

Digital transformation - Impact and challenges for occupational injury insurance

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1. Introduction

1.1 Forms of expression of the digital economy

The global economy's shift into the digital era is becoming more significant every day, both for individuals and for private and public organizations. Some now speak of a fourth Industrial Revolution and are developing the "Industry 4.0" concept¹.

This change is due primarily to the development of the IP technology (Internet Protocol: a family of communication protocols in an IT network) and optical fibre. These protocols are accelerating the development and increasing use of new information and communication technologies (ICTs): the mobile internet, cloud computing² and the Internet of Things³, which have become possible because of the widespread adoption of the internet, accessible worldwide.

In everyday life, digitization has two main characteristics.

The first is the development of the *collaborative economy*, also called the *sharing economy*, via digital platforms.

The sharing economy involves establishing direct relationships between private individuals, for gifting, swapping, renting or selling goods, services, information and knowledge, via web and mobile platforms. The advantage is that it facilitates direct cooperation between private individuals by promoting optimization of the available goods and resources.

The collaborative economy, which is a source of work and income for numerous private individuals, helps prevent the under-utilization of goods, wastage of resources, over-

consumption or insufficient product sustainability. However, by investing highly regulated sectors of the economy (passenger transport, meal services, accommodation), it increases the vulnerability of numerous workers in place and exacerbates competition in ways that are often considered unfair: many platforms use tax optimization to reduce their corporation tax and take advantage of the self-employed worker status to avoid paying compulsory social security contributions.

The platforms apply new business models, based on a "winner takes all" philosophy. The most striking examples are the platforms for chauffeur-driven cars (Uber) and for home delivery of meals (Deliveroo). More generally, the digital economy has enabled the emergence of "unicorns"⁴.

The second characteristic, more visible in the private sphere, is the development of *peer-to-peer*⁵ services, that can be seen, for example, in the frequent use of so-called "torrent" sites⁶ by private individuals.

On the technological level, the phenomenon has been reflected by the rapid development and then the "marriage" of two major applications: *Big Data* analysis and advanced robotics.

So the definition of the digital economy is very broad: it covers all these information and communication technologies and extends to goods and services such as smartphones and tablets.

This revolution could produce many new benefits for employees and employers: a connected world, greater potential for working together, machines to perform heavy work and therefore less painful conditions for workers, computers to help with complex tasks, etc. But it could possibly also completely disrupt the

¹ According to this theory, the first industrial revolution was characterized by the advent of steam engines; the second by mass production based on the division of labour and the rapid development of oil and electricity; the third by the advent of microelectronics to control machinery, and the fourth by "complete interconnectivity".

² Use of the memory and computing capacity of computers and servers distributed throughout the world, and linked together by a network such as the internet.

³ The Internet of Things (IoT) represents the extension of the internet to things and places in the physical world.

⁴ Unicorns are digital economy start-ups valued at more than one billion dollars even before their initial public offerings. They are reminiscent of the digital economy giants known as the GAFAs (Google, Apple, Facebook, Amazon).

⁵ Type of network connection by which two machines communicate with one another as equals. This type of connection allows millions of net surfers affiliated to a network to share their files stored on the hard disk of their computer.

⁶ The BitTorrent is a protocol for peer-to-peer (P2P) data transfer via an IT network.

labour market, with regard both to workers' status and their working conditions and training.

The European Trade Union Institute (ETUI) lists the main effects already seen in the labour market:

- Job creation: new sectors, new products, new services;
- Job transformation: new forms of interaction between man and the machine; new forms of employment – e.g. with what is called Uberization - which involve new social risks (greater work intensity, new occupational risks, increasingly vague boundary between working life and private life, inadequate training, discrimination); impact at the management level (new digital management);
- Job destruction: a very large number of jobs will be threatened by computerization, automation and robotization in the next ten to twenty years. Although there is no consensus regarding the scale of these job losses, it is clear that the figures will be very high;
- Job displacement: development of digital platforms and *crowd work*⁷, in which workers from countries with a high level of social protection will be placed in competition with those from developing countries with a low level of protection. The offshoring of services facilitated by certain "sharing economy" platforms will also threaten highly qualified jobs, such as those in accounting and finance.

In France, the Labour Act enacted in August 2016 made adaptations designed to meet the numerous problems posed by the digital transformation, especially those concerning the Occupational Injuries Branch: coverage and patient management for digital platform workers, right to disconnection, teleworking, etc.

Regarding working conditions, Bruno Mettling, Deputy CEO in charge of *Orange Middle East and Africa* operations, in his report on "Digital transformation and life at work", submitted to the French Minister of Labour in September 2015, described the six major impacts that the digital transformation will probably have on the working world [1], namely:

- Massive dissemination of new work tools;
 - Impact on jobs and skills;
 - Managers' work environment;
 - Impact on work organization;
 - Impact on management;
 - New forms of work without employee status.
- These impacts will be discussed further on in this document.

2. Social protection for new forms of work

The European Foundation in Dublin, *Eurofound*⁸ [6], has identified the development of nine new forms of work throughout the continent, most of which have gone hand-in-hand with the digital transformation. Some of them had remained very marginal until then. **Table 1** (see next page) summarizes these new jobs and their identified effects on working conditions.

The diversification of workers' activities raises numerous legal issues for social welfare organizations.

⁷ *Crowd work* designates work by individuals, who are more or less anonymous, organized by an internet platform.

⁸ European Foundation for the Improvement of Living and Working Conditions: <https://www.eurofound.europa.eu>

Table 1: Review of new forms of employment and their consequences for workers' health

