complex new technology applications are increasingly used in the workplace. Safety and health aspects should be taken into account as early as possible during their development. Moreover, it should be noted that risks can emerge not only when these devices are used, but also throughout their entire life cycle. It is therefore important to consider in advance not only the environmental but also the potential occupational hazards related to these applications, from research and development to disposal and recycling (prevention through design). New modelling and simulation methods can be advantageously used for these purposes. Virtual and augmented reality applications are particularly useful when designing safe workplaces and should be further developed.

Smart and interactive materials have the potential to improve OSH. New high-performance materials based on, for example, nanotechnology applications may be used to improve the safety and performance of working clothes, personal protective equipment and so on. Moreover, new adaptive/wearable sensors monitoring workers' physiological parameters and environmental conditions can be integrated to give online information that helps in decision-making in difficult working environments. Their efficacy and functionality in prevention applications should be evaluated, particularly with regards to new hazards and changes in the working environment.

Use of new technologies brings about varied and potentially increasing risks regarding exposure to electromagnetic fields (EMFs). Although most sources emitting EMFs can be considered harmless, some types of appliances, such as magnetic resonance imaging scanners and transmitting antennae, may expose workers to acute risks such as induced currents and elevated temperature. Owing to the extensive use of wireless communication devices, there has been growing concern over the possibility of adverse impacts on health, including carcinogenic effects, resulting from exposure to radiofrequency EMFs. The potential adverse health effects of long-term EMF exposure have not been established, as the results of research so far are contradictory and warrant further study. In order to evaluate the long-term effects of exposure to EMFs, there is a need to conduct a systematic evaluation of the number of workers exposed to EMFs and a characterisation of emitting sources. Furthermore, tools are needed for workplaces to assess the risks to particular groups of workers, such as persons with medical implants and pregnant women, as required in the EMF directive.

The number of applications generating intermediate-frequency fields is increasing as a result of increasing use of devices emitting in the range of 300 Hz to 100 kHz, examples of which include radiofrequency identification devices and anti-theft devices operated in shops. Knowledge on their possible health effects is limited and they should be studied further. There is also a need to conduct research in order to evaluate the possible health effects of new frequencies, such as in the terahertz region, the utilisation of which is currently being developed for emerging applications.

Industrial biotechnology enables the development of promising energy-efficient, sustainable processes for producing food, chemicals and pharmaceuticals. These processes have the advantage of relying principally on low-energy atmospheric pressure systems and they use far fewer synthetic chemicals as raw materials than the equivalent chemical processes. The corresponding risks may therefore be diminished. The unknown OSH issues in industrial biotechnology are primarily related to exposure to biological agents (micro-organisms and their components), which can be harmful to workers' health, provoking, for example, infections or allergies.

▪ **Increasing occupational exposure to chemical and biological agents**

Innovations necessary to improve productivity and regain competitiveness according to the Europe 2020 strategy are likely to result in new challenges for OSH: new or increased exposure to biological and chemical agents, as well as mixed exposures. The burden of ill health at work is already heavy: 23 million people in the EU reported a work-related health problem in 2007. The majority of work-related fatalities are attributed to work-related diseases, almost half of which are the result of exposures to hazardous substances at work. European statistics show that the number of fatal occupational accidents is decreasing, whereas the number of fatalities due to occupational diseases is increasing. Moreover, a growing number of allergies, asthma and illnesses related to sensitisation have been observed in workplaces. Their onset is associated with exposure to chemicals and biological agents present in the working environment.

Related to this trend, the use and safety of chemicals is becoming more challenging. The EU REACH regulation (EC 109/2006) intends to respond to this development: its registration process requires the industry to prove the safe use of chemicals. A revision is currently under way, which aims to extend the REACH legislation to cover the risks of exposure to carcinogenic, mutagenic, reprotoxic (CMR) and sensitising substances. Exposure to these substances is not limited to the chemical industry; it also concerns waste management and recycling, as well as the development of 'greener' industrial products and processes.