New forms of employment	Description	Positive effects	Negative effects	Presence in France
<i>Work sharing</i>	A worker is recruited jointly by a group of employers.	Skills sharing	Less stable relations with supervisors	Yes
<i>Job sharing</i>	An employer hires two or more workers, who share the tasks involved in a specific job position.	Better balance between personal and working life Sharing of experience with other workers	Greater work-related stress	No
<i>Temporary managers</i>	Experts are hired temporarily for a specific project.	A little flexibility	Greater stress, isolation and job insecurity	Yes
<i>Casual work</i>	The employer does not give employees regular work and has them come in when required.	A little flexibility	Less job security, instability, unpredictable timetable and working hours.	Yes
<i>ICT-based mobile work</i>	By agreement with the employer, the worker can work anywhere and at any time, using modern technologies.	Flexibility, autonomy, balance between private life and working life	Longer working hours, more stress and lack of separation between work and private life. Workers are responsible for their occupational health.	Yes
<i>Cheque-based work</i>	The work relationship is based on a cheque from an approved organization used as a means of payment for services, covering both wages and social security contributions.	Good social protection, OSH standards	Job insecurity, isolation, no career development	Yes
<i>Work broken down among several activities (portfolio work)</i>	A freelance worker works simultaneously for several customers.	Interest due to multiple tasks, autonomy, balance between personal and working life	More competition between workers, pressure to achieve results, job insecurity, little social protection	No
<i>Crowd work</i>	An online usage platform establishes a relationship between employers and freelance workers, with large jobs divided among several workers organized in a "virtual cloud".	Same as for <i>portfolio work</i>	Same as for <i>portfolio work</i>	No
<i>Cooperative work</i>	Freelance workers cooperate with one another via an umbrella organization, co-working or cooperatives.	Same as for <i>portfolio work</i>	Same as for <i>portfolio work</i>	Yes

The Pennel Report [3] refers to the issue of new forms of non-employed work as “the most problematic issue raised by the digital transformation concerning work and its links with traditional enterprises”. The digital economy's constant demand for flexibility and adaptability is based on the growing number of freelance workers (or “independent contractors”), including the increasing number of self-employed entrepreneurs⁹ (982,000 in

France at the end of 2014). According to the report, it is estimated that one out of ten workers in the digital economy already works as a non-salaried employee and the trend is

The self-employed entrepreneur is not the only one to work without any ties of subordination. Other previous regimes also make it possible to work alone and in complete independence, although with different rules in terms of tax treatment and social protection. Apart from the professions (“professions libérales”), there is the sole ownership business (“entreprise individuelle”), which can enjoy the same microsocial regime as the self-employed entrepreneur but is tied by a greater number of other obligations (calculation of VAT, extensive bookkeeping, a minimum of social security contributions, etc.). This status was reclassified as “microentrepreneur” in January 2016.

⁹ In France, the self-employed entrepreneur (“autoentrepreneur”) is merely one category of freelance workers, which in fact include all non-salaried workers.

still rising. In 2014, the number of freelance workers increased by 8.6%, and they represented 18% of workers in the service sector in the Netherlands, 11% in Germany and 7% in France¹⁰[2].

The proportion of salaried employees of course remains preponderant: in 2015, France had 24 million salaried workers, versus 2.8 million non-salaried workers. But the trend is striking, as stressed by Dennis Pennel [3]: from 2006 to 2011, the number of non-salaried workers increased by 26%, up sharply especially in service activities.

2.1 The distinction between salaried workers and freelance workers

At the end of 2011, 2.8 million people had a non-salaried job in France, either as their primary activity or in addition to a salaried job. Excluding agriculture, the number of non-salaried workers (or freelance workers) increased by 26% between 2006 and 2011. The increase in numbers was substantial in the following sectors:

- +250% in "other" specialist jobs: advertising, design, photography and translation;
- +100% in management consulting and in miscellaneous healthcare services and social action;
- +80% in information and communication, the arts, entertainment, recreational activities and teaching;
- +50% in non-store retailing;
- +47% in business services and mixed services;
- +38% in personal services excluding healthcare.

This increase can be explained in particular by the success of the new self-employed entrepreneur ("auto-entrepreneur") status, created in 2008. By the end of 2011, it already covered 487,000 non-salaried workers, then 982,000 by end-2014 [2].

¹⁰ Data compiled by the *McKinsey Global Institute Analysis* based on studies by Eurostat, the *US Bureau of Labor Statistics* and the OECD. Those included in the reference population are freelance workers in the information and communication sectors, finance, research and development, and administrative services.

The development of new forms of non-salaried work represents a major challenge for all social welfare organizations. In particular, the growing number of freelance workers raises the question of the legal classification of salaried and freelance workers.

The Pennel Report [3] notes an "increasingly porous and vague boundary" between salaried work and freelance work. This phenomenon raises questions about legal subordination and the responsibility assumed by the employer in the event of an occupational injury or disease: there are, on the one hand, an increasing number of employees without bosses and, conversely, an increasing number of freelance workers who work for only a single client in a situation of complete economic dependence.

This issue is not specific to France. Many countries have started thinking about this and plan to legislate in order to clarify the legal status of these workers. The US Department of Labor has undertaken research on the "incorrect classification of salaried workers as freelance workers" [4][5]. In its opinion, the conventional work relationship between employer and employee has "cracked" due to the fact that businesses increasingly delegate their work: subcontractors, temporary work agencies, labour brokers, franchising, licensing and third-party management.

To curb their costs, many businesses take advantage of the freelance worker status. This deprives such workers of minimal social welfare benefits: minimum wage, payment of overtime work, unemployment insurance, occupational risk insurance and decent working conditions (paid leave, mutual insurance, meal vouchers, etc.).

In theory, this situation creates no financial problem of payment collection for the Occupational Injuries Branch: occupational risk is autonomous, since the revenues from corporate contributions are assigned to risk coverage only for employees, former employees and their legal beneficiaries (unlike the health insurance and family benefits branches, which redistribute the revenues from companies' and employees' contributions among the entire French population).

However, many workers are potentially not covered against work-related risks. If the legal

situation were to change and the contractual relationships of these workers were reclassified as employment contracts, within the next few years the injury insurance organization may possibly expect to cover millions of extra workers against occupational risks. It must therefore prepare to adapt its services and benefits for this new contingent.

2.2 Coverage of digital platform workers

- In France

Pierre-Yves Geoffard [7], head of the economics school Ecole d'Economie de Paris, emphasizes the lack of protection for these digital economy workers. Apart from the fact that they incur directly the risk related to fluctuations in demand and work, they have only "a very limited access to the conventional welfare benefit schemes available to salaried workers".

Around September 2015, the URSSAF (family benefits fund) of the Ile-de-France region brought civil proceedings against the American firm Uber, with a view to having its drivers recognized as salaried workers (and no longer as independent contractors), claiming millions of euros in unpaid contributions. Its case is based on the possible "link of subordination" existing between the chauffeur-driven car company and the drivers, a link that it explains by the following factors:

- It is Uber that recruits and trains its drivers;
- Fees are capped and Uber takes a percentage on them, whereas an independent contractor sets his prices himself;
- The route cannot be chosen freely, nor the vehicles, which must meet certain criteria (colour, date of registration, general condition, etc.);
- The drivers sign a charter, they must provide reports and they are liable to penalties. Their rating by customers may also be a reason for exclusion.

In return, Uber ensures that its "driver partners" indeed come within the category of freelance workers (or "independent

contractors"). As proof of this, the platform maintains that it imposes no exclusivity clause and that its drivers keep complete freedom regarding their working hours. Moreover, the drivers incur directly the risk of their activity (if a customer cancels a trip, the driver is not paid).

Here the boundary with salaried work is very slim. If legal subordination were confirmed by the courts, the case could establish a legal precedent and would make Uber and many other platforms liable to possible reclassifications of the relationship as an employment contract.

Unlike other social security contributions (health, family benefits, pensions), occupational injury insurance is not compulsory for freelance workers¹¹. At present only a minority of them are covered against occupational risks.

The Labour Act [8] partly answered the digital platforms' question regarding occupational risks. Non-salaried workers who are tied to the platforms now have access to certain welfare benefits (injury insurance, training) in exchange for new tax obligations. Since 1 January 2016, relationship management platforms are "required to provide, on the occasion of each transaction, fair, clear and transparent information regarding the tax and social security obligations incumbent on those who perform commercial transactions via them"¹².

Hard as it may be, the law¹³ tries to target a category of platform: those which "determine the characteristics of the service provided or the good sold and set its price" (like Uber and Deliveroo). The law recognizes that these platforms have "a social responsibility with regard to the workers in question"¹⁴. The platforms are required to either take out a collective insurance policy covering

¹¹ Freelance workers can take out a voluntary occupational injury insurance policy with a primary health insurance fund ('CPAM').

¹² The measure applies to transactions performed as of 1 July 2016. Cf. <http://www.assemblee-nationale.fr/14/amendements/3308/AN/334.asp>

¹³ Article 60 of the Labour Act.

¹⁴ The Labour Act in the digital era, <http://travail-emploi.gouv.fr/grands-dossiers/LoiTravail/quelles-sont-les-principales-mesures-de-la-loi-travail/article/la-loi-travail-a-l-ere-du-numerique>

occupational injuries, or to reimburse the premium paid by workers who take out individual insurance (either by voluntary affiliation to the social security system or by a private insurance policy).

Finally, to calculate the contribution relating to occupational injuries, only the revenues generated by the worker on the platform are taken into account. However, these revenues must be above a threshold (set by decree) to be subject to a contribution.

Platforms not meeting this criterion of services provided (such as Leboncoin or Blablacar) are therefore not affected by this measure.

- In Germany

In Germany, the social partners are discussing the working conditions of digital platform workers, and of *crowd workers* [9] more generally. The employers' federations BDA and BDI "emphasize in particular the gains in flexibility, new regulations for the work environment which should be set at the European level, or again the will to limit trade union lobbying both for digitization of the enterprise and for the issue of protection of the new work statutes (*Planet Labor*)." These forms of employment "should not be limited by over-regulation" and should not benefit from a special status or protection.

For their part, the trade unions fear that the German model of co-management and work protection may be jeopardized. The trade union for the chemicals and energy sector refuses to accept that "each worker could become, as it were, a small business, that their services could be paid for via a contract for the provision of services and that they could be responsible for paying for their social welfare and their training". Although workers' physical health has improved on the whole, the DGB fears that this situation might increase today's occupational risks, of a more psychosocial nature.

IG Metall calls for the establishment of rights of participation and protection for *crowd workers*, and for the introduction of comprehensive regulations for mobile work. The federation has developed a website, *Fair Crowd Work Watch*, which allows these workers to assess the

companies which use them in terms of working conditions and remuneration, to exchange ideas with one another, and to receive legal advice provided by IG Metall. The ETUI emphasizes that "this is an initial attempt to organize workers who are in a parallel labour market employing a massive but completely fragmented workforce".

An alternative: the intermediary cooperative

In Europe, other alternative schemes have been implemented to provide social protection for these new digital economy workers, e.g. in Belgium, where the self-employed entrepreneur status does not exist. To obtain more clout in relations with the home meal delivery start-up "Take Eat Easy", 400 deliverymen have joined the SMart (Société Mutuelle pour Artistes) organization, which then invoices the start-up for a comprehensive service.

This organization, generally described as a "temporary work cooperative platform"¹⁵, is present in nine European countries (including France). Originally created for workers in the artistic sector, it acts as an intermediary between workers, the digital platform and the social security organizations. In the case of Belgian workers, it takes charge of:

- debiting employers' and personal contributions;
- holiday savings;
- payment of the work-related tax deduction at source and establishing the tax sheet (equivalent to an income tax return);
- establishing the pay slip;
- establishing form C4 (certificate of end of work for unemployment insurance);
- payment of net wages and reimbursement of expenses.

In particular, by means of a contract management system the cooperative platform has provided social protection for freelance workers, notably by taking out several

¹⁵ In 2013, SMart had around 4,000 members, it adopted a cooperative governance system based on multi-membership and it changed its status to a "Société Coopérative d'Intérêt Collectif" (cooperative society in the collective interest).

insurance policies, including a compulsory insurance policy covering accidents in the workplace and commuting accidents. Via a protocol agreement signed with "Take Eat Easy" and other platforms, it also ensures decent working conditions for its workers: a guaranteed minimum wage, an exhaustive report on hours worked, reimbursement of business expenses, and a minimum commitment of three hours as of the first delivery performed (whether or not it is followed by other deliveries).

And when the home delivery start-up was placed in court administration in July 2016, its deliverymen were paid in priority thanks to their position as a "large creditor". The couriers' collective considers that this cooperative platform was "a more controlled system which protected the deliverymen". For their part, the French deliverymen of "Take Eat Easy" are taking legal action to obtain a reclassification of their work under an employment contract.

Pending a legal clarification of these activities, this type of insurance and cooperative scheme is an example that it would be worth investigating in greater detail.

2.3 Between amateur activity and undeclared work

In addition to the opposition between salaried worker and freelance worker, it is sometimes the definition of the work itself which can be brought into question by the new activities of the collaborative economy. Some of these platforms have become an opportunity for many private individuals to go beyond mere sharing and generate income from activities that are supposed to remain non-remunerated:

- On Blablacar, drivers use the platform's services and do commercial trips, sometimes taking ride sharers in minibuses;
- Some private individuals have decided to go into accommodation by buying a specific housing unit which will then be offered all year round for hire on Airbnb.