Occupational cancers are one of the major causes of work-related fatalities. However, many are considered avoidable. A lack of exposure data is a shortcoming in connection with not only carcinogens but also substances that have mutagenic and reprotoxic effects, such as endocrine disruptors (EDCs). According to a recent study requested by the European Parliament's Committee on Employment and Social Affairs, 'the absence of adequate exposure data is the weakest link' in connection with EDCs. The report underlines that 'prevention very much depends on uncertainties about the effects of EDCs', whereas there is a lack of exposure data which could determine 'whether the observed health effects in humans are linked to EDCs'. The extent of exposure to CMR substances should be determined to gain a better knowledge of the factors leading to occupational cancers; comprehensive international data need to be collected. In parallel, biological monitoring of workers should be further developed, as this will provide information on the internal dose, as well as the toxic effects and individual susceptibility. A further fostering of biomonitoring will necessitate the development of appropriate biomarkers.

The substitution of hazardous substances with non-hazardous ones is preferred to minimise exposure. This is not always possible and therefore quantitative data on the potency of CMR and sensitising substances are needed, as well as improved and harmonised risk quantification methods.

The number of substances (e.g. epoxy resins or isocyanates) that are predicted to have sensitising effects and cause allergies is continually increasing. Currently, 20 % of the general population is sensitised to one or more substances. Allergic diseases have the potential to become chronic and reduce a person's ability to work. In order to minimise the risks associated with dealing with sensitising substances and to establish safe working routines, a more refined allergenic potency ranking needs to be developed for these substances. For those sensitising substances that cannot be substituted, reliable toxicological thresholds at which a sensitising effect is produced should be established. This would help to design more efficient prevention measures. Another current concern is the increasing sensitivity of the human body; factors leading to this should be identified.

The development of reliable measurement methods is the first step towards reducing workplace exposure to CMRs and sensitising substances. As these substances can be harmful at extremely low concentrations, analytical methods should be further refined to be able to reliably detect and quantify trace amounts.

Nanomaterials possess unique chemical, physical and mechanical properties, and therefore are used in a variety of applications in different industrial sectors, ranging from food and feed to transport. New sophisticated multicomponent or hybrid materials are being designed at an accelerated pace. Developing these innovative materials is an important driver for European competitiveness, but an increased use of nanomaterials also means that an increasing number of workers are potentially

exposed at every stage of the materials life cycle, from research and development through production to disposal and waste treatment. The knowledge gap between the technological progress and nanosafety research is estimated to be 20 years, and it is likely to expand. This means that knowledge on new-generation nanomaterials in the work environment has to be rapidly increased. New toxicity testing methods and risk prediction tools have to be developed to be able to consider safety aspects from the product development phase onwards (safety by design).

Risk management of nanomaterials requires exposure assessment data, which in turn calls for standardised measurement methods to quantify and qualify (i.e. characterise chemically and physically) the nanoparticles present in the working environment. It is crucial to develop such methods to facilitate the development of risk management tools. To be able to compare measurement data globally, internationally harmonised measurement strategies should also be established.

There is evidence that some nanoscale particles are toxic, with their toxicity inversely proportional to their diameter. However, decisive scientific knowledge is still lacking. In this situation, a precautionary approach should be applied, and pragmatic, easy-to-apply exposure assessment methods need to be developed in order to estimate the related risks. Appropriate risk management approaches could then be created so that workplaces could be designed to be as safe as possible. The final aim would be to validate and implement harmonised risk assessment and management at an international level.

Data on workplace exposure to nanomaterials are needed to develop exposure scenarios and models. As the measurement of nanoparticles is difficult and expensive, it is necessary to further develop information databases that could give a realistic overview of the occurrence of nanomaterials in the workplace and of the workforce exposed to them.

A parallel complementary approach would be to develop and promote 'responsible' nanotechnology, integrating safety and health considerations.

The progression of a greener and more resource-efficient economy may result in an increased exposure to *biological agents* (micro-organisms that may be able to provoke infection, allergy or toxicity). At the same time, globalisation, that is international trade and traffic, fosters the worldwide spread of old and new pathogens. The occupational health effects attributable to biological agents range from sensitising effects and allergic reactions to acute and chronic disease. They are still far from being fully understood.

Workplace exposure to biological agents can be direct or indirect as an unintended result of work processes. Direct exposure may occur during the use of micro-organisms in, for example, the food industry or research laboratories, whereas indirect exposure occurs during activities such as waste treatment, retrofitting and agricultural activities and in the healthcare sector, where antimicrobial-resistant micro-organisms can pose a serious threat. Workers in the rapidly growing waste management and recycling industry face various health problems including pulmonary, skin and gastrointestinal problems owing to exposures to bioaerosols that may contain not only micro-organisms, but also endotoxins, sensitising substances and volatile organic compounds. They can also be present in biotechnology installations.

In order to develop suitable risk management strategies, a further development of detection and identification methods for biological agents is needed to cover the whole spectrum of micro-organisms. This is particularly true for airborne viruses, which can be an occupational health risk for transport, public and health service workers (recent examples include severe acute respiratory syndrome (SARS) and avian influenza) and which are prone to spread quickly in a globalised world. Direct measuring techniques allowing for quick decisions to be made are needed, and it is particularly important to develop and validate protective measures. To be able to understand the complex relationships between work-related exposure to bioaerosols and observed health effects, new investigation methods also need to be developed.

Mixed exposures are a reality in workplaces. In all working conditions, workers are exposed to varying extents to different kinds of hazards (including chemical, physical and biological). Workplaces, technologies and work tasks are becoming ever more complex; knowledge of multifactorial exposure is not sufficient and should be developed.

In particular, workers are often exposed simultaneously to several chemicals used in or generated by industrial processes. Exposure descriptions to such chemical mixtures are lacking. Their toxicology, mechanisms and modes of action should be studied and criteria should be defined to predict potentiation or synergy between different chemical agents.

2 Overview of research priorities

2.1 The economic dimension of occupational safety and health

- Strengthen research on the economic dimension of OSH, including an estimation of the socioeconomic costs of the consequences of poor or no OSH and an analysis of costs and benefits of OSH prevention to support evidence-based policies and decision-making at society and enterprise levels.
- Develop further the methodologies for estimating the socioeconomic costs of occupational diseases, work-related stress and violence at work.
- Undertake studies on the effects of regulatory systems, employment relations, social security systems and other contextual factors at the society–enterprise interface in order to identify ways in which to influence OSH decision-making at the company level.

2.2 Occupational safety and health communication and risk communication

- Identify and characterise stakeholder and target groups (e.g. in terms of risk perception and factors influencing it) to be able to define optimal message contents and formats. Focus on the groups that are difficult to reach, such as small and micro-enterprises, self-employed, workers in temporary and precarious work, etc.
- Evaluate the effectiveness of different communication channels and media and adapt these to the specific characteristics and needs of different audiences.
- Investigate the possibilities that new technologies can offer in fitting communication to the attitudes and expectations of different audiences.
- Identify and investigate the influences and underlying mechanisms that are determinants for a sustainable adoption of prevention measures and innovations.
- Further develop methodologies suitable for evaluating the effectiveness of communication in the specific context of OSH.
- Develop risk communication strategies that can handle uncertainties surrounding possible hazards associated with new technologies or materials. For example, for risks associated with nanotechnologies, where knowledge of new, emerging nanomaterials will continue to lag behind their development and use.

2.3 Intervention research

- Formally evaluate OSH interventions at all levels, including evaluation of the process, effectiveness, feasibility and cost-effectiveness, in order to justify and improve safety and health investments. The quality of OSH intervention research needs to be improved by developing the methodology, including process documentation and evaluation.
- Develop comprehensive intervention models and strategies in which good working conditions and a high level of employee health and well-being are integrated into the efforts for increased productivity and quality.

2.4 Demographic change — sustainable work for healthier and

longer working lives

■ Older workers

- Investigate the physiological, pathological and psychological effects of prolonged workplace exposures to physical, chemical, biological and psychosocial hazards on older workers. In addition, investigate how these exposures affect the trajectory of normal ageing throughout the life span as well as functional abilities and the occurrence of diseases later in life.
- Investigate the association of work, health, work ability and work motivation with work participation. Further research on the determinants of early withdrawal from the labour market is needed, with a specific focus on the age group 45–54 years, in order to support the development of efficient interventions.
- Conduct high-level intervention studies, including organisational, training and accommodation interventions, and evaluate their efficacy for older workers and their cost-effectiveness.