In these cases – which are still a minority but are tending to increase – this is no longer a collaborative economy, but a real undeclared

professional activity. In France, remunerated passenger transport, under the pretext of carpooling, is illegal, while a private individual can obtain income from their apartment only exceptionally (when it is not a rental property).

Regarding the use of these platforms, Bruno Mettling [1] recommends "distinguishing between users for whom this amateur activity is marginal and users who make it a significant source of income (...) so that it may be subjected to similar obligations, in terms of social security contributions, as activities in the formal sector".

2.4 Toward a redefinition of work

In short, employment has become extremely diversified and it is hard to find common criteria, as emphasized by the Pennel Report [3], with four major trends:

- Lifetime employment is no longer the norm, being threatened by greater flexibility internally (transformation of work in the enterprise) and externally (outsourcing, fixed-term work contracts, temporary work);
- Status is no longer defined merely by the worker's job, but by monetary criteria;
- Multiple employee statuses: there are now more than 35 different employment contracts. Only 58% of private-sector employees still have a permanent work contract;
- The end of the single employer (accumulation of part-time jobs, a series of employers for temporary work or freelance work with employee status for welfare benefits). 2.3 million people in France combine several occupations.

Even for permanent work contracts, there has been a diversification of working conditions. The traditional employee no longer necessarily works from Monday to Friday in accordance with fixed working hours, for a fixed remuneration and at a fixed workplace. Moreover, these contracts are no longer synonymous with job stability: one-third of the new permanent work contracts registered are terminated prematurely before one year due to a resignation, the end of a trial period, a

dismissal or a mutually agreed termination of the employment contract.

Faced with these changes, the head of the economics school Ecole d'Economie de Paris [7] calls for an overhaul of the social welfare system: "these are people who must be covered against the major risks of life, irrespective of the form of their job, salaried or not, or even irrespective of their job itself".

At a conference held by the European Forum of Insurances Against Accidents at Work and Occupational Diseases, the Director of the DGUV¹⁶, Dr Joachim Breuer, posed questions concerning the establishment of a new social model suitable for the digital economy. The focus of the debate is whether the new forms of activity can be considered as "employment". It is on this concept that the entire Bismarckian social security system is based: an employer who takes workers under his subordination, gives them remuneration, ensures their social welfare via payment of the related social security contributions and provides insurance for their health and safety at work.

The German accident insurance organization is reflecting on the gradual disappearance of the employer from this scheme, being replaced by an imaginary interface between customers and workers, now assimilated to a multitude of isolated crowd workers. In this context, there would no longer be any formal employment contract (replaced by a virtual contract for the supply of services generated automatically). The calculation and collection of social security contributions would have to be revised, because the employer would no longer be there to collect them. Finally, without employers, there would no longer be any action to ensure workers' protection: they would be completely autonomous in their work, but also responsible for their health and safety at work.

In Austria, the ÖGB (Austrian trade union federation), UNI-Europa (European trade union federation) and GPA-DJP (Union of private-sector employees) are calling for the creation of ways to establish co-management, collective bargaining and workers' rights to protection for the working population as a whole, and social

security systems open to all workers independently of their status [9].

3. The emergence of new activities and new occupational risks

Digital innovations can simplify and facilitate work, by increasing hourly productivity, but bring with them a whole new set of occupational risks.

These new tools are mostly smartphones and tablets, and all the associated professional applications. For the great majority of employees, this is the most visible symptom of the digital transformation. The number of personal smartphones has been multiplied by six since 2006, with a fourfold increase in tablets between 2011 and 2013. 55% of workers now have a microcomputer in their workplace. For managers the figure is 90%, and for intermediate occupations around three-quarters.

The organization of communications is changing, both inside the enterprise and with its external partners, due to the development of communication via the social networks (Facebook, LinkedIn, Twitter) and instant messaging software (Skype for Business), which is tending to replace conventional messaging services.

3.1 Stress factors related to occupational instability

This applies especially to our German neighbours who, in addition to the arrival of digital platforms and the expansion of non-salaried work, must also cope with the development of "mini-jobs": work over limited periods of time for a salary of less than €450 per month. This salary is then exempted from any social security contribution or taxation.

The DGUV [10] notes that the heterogeneity of work has become a psychosocial risk factor for workers, because atypical work deviates from

¹⁶ Deutsche Gesetzliche Unfallversicherung, the German accident insurance organization.

the norms in terms of working hours, remuneration and job security, which can result in stress and additional constraints:

- Job stress and the pressure of job hunting;
- The impression of being constantly evaluated: even more than other workers, temporary workers and contract workers must prove that they are efficient if they are to hope that their job could be extended;
- Being employed by several companies at the same time creates new constraints of time management;
- The uncertain future of the current job and the decision to maintain it in the future or not;
- The change of occupational environment (job or teams), which requires constant work of adaptation, for example, to safety rules;
- The impression of isolation due to the lack of social contact and support from colleagues and supervisors.

However, it has been noted that part-time employment, and more generally the new self-determination of one's own working conditions, can produce a better balance between private life and working life. But this is often offset by the workload and tight deadlines stipulated in exchange by supervisors or customers.

3.2 Worker flexibility in space and time

Electronic agendas, tablets and smartphones, combined with the new opportunities for remote internet connections, have pushed back the traditional work boundaries in space and time. It is now possible for a large number of workers to perform their work from different places and at any time of the day, provided that they can establish an internet connection and access their software, applications and work data.

Due to the particular constraints entailed by the responsibilities of managers, but also the autonomy which often characterizes their job, for a growing number of them the balance between private life and working life is hard to

achieve. This raises even more acutely the difficult question of measuring and monitoring the workload.

The workplace is now more flexible, subject to *residential mobility* (moving, expatriation) and *circular mobility* (long-distance travel each day, weekend travel, seasonal work).

Moreover, proxy mobility¹⁷ - remote control and virtual cooperation - are developing and allow a worker on site to work with a person operating in a different location or to take control of external devices. This type of application is becoming routine in the medical sector: a doctor who performs an operation with the assistance of a remote specialist or a paramedic who carries out the instructions given by a practitioner by phone.