■ Women at work and gender aspects in occupational safety and health research

- Improve OSH research, epidemiological methods, monitoring and prevention activities by systematically including the gender dimension in order to provide an evidence base for gender impact assessments of existing and future OSH directives, standard settings and compensation arrangements.
- Conduct further scientific research on the effects of exposure to hazards associated with reproductive health problems (such as certain hazardous substances, physical work, noise, extreme temperature conditions and occupational stress) for males and females, including fertility and sexuality.
- Conduct research on women's reproductive health issues, such as menopause and menstruation disorders, including the occupational risks that can cause menstrual disorders, and the effects of menstrual or menopausal symptoms (including tiredness, stress and anxiety, headaches and migraines) on coping with work.
- Focus on specific female-dominated sectors and types of jobs in which women are over-represented, such as healthcare, education, retail, hospitality, personal and household services, and part-time and precarious jobs. The safety and health needs of domestic workers (who are predominantly female) should be a particular focus, especially as they currently fall outside the terms of existing EU legislation.

■ Migrant workers and other vulnerable groups

- Identify major challenges for OSH arising from an increasing proportion of workers with a migration background in the labour force and ways of improving their integration into the labour market in order to make full use of their potential.
- Conduct further research on migrants and other vulnerable groups of workers and the jobs they occupy; as the proportion of these groups in the workforce is increasing, monitoring and research on the changing scale and nature of the associated risks is needed.

■ Health inequalities and work

- Develop strategies and interventions to reduce socioeconomic and gender-specific health inequalities at work. Direct these measures at business activities and professions with the highest levels of exposure and strain and in which unhealthy lifestyles are common.

■ Major health problems

Work-related musculoskeletal disorders

- Clarify the interaction of combined physical and psychological factors and their effects on the development of MSDs.

- Develop and conduct high-quality multidimensional intervention studies combining technical, organisational and person-orientated measures and a participatory approach to prevent MSDs, and evaluate the efficacy and cost-effectiveness of such interventions.

Working with chronic diseases

- Conduct research on the effects of harmful workplace exposures on individual and population outcomes among older workers with existing chronic conditions, both during employment and after retirement, to facilitate evidence-based interventions and improve accommodations.
- Evaluate models of integrated and collaborative health management (including work design, work organisation, workplace health promotion and rehabilitation) for workers with chronic diseases and health conditions, including mental illness and disorders, to prevent work disability and unnecessary job losses. Interventions also need to address the psychosocial aspects of working with a chronic disease.

■ **Early retirement versus prolonging working life — work disability prevention and return-to-work research**

- Investigate practical and feasible ways of modifying the physical and psychosocial working conditions at both individual and company levels to prevent work disability in long-term settings. Various industrial sectors and occupations where the risk of work disability is particularly high need to be targeted.
- Develop the methodology for designing and implementing complex, high-quality workplace interventions, aiming to reduce the duration of time off work and improve the sustainability of return-to-work (RTW) following long-term sick leave or work-related disability. A tailored and multifaceted approach directed at various groups and settings, including evaluations of the process, effect and cost-effectiveness, should be used.
- Conduct further studies in order to better understand the individual, environmental and societal determinants of RTW outcomes and identify principles and solutions that are common across health conditions and work situations.
- The priority target groups for work disability prevention and RTW are ageing workers with chronic health conditions at risk of early retirement and temporary workers in unsecure, flexible work arrangements without a job to return to after the disability occurred. The latter is a growing group of vulnerable workers representing 15–20 % of the workforce in the EU.

2.5 Globalisation and the changing world of work

■ **Health management in restructuring**

- Monitor the health effects of restructuring, including in SMEs: collect and evaluate data and evidence on the effects of restructuring on the health and well-being of workers.
- Conduct workplace health interventions aimed at providing psychosocial support to workers before, during and after restructuring processes. These interventions should better enable them to cope with the transition and new demands placed on them while maintaining their health. Evaluate the efficacy and cost-effectiveness of interventions.

■ **Changing organisations, new employment and work patterns, and psychosocial risks**

- Investigate the impact of new employment and working patterns, including different forms of flexibility, on safety and health at work in order to support evidence-based policies and practices at societal and company levels. This should consider the potential psychosocial risks and the associated adverse health effects, as well as the opportunities they may provide for improving health and well-being at work.

- Focus on the safety and health aspects of precarious work in terms of access to occupational healthcare, health surveillance and traceability of occupational diseases, worker participation and access to training.
- Conduct further research on the determinants of work–life balance in a wider societal context, including societal values and systems. Investigate how new working patterns and different types of flexibility, as well as implementation of new technologies, affect work–life balance and, consequently, health and well-being at work and organisational performance. This should provide an evidence base for policy development and good practices at the company level.
- Monitor and analyse the impact of the economic crisis on safety and health at work.

■ **Violence and harassment at work**

- Clarify the terms, definitions and classifications used in relation to different types of work-related violence and harassment. Commonly accepted operational definitions of what constitutes workplace violence and harassment will be necessary to facilitate uniform data collection. Standardised data collection using common definitions is essential to draw conclusions on effective prevention.
- Conduct more sector-orientated research to clarify the influence of various situational and environmental factors of third-party violence or harassment in worker–client interactions in different workplace settings.
- Conduct high-quality interventions aimed at developing, testing and evaluating strategies to prevent harassment and violence in a variety of workplace settings and the negative consequences of such behaviours. Evaluate the process, efficacy and cost-effectiveness of the interventions.

■ **Psychosocial risk factors, work-related stress, and chronic diseases and health conditions**

- Investigate the complex interactions between work-related psychosocial and organisational risk factors, work-related stress, physical inactivity at work, risk behaviours, and chronic diseases and health conditions to provide an evidence base for policy development and effective prevention strategies. Focus on groups that are particularly vulnerable to the adverse health effects of psychosocial risk factors at work.
- Develop interventions, programmes and strategies that merge traditional workplace health protection with workplace health promotion and address both work-related risks — organisational and psychosocial — and behavioural factors simultaneously. This logically includes a focus on both the work environment and individual choices and behaviours.

■ **Well-being at work — a positive approach**

- Reinforce the positive approach to occupational health psychology research, focusing on positive job characteristics and well-being, including work engagement, job resources, psychological capital, job crafting and positive spill-over.
- Explore further the relationships between workplace innovation, safety and health at work and company performance, and the possibility of improving health and well-being at work through workplace innovation.

■ **Occupational safety and health in small and micro-enterprises**

- Conduct further studies on specific features of small and micro-enterprises, the success and obstacle factors throughout the enterprise life cycle in different economic contexts (growth, recession) and the key factors affecting OSH decision-making in these entities.

- Improve the quality of research on small and micro-enterprises with an emphasis on the use of existing knowledge in new research and the exchange of experience between researchers. Higher priority should be given to interdisciplinary studies and the evaluation of the effect of the various interventions. Intervention research should cover the whole intervention process, from intermediaries through dissemination methods to preventative activities, evaluation of the efficacy and cost-effectiveness of the intervention.
- Develop, implement and evaluate innovative support schemes adapted to the realities and needs of small and micro-enterprises, including the self-employed, taking into account their unique nature and combining different approaches (information, training, development of support networks or guidance from external OSH services and economic incentives). Develop cost-effective programmes that can be applied on a larger scale.
- Conduct further nationally comparable research to identify the key conditions that contribute to a 'favourable' environment, by which levels of OSH management practice among smaller establishments (especially those with fewer than 100 employees) could be increased.