Expected future developments will probably result in completely remote-controlled activities, especially in factories and for maintenance.

3.3 Hyperconnectivity, a psychosocial risk factor

The phenomenon of "hyperconnectivity", already widespread in the private sphere, has also developed in the professional sphere. Many managers now have "professional" smartphones and tablets provided by their company. In return, the managers have access to their mailbox round-the-clock and can be solicited at any time.

¹⁷ A proxy is a computer (or a software run on a computer) which serves as an intermediary between a terminal and another server from which a user requests a service.

Table 2: Examples of new location-flexible work forms (DGUV)

Work forms	Details
Teleworking	Work at home (with possible alternation between home and workplace).
Telecommuting	Some workers spend most of their working time in work-related travel, business trips, with customers or simply at different locations. They depend on traffic conditions and/or public transport systems. They use this transport time to communicate with their colleagues or work on laptop computers, smartphones or tablets.
Virtual teamwork	<i>Knowledge workers</i> (*) must regularly join new teams in remote locations, but they save the cost and effort of physical travel thanks to a shared network. Work is no longer measured in terms of working time but by the results achieved.
<i>Crowd working</i>	Freelance workers are in competition and are recruited via a virtual network for specific projects. They are paid and rated by the customer once the customer has accepted the deliverable.

(*) *Knowledge workers* are workers whose activity consists in developing and using knowledge, rather than producing goods or services: they include, for example, scientists, engineers, physicists, IT specialists, architects, accountants, lawyers, etc.

The report by Bruno Mettling[1] considers the digital transformation as a work-related stress factor: directly, by creating in the employee a “feeling of constant stress, a sustained acceleration of interactions”; and also indirectly because, like any change, it can cause concern regarding changes in employment.

According to *The Boston Consulting Group*, the speed of change, the removal of boundaries between private life and working life and the virtualization of human relationships in the work environment are potential factors triggering work-related conditions such as job burn-out or “FOMO” (“*Fear Of Missing Out*”¹⁸), which reflects a form of social anxiety leading to an obsessional relationship with professional communication tools.

Meanwhile, the report on “Well-being and efficiency at work, 10 proposals to improve psychology in the workplace”¹⁹ points to the fact that with the increasing number of communications, there is an increase in

psychosocial risks due to the confusion between what is urgent and what is important.

Ultimately, the report maintains that the digital transformation would be an opportunity to improve systems for psychosocial risk prevention, and in particular:

- The right and obligation of logging off, for an improved balance between private life and working life;
- The need to supplement the working hours approach with a workload approach;
- Moreover, proximity management is identified as the main factor in psychosocial risk prevention and social dialogue is encouraged more than legislative and regulatory measures in the management of working conditions.

3.4 New virtual work environments

The digital economy has allowed the development of virtual reality, used especially in the construction and development sectors via CAD (Computer-Aided Design²⁰) models.

²⁰ This expression covers the use of computer software for drawing and designing real systems. These activities are referred to as CAD (computer-aided design) and CADD (computer-aided design and drafting).

¹⁸ *Fear of Missing Out* is a mental disorder related to new technologies such as mobile phones and social networks. Literally, it refers to the worry of missing out on something. Some users develop an addiction to these tools and fear being disconnected.

¹⁹ This report was submitted to François Fillon on 17 February 2010 by Henri Lachmann, Chairman of the Supervisory Board of Schneider Electric, Muriel Pénicaud, HR Director of Danone, and Christian Larose, Vice-President of the Economic, Social and Environmental Council (CGT).

The complexity of these models ranges from simple mechanical components to large industrial installations. The work environment is no longer real but in this case exists as a computer projection. Examples of these 3D projections of work objects in the real world, or of simulation of complete work environments, exist under the name *Cave Automatic Virtual Environment* (CAVE). Virtual work areas can be projected for training purposes or to assist with the development of complex systems.

In France, some cutting-edge firms such as Dassault Aviation have developed this type of area: the *Virtual Reality Center* in Saint-Cloud can display a full-scale computer model of an aircraft and have it tested by test pilots.

Furthermore, augmented reality makes it possible to superpose virtual data on the real world ("augment" it), generally through special glasses or a computer screen. Cameras can identify the user's position and the angle of view. The objects or spaces that the user observes are then augmented with virtual data or objects which can expand the field of real life (an example is the *Google Glass*). In the professional area, these devices can assist with medical diagnoses and treatments, maintenance work and product drawing and design, and they can assist aircraft pilots by displaying flight data.

These environments, designed to assist workers and facilitate the performance of complex tasks, entail a reappraisal of the framework of "human/machine" interactions. Repetitive work in these forms of environments, combined with the increased use of digital technologies (screens, headsets), can also cause sight or hearing deficiencies in workers.

3.5 New autonomous production systems

"Industry 4.0" is the expression used to describe the establishment of an intelligent relationship between humans, machines, objects and ICT (Information and Communication Technologies) tools.

Despite all the new technological resources employed, production process control is still

based on intelligent planning by production and logistics experts and operators. In its report on "Work 4.0", the German DGUV emphasizes their replacement by *self-organising production systems*. Thanks to high-speed remote data transfer, integrated smart sensors and internet access, these systems are capable of acting in an independent, autonomous manner.

Smart machines, storage systems, equipment and products can themselves exchange information, trigger processes and control them. Workers are still an integral part of the production process, but act in a support role or when a serious failure occurs. They are sometimes assisted by "collaborative robots".

3.6 Physical assistance robots

In a context of longer life expectancy and population ageing, experts foresee an increase in the dependency ratio²¹: for each pensioner, it is estimated there will be less than two working persons. This development will eventually exacerbate the problem of dependence and support for the elderly. Also, within the labour force, there will be an increase in workers' average age, together with an increase in the number of older workers against the backdrop of a rising legal retirement age and longer social security contribution periods.

In the job market, there is likely to be an increase in the number of jobs in goods and services consumed by senior citizens. These jobs are mostly low-skilled, strenuous and in sectors exposed to occupational risks: healthcare, agriculture, building, hotels, restaurants and catering and personal services. This would accentuate the recruitment problems in these sectors.

In this context, the INRS²² has carried out a prospective study [11] on the role that physical

²¹ The dependency ratio is the ratio between the number of pensioners and the number of working persons. French national research and safety institute INRS expects it to exceed 50% in the EU-25 in 2045.