2.6 Occupational safety and health research for safe new technologies

■ Occupational hazards in green technologies

- Conduct more 'prevention through design' research on the safe development of technologies, processes and substances during their conception and before their introduction into the market. Their entire life cycle should be taken into consideration in order to 'design out' any potential hazards. Outcomes of this research could be used to harmonise/standardise designs.
- Evaluate traditional and new OSH risks found in different situations and combinations within green jobs. This would facilitate the transfer of existing OSH knowledge to green technologies, the development of job-specific risk assessment for green jobs and the identification of OSH training needs.
- Analyse, in depth, the methods which can be used to identify current and future OSH skills needs at all levels within green jobs.
- Develop new toxicity research methods that support speed-to-market practices, and make them available quickly to apply to green technologies as they develop.
- More toxicological and epidemiological research is needed to assess health risks from occupational exposures to multiple substances and to new materials (e.g. development of job-exposure matrices). This needs to be considered for the life cycle of new green technologies (cradle-to-cradle).
- Conduct research on occupational risks related to waste management in general, including the collection, transport, and disposal and processing of waste and, in particular, on the OSH risks of landfill mining, processing of bio-waste and waste-to-waste technologies. Investigate better exposure assessment (job hazard analysis) through improved research methodologies.
- Investigate the long-term health implications from exposure to biological agents in these new technologies (e.g. risks from green construction materials, bioenergy or waste management).

■ Information and communication technology: opportunities and risks in the working environment

- Explore the possibility of using AMI-based solutions for creating tailored support systems to adjust workplaces (ambient-assisted working following the model of ambient-assisted living). Identify the impact that usage and usability could have on older workers and on people with varying skill levels, physiological states and cognitive abilities.
- Owing to more intelligent and more complex human-machine interfaces being introduced into workplaces, conduct research on their safe and effective use. This would include studies of

cognitive ergonomics and neuroergonomics for user-centred designs of new ICT applications, with a particular focus on the needs of specific worker groups such as workers with disabilities, maintenance workers or migrant workers.

- Conduct further research on OSH relevant to (mobile) IT-supported work; for example, on topics such as mental workload, decision-making, skilled performance, permanent accessibility, work–life balance and human–computer interactions.

■ Risks regarding exposure to electromagnetic fields

- Systematically evaluate the number of workers in Europe exposed to EMFs and characterise the sources to which they are exposed.
- Conduct research on the long-term health effects of occupational EMF exposures.
- Identify better exposure assessments, which are crucial for the evaluation of exposure conditions of workers. A better understanding of real exposure is needed for informing future experimental settings and designing more conclusive epidemiological studies and adequate risk assessments, which are key requirements of scientific studies on the biological effects of EMFs.
- Assess EMF exposure of workers who are particularly at risk (e.g. persons with medical implants, pregnant workers).
- Develop accurate and reliable dosimetry and exposure assessments, which are key requirements of scientific studies on biological effects of EMFs.
- Investigate the exposure to intermediate frequency (IF) fields, for example antitheft devices or welding, and their possible health effects, as there are only a limited number of investigations into IF field exposures.
- Investigate the exposure to extremely low frequency (ELF) fields and their possible health effects, since the biological cause–effect relationship between ELF magnetic fields and disease causation is not understood.
- Conduct more research on the health effects of static fields, including possible health effects from chronic short-term exposure to several teslas.
- Investigate non-specific effects (cognitive and sensory functions, sleep disturbance, etc.) of radiofrequency fields in order to gain a better understanding of their mechanistic explanation.

■ Unknown risks of biotechnology

- In order to fill in the knowledge gaps, acquire a better understanding of activities, associated hazards (including biological, chemical and physical hazards and production scale-up) and exposures; for example, OSH risks in production, processing and use of biofuels.
- Carry out further toxicological and epidemiological research into topics such as occupational exposure to the biological agents being utilised in the biotechnological sector.
- Develop tools for risk assessment and prevention measures, as these are required for the increasing use of biotechnologies in the industrial sector. The development of medical surveillance programmes is also needed for the collection and use of medical information, biological monitoring, medical screening or other health data for developing strategies for the prevention of disease.

2.7 New or increasing occupational exposure to chemical and biological agents

■ Carcinogenic, mutagenic, reprotoxic and sensitising substances

General

- Develop alternative analytical methods for testing the toxicology of chemical agents (e.g. detect minimal amounts of CMR and sensitising substances).
- Develop reliable tools for quantitative risk assessment that will generate better quantitative data for the potency/potential of carcinogenic, mutagenic and sensitising substances.
- Bio-metrology for occupational exposure – development of appropriate biomarkers. This will help to identify the nature and amount of chemical exposures in occupational situations and will permit the prediction of the risk of disease in individuals and groups exposed (including ‘vulnerable’ groups).
- Conduct gender-specific research; most carcinogenic exposure studies have been generated from studies of men, whereas reprotoxic studies focus on women. Few studies have estimated the variability in exposure measurements based on gender, race, ethnicity or related variables. Research methods are needed to evaluate, for example, occupational cancer among women and minorities that will allow determination of whether the same external exposure could result in different internal doses.
- Further develop the methodology and use of job-exposure matrices to identify exposure risks in the working environment.

Carcinogenic, mutagenic and reprotoxic substances

- Develop the existing knowledge on CMR effects by conducting research on health problems and their link to work (e.g. collection of exposure data). This will improve understanding of the relationship between occupational risk factors (including ‘hidden’ CMR risk factors) and the incidence of occupational diseases.
- Conduct research that will cover more occupational groups and involve long-term population studies (e.g. research should include service industry, vulnerable workers such as young migrant females in maintenance work, organisational factors or lifestyle factors often influenced by the way work is organised).
- Validate and improve models for worker exposure assessment: measuring, modelling and risk assessment. These models can be used to identify exposure reduction needs and methods, to define exposure–response relationships in epidemiological studies and to demonstrate the effectiveness of interventions and engineering controls. Moreover, conduct research and develop instruments and tools for workplace management of CMR substances.
- Investigate the criteria or process for setting occupational exposure limit values for CMR substances. Investigation is needed to develop a clear overview of occupational carcinogens and related work processes outside the scope of REACH. These substances/processes need to be addressed by research, monitoring and prevention so that the same level of protection is provided to workers.
- Reprotoxic studies in humans have mostly looked at effects closely related to the course of pregnancy, for example abortion, gestation length and birth weight. Thus, conduct additional research on functional disorders related to, for example, the immune, cardiovascular and nervous systems.
- Conduct additional research in order to update reproductive and developmental toxicity databases which have limited information for many chemical exposures in the occupational setting.

Sensitisers

- Establish a more detailed system for an allergenic potency ranking, resulting in different categories of sensitising substances.
- Identify factors leading to an increasing chemical sensitivity of the human subject.

- Establish scientifically sound and reliable toxicological thresholds that provide information on the ‘dose’ of a substance that must be reached to produce a sensitising effect.
- **Endocrine disruptors**
 - Expand and strengthen knowledge of EDCs on occupational populations. Research is needed on exposure assessment strategies that will help pinpoint and identify unrecognised substances with EDC properties within workplaces. With current assessment methods, the full spectrum of chemicals that potentially contribute to endocrine-related diseases is far from known.
 - Establish new approaches to examine the effects of mixtures of EDCs on disease susceptibility, as examination of one EDC at a time is likely to underestimate the combined risk from simultaneous occupational exposure to multiple EDCs. Assessment of human health effects owing to EDCs needs to include the effects of occupational exposure to chemical mixtures on a single disease as well as the effects of exposure to a single chemical on multiple diseases.
 - Develop more specific and sensitive biomarkers for detecting endocrine-mediated effects in workers exposed to EDCs.
 - Focus work on the occupational populations/subgroups that are most likely to be susceptible to EDCs.
- **Nanomaterials in an innovation-driven society**
 - Increase the knowledge on nanomaterials in occupational settings including new-generation nanomaterials.
 - Increase the understanding of how chemical and physical modifications affect the properties of nanomaterials. Develop risk characterisation information to determine and classify nanomaterials based on their physical or chemical properties.
 - Understand generalisable characteristics of nanomaterials in relation to toxicity in biological systems.
 - Develop new toxicity testing methods and risk prediction tools to allow for safety aspects to be considered as early as in the product development phase (safety by design). Research will allow for ‘responsible’ nanotechnology which integrates safety and health considerations.
 - Develop standardised measuring methods for both qualitative and quantitative measurement of nanoparticles to obtain reliable exposure data as a basis for exposure assessment and risk management.
 - Develop exposure assessment and risk management tools for the field that will help in understanding and improving best workplace practices, processes and environmental exposure controls.
- **Biological agents in a greener yet globalised economy**
 - Develop methods to investigate the relationship between occupational microbiological exposure and observed health effects. The precise role of micro-organisms in the development and the aggravation of symptoms is poorly understood.
 - Develop the understanding of the dose–response relationship for most biological agents.
 - Conduct research into metrology, epidemiology, appropriate measurement and assessment methods, and prevention of risks, as the study of occupational biological risks is insufficiently developed.
 - Develop accurate sampling and analytical methods for micro-organisms, in order to identify the whole spectrum, for example airborne micro-organisms, allergens in bioaerosols, microbial fragments, etc.