²² Institut National de Recherche et de Sécurité pour la prévention des accidents du travail et des maladies professionnelles (French national research and safety institute for the prevention of accidents at work and occupational diseases).

assistance robots will play in the working world on the 2030 horizon. These so-called “cooperative” robots “are designed to interact with humans in a shared work area in which robots and humans can perform tasks simultaneously”. In a work context, they would be used mainly:

- To take the place of humans (cleaning of public places, retailing);
- In remote operation to avoid user exposure to risk factors;
- Or in a role of physical personal assistance:
 - to help users perform tasks that they are no longer capable of doing because of their age or a disability;
 - but also to allow an able-bodied user to perform repetitive or painful tasks (exoskeletons).

If physical assistance robots were to become established in these sectors, they would greatly improve the working conditions of workers by reducing physical stress and assisting elderly and disabled workers. But they would pose new challenges from an occupational safety and health viewpoint:

- Risk of mechanical shocks: for example, a collision between the arms of the robot and the user, due to a wrong movement by the user or a failure of the robot control system;
- At the same time as they reduce certain physical stresses, physical assistance robots could cause new musculoskeletal disorders;
- Moreover, the advent of these robots could face low social acceptability and be a source of psychosocial risks: fear of the machine, fear of losing one's bearings and technical skills, impression of reduced autonomy, or ethical considerations regarding the replacement of humans by machines.

An example: humanoid robots at Airbus

With the Franco-Japanese laboratory JRL (*Joint Robotics Laboratory*), Airbus is currently developing humanoid robots dedicated to its aeronautics assembly lines. These robots, scheduled to reach the workshops within 10 to 15 years, should be able to relieve human operators of the most laborious or dangerous tasks.

According to Adrien Escande, head of the joint research programme, “the robots must be capable of moving in small spaces such as a

fuselage, and performing complex tasks in numerous positions. Concretely, industry needs humanoid robots capable of kneeling or stooping like a human being, and which can perform more sophisticated operations such as screwing up or tightening a bolt” [12].

The main research challenge concerns robots' movement. Robots must be able to move in confined spaces, climb on ladders, and walk on irregular surfaces without bumping into objects or the companions who will work alongside them. European researchers are currently working on the development of *multi-contact* mobility, i.e. the ability to lean against a wall or a table to move in places that are hard of access, such as narrow passageways or in a fuselage cluttered with numerous cables and equipment items. From a safety viewpoint, the robot must not endanger human operators, the aircraft or themselves.

In aeronautics manufacturing, the work concerns few units produced, but there is a very large variety of tasks to be performed, and this constitutes an additional constraint in the specifications. Conversely, other sectors such as automotive manufacturing will use robots to perform chain work on a large number of products. So far, Airbus has introduced robots and a few humanoids into its workshops, but they do not move and they remain riveted to their work station.

4. The increased role of risk prevention

Faced with the massive arrival of digital tools in the workplace, the occupational injury insurance and occupational risk prevention organizations will have to study and prevent the new risks upstream, in particular taking into account the preponderant role of standardization.

4.1 Preventing emerging risks

The risk factors for workers' mental and physical health have increased tenfold due to the changes observed: occupational instability, isolation of autonomous workers, difficulties in cutting the link with new technologies. By

bringing together employees and employers, the OSH organizations will have to facilitate these changes by developing new programmes such as:

- Adapting communication with businesses to help them support flexible workers (see **5.1 The health and safety of flexible workers**);
- Preventing psychosocial risks in precarious workers: temporary work contracts, part-time work, new recruits in trial periods, etc.;
- Preventing risks related to the continual use of digital devices: right to log off, separation between private life and working life, sight disorders (increased use of screens) and hearing disorders (headsets and headphones);
- Helping companies develop their own culture of workplace health, by encouraging employees to themselves adopt healthy and responsible living habits;
- Allowing for the fact that workers react differently to these changes, depending on their age, gender, living habits, etc.

4.2 The preponderant role of standardization

Like for the New Approach²³, where they became invested in product standardization, injury insurance organizations will have to watch closely the new normative fields which are opening up. Faced with the development of flexible law, allowance for risk prevention as of the design stage, via standardization, represents a major occupational safety and health challenge.

The European Trade Union Confederation (ETUC) considers that it is essential to establish standards in order to ensure the digital

²³ The principle of the "New Approach" was laid down by the resolution of the Council of the European Union of 7 May 1985 which defined a "new approach in the area of technical harmonization and standardization". With this resolution, the European institutions decided to change their approach for enacting legislation harmonizing the technical rules for the movement of products in the European internal market (according to France Normalisation).

integration of European services and manufacturing industries, for example by ensuring interoperability of the communication protocols and data formats used for data storage, processing and transmission between machines and devices, in order to contribute to the health and safety of all workers [13].

Furthermore, digitization also goes hand-in-hand with a normative trend concerning *Big Data* which is not without consequences for Social Security organizations.

On 14 April 2016, the European Parliament passed the reform of the EU legislation on data protection (the *General Data Protection Regulation*). This General Regulation, published in the OJEU on 4 May 2016, will be directly applicable in all the Member States within two years. It aims to give citizens more control over their private information by establishing a right to be forgotten, the clear and explicit consent of the person concerned regarding the use of their personal data, or again the right to transfer one's data to another service provider.

As of the enactment of this Regulation, in April 2016 the CEN-CENELEC Management Centre (CCMC) received a request for the production of a draft standard document (a "Workshop Agreement") with a view to creating a personal data identifier on the internet in the form of an algorithm (*ISÆN, Individual Social data Auditable addrEss Number*).

The project aims to materialize the aforementioned European policy initiatives with regard to data protection by creating the first personal data management standard.

The aim is to design an identifier capable of measuring where and how people's data are used, allowing people to monitor information concerning them, facilitating their portability, knowing how they are used and checking that use.

Citizens could generate their ISÆN themselves, and this would enable them to retrieve information concerning the precise location and use of their data.

The management of *Big Data* is obviously strategically important for national occupational injury insurance organizations. Apart from the innovative and personalized health services which could be proposed to patients, the fact

that the latter have control over the use of their data will be an important factor in the acceptance and deployment of “cyberhealth” platforms in the near future.

On a more forward-looking level, thinking is needed regarding the increasing growth of smart personal protective equipment (PPE) in the occupational safety and health market. These interconnected devices will produce a large mass of personal data to encourage fast decision making for the protection of employees.