- Develop direct measuring techniques for microbiological agents as a prerequisite for quick decisions on suitable workplace protective measures.
- Conduct further research on the evaluation of bioaerosol occurrence and their variability of exposure.
- Work on determining occupational exposure limit values, as standardised analytical methods are still lacking.

■ **Mixed exposures in complex workplace settings**

Chemical and biological mixtures

- Investigate the toxicology and mechanisms of the action of chemical or biological mixtures.
- Increase the knowledge of the rather limited number of chemicals for which there is high-quality information on their mode of action. Develop more and improved exposure descriptions for chemical or biological mixtures (i.e. where, how often and to what extent).
- Develop robust and validated tools for the prediction of interactions.
- Increase the knowledge of how exposure and/or effects change over time.
- Define criteria to predict the potentiation or synergy of chemical mixtures.

Ototoxic substances

- Improve toxicity testing of new chemicals in order to properly evaluate their ototoxicity.
- Identify the levels of simultaneous noise and specific chemical exposures which are considered safe to the human auditory system.

3 Main findings of the seminar ‘Moving towards 2020: Priorities for occupational safety and health (OSH) research in Europe for the years 2013–2020’

- The general feedback on the report was positive; it was pointed out that it is an important document and that the priorities for OSH research listed in the report reflect the challenges identified in the Europe 2020 strategy.
- EU-OSHA’s central role in identifying priorities for OSH research and promoting research coordination in Europe, as well as in communication, was recognised.
- It was suggested that, by establishing a shorter list of priorities and focusing on fewer issues, the impact of the EU-OSHA report could be greater.
- Swift translation of research results into action is crucial, but transfer of research results into practice and concrete policy action remains a challenge.
- The importance of intervention research was acknowledged.
- It is important to strengthen research on the economic dimension of OSH to support evidence-based policies and decision-making at society and enterprise levels.
- The importance attached in the report to sustainability and to the social dimension is appreciated, as is the important role of OSH in this respect; this is something that should be emphasised.
- The role of working conditions as an important social determinant of health should be recognised, as well as the role of the workplace in reducing socioeconomic and gender-specific health inequalities.
- As regards OSH research related to demographic change, the need for a multidisciplinary approach considering the whole life course was stressed. Research should address issues of

adapting working conditions to age/ageing and of preventative work design. New employment and work patterns should also be taken into account in the context of demographic change.

- In the context of globalisation and the changing world of work, the measurement of exposome – the measure of lifetime environmental exposure on health — is a challenge (many relevant exposures, interaction between exposures, etc.) and requires an interdisciplinary approach. Exposome measurement would provide better insights into disease risk factors and mechanisms, which could enhance disease prevention.
- In the context of globalisation and the economic crisis, providing support to SMEs was highlighted as crucial.
- There is a need for the development of integrated OSH intervention policies, at individual, organisational and societal levels, supported by new design and technology.
- With regard to new or increasing occupational exposures to chemical and biological agents, the complexity, ambiguity and uncertainty of risks was highlighted. Research on new methods for risk assessment is needed, taking into account these aspects.
- Challenges related to the risk management of chemical and biological agents, such as the lack of exposure data, were highlighted. Research needs, in this context, to include, among other things, the development of a European job-exposure matrix and the support of SMEs in the management of chemical and biological risks.
- It was pointed out that a high level of political commitment is needed to improve safety and health at work in Europe and that, at the moment; this commitment is missing at the European level. It was generally acknowledged that there is a need for an EU OSH strategy, especially in the current climate of the economic crisis, as there are already signs of deteriorating working conditions owing to the crisis. It was argued that issues related to safety and health at work need to be put high on the political agenda.