They will keep in memory all the data produced (pulse rate, temperature, geolocation of the equipment wearer, etc.) and will be entered in *Big Data*. The control of this information by the employee via a unique identifier could have major consequences, in occupational injury and disease investigations, insofar as concerns proof of the causal link between the work activity and the injury/disease.

In April 2016, the French Minister of the Economy emphasized the strategic aspect of voluntary technical standardization for the deployment of the Industry of the Future during a government plan steering committee meeting [14] to which the Director General of French standardization association AFNOR was invited. In response to the Minister's request, AFNOR initiated a vast consultation with those taking part in the standardization committees. A 'strategic impetus group' ('GIS') was also set up to propose ideas and recommendations for voluntary standards for the Industry of the Future. This group met for the first time in July 2016 to examine nine priorities identified by the consultation:

- Non-destructive testing chain and incorporation in the production line, to remove the technological obstacles concerning digital systems and tools in order to perform non-destructive testing in a reliable, fast and flexible manner;
- Additive manufacturing, related to the three-dimensional printing technology (3D printing) and computer-assisted part shaping processes, by adding material, stacking successive layers, unlike machining operations where material is removed;

- Corporate energy efficiency and environmental footprint (clean, silent and environmentally friendly processes);
- Organization, production scheduling and logistics;
- Digital production line, to promote smooth communications by working on software interoperability, image processing, the reliability of the Internet of Things, information systems security and reference architectures;
- Industrial robotics, cobotics and augmented reality, to handle the safety of new collaboration techniques enabling workplace sharing by the operator and the robot;
- Use of composite materials and new materials;
- Role of humans in the factory of the future, to define a new balance with cutting-edge technologies;
- Circular economy, including the reclaiming and recycling of materials (especially rare earths).

A review and an evaluation of the existing situation are planned for December 2016. Since the group forms part of the French standardization strategy 2016/2018, the deadline for the work of the 'GIS' group is the third quarter of 2018. The group will submit its recommendations to the CCPN (the AFNOR standardization coordination and steering committee).

4.3 Adapting risk prevention to robotics

In the Netherlands, the *Scientific Council for Government Policy (WRR)*, an independent think tank on social issues, has recommended putting in place “a robotics agenda for governments, employers and workers, their representative organizations, researchers and all the other stakeholders who will help manage robots in various ways” [9].

Apart from the mechanical and electrical occupational risks related to the use of robots, the thinking mainly concerns the role of humans in a dehumanized environment and the

mental risks that could result from their massive arrival in workplaces. The WRR discusses the following issues:

- Inclusive robotization: robots must not replace humans, but be used as supplementary tools to make workers more productive;
- Appropriation of the work by humans: how to have humans and technologies work together by allowing humans to retain responsibility for their work;
- The possibility of workers becoming co-owners of the robots and other machines, because "co-ownership is a way for workers to continue to control robots".

Note, nevertheless, that safety-related issues concerning industrial robots, especially for collaborative applications where humans and robots share the same work area, have already been the subject of standardization work (EN ISO 10218 standard - Robots and robotic devices, Parts 1 and 2).

In addition to these documents, a technical specification referenced ISO/TS 15066 dedicated to collaborative applications has been drafted. The aim of this specification is to clarify the safety principles to be applied for such activities and guide the risk analysis which has to be performed by the economic operators (robot manufacturer and integrator).

For industrial firms, however, the collaborative robot concept seems likely to gradually move away from the strict framework of direct interaction between humans and machines, and thus no longer confine the robot in a secure enclosure inaccessible to humans. Such arrangements represent new physical risks related to potentially dangerous contacts and shocks, but also psychological risks for workers.

Finally, note that within the specific framework of exoskeletons, capable of improving humans' performance for actions that are too complex to be performed by an autonomous machine, some industries are also considering them to facilitate recruitment in disregarded sectors. For example, Colas, world leader in the construction and maintenance of transport infrastructure [20], has experimented with an exoskeleton for asphalt rakers for road

construction. By reducing worker exertion, it also helps give a more modern and attractive view of this job.

4.4 Adapting risk prevention to smart PPE

The digital economy is also contributing to the rapid development of new smart personal protective equipment (PPE) [11]. This equipment comes complete with sensors capable of measuring various parameters. Some respond to the worker's physiological condition, while others give a warning in case of problems: pulse rate, temperature, humidity level, geolocation, etc. This information is then collected and analysed in electronic devices. For example, fire fighters and the French Navy already use protective jackets which trigger an audible and visual alarm when the temperature exceeds 45°C under the jacket and 144°C outside. "Modern jackets are so efficient that it is becoming difficult for fire fighters to get an idea of the external temperature. It also occurs that, when in action, they do not observe that they are no longer transpiring, hence the usefulness of such sensors", explains INRS expert Patrice Marchal.

An INRS study will be started soon to produce an overview of current smart personal protection systems and allow a definition of these devices to be proposed. This work will be supplemented by a classification established on the basis of various criteria (technical, normative, OSH). Finally, the study will have the objective of developing a process for risk analysis in case of malfunctions. In any case, the INRS warns that these devices "should not be substituted for the general principles of risk prevention, which consist of giving priority, above all, to collective protection measures and the use of PPE as a last recourse".

In practice, despite numerous initiatives, the sale of smart PPE is still rare. Several challenges still have to be met in order to bring it into general use. There is notably the question of their cost, which increases sharply whenever electronic systems are included. The figures vary, but the increase mentioned is generally in a range between 30% and 300%. It is also essential to take into account the procedures for certification of these products,

for which the level of performance of their control systems must be evaluated and tested. Electronics of course also means a power supply, hence the question of the autonomy and lifetime of these systems.

Workers, for their part, fear that this connected equipment may be used to monitor their activity. Finally, these new functionalities must also be taken into account by the standards.

In the smart PPE category we can also include equipment for which the protection system is actuated after detection of the risk or dangerous event via electronic controls. From so-called passive PPE which protects its user against a possible risk, there is a transition to active PPE, which protects its user as soon as the dangerous event occurs.

Standardization is already interested in this type of active PPE, e.g. in work relating to inflatable guards for motorcyclists, EN 1621-4.

4.5 Adapting occupational safety and health training

Training in occupational safety and health (OSH) is a major lever for occupational risk prevention. The development of digital tools is an opportunity to reintroduce OSH aspects in conventional initial training circuits, but also in further training directly in the enterprise.

In 2009, a French initiative established the French network for occupational health training, RFFST (Réseau Français de Formation en Santé au Travail). This was to produce, on online platforms, a reference guide for managers, and training tools in digital format (slide shows, videos, case studies, bibliographies). These tools were

interconnected and were supposed to “facilitate assimilation of the basics of occupational health by those who have management responsibilities”, using modern communication tools.

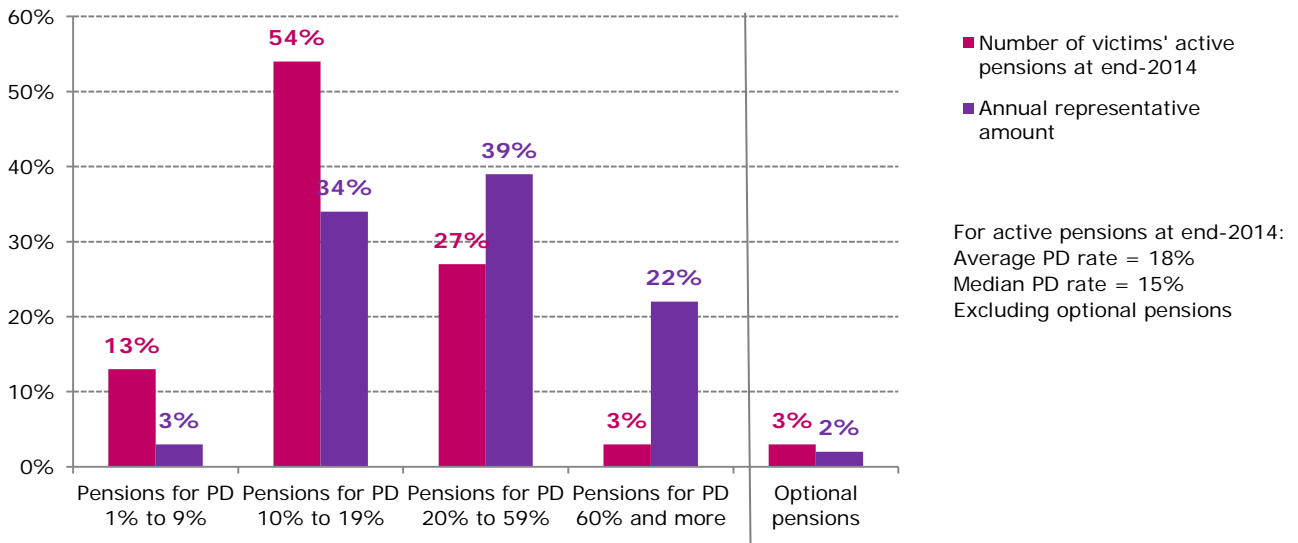
In the end, this initiative did not see the day, but the everyday use of new digital equipment by workers, including smartphone applications, should enable a new approach in order to communicate and reach a broader public by means of play activities involving no stress.

4.6 Making the Social Security system more efficient

In Germany, the DGUV has performed a comparative study to analyse the impacts of automation on its own administrative costs. In the end, the German accident insurance organization showed that the cost per case handled had decreased slightly (from €22 to €21), especially for injury cases of low severity, as a result of the use of new IT resources. Information systems have freed up time spent on routine tasks, time which has been reallocated to activities requiring more creativity and ingenuity. The digital transformation has therefore gone hand-in-hand with a fall in administrative costs for simple cases and, in the economy more generally, on all repetitive tasks in the service sector.

Figure 1: Breakdown by permanent disability (PD) rate bracket, in numbers and annual representative amount, of victims' pensions, active at end-December 2014

Source: Occupational Risks Department (DRP), 2015 annual report.



In Europe, digital tools have also enabled occupational injury insurance organizations to invest in “active case management”. This entails personalized management of complex cases of injury or disease, based on a case manager and standardized tools.

In France (see Figure 1), 22% of expenses for permanent disability compensation (about €1 billion) are concentrated on only 3% of victims (14,300 cases). This represents more than €60,000 spent each year for each of these pensioners [15].

In France, digital tools have been an essential lever for working out the programme to optimize and smooth out the treatment process for victims of complex occupational injuries.

As owners of anonymous databases concerning the medical profile of the entire population, health insurance organizations will have increased responsibility in collecting and using the data of their affiliated members. They will also have to take into account new jobs that are gradually emerging thanks to Data Science: database management, risk management and actuarial science. They will also have to gradually automate the processing of simple cases in order to focus on personalized management of serious occupational injuries and diseases.

An example: the occupational safety and health register

OSH organizations can now rely on new media to communicate with companies and their employees. They can also encourage the deployment of new facilities for corporate information and internal communication in order to improve working conditions.

For example, new IT resources can be an opportunity to enhance the value of the occupational safety and health register [16]. This document, provided for by the regulations, is made available to all personnel so that they may record in it their observations regarding health and safety in their everyday work, e.g. report a malfunction, an anomaly, problems relating to working conditions (cluttering, temperature, noise), training, the presence of dangerous products or equipment, or again the environment (condition of the premises, plant obsolescence, etc.); more generally, questions are asked there concerning occupational risk prevention, and improvements are proposed in this area.

This is a communication and traceability tool, which is not always sufficiently used. One of the explanations suggested was the impractical aspect of the paper medium. Some departments therefore proposed to their personnel a register in PDF format, as authorized by the regulations. That encouraged expression by the personnel and publicized the existence of this tool, because ignorance of it was one of the reasons why it was not sufficiently used.

5. New responsibilities for enterprises

Faced with technological and organizational change, the injury insurance organization will have to continue to adapt its communication with enterprises, targeting the specific risks involved in new technologies and new forms of management.

5.1 The health and safety of flexible workers

Enterprises will have to adapt the workplace to new ICT and help mobile workers develop their personal OSH culture. For example, in Germany the DGUV provides the following list of recommendations:

- Establish clear rules concerning the use and accessibility of mobile handsets, consistent with the legislation on working hours;
- Plan work and projects over the long term, in order to plan rest periods beforehand and organize “logging off”;
- Establish relationships of mutual trust and limit the continuous monitoring of workers;
- Organize mobile work individually according to the specific constraints of each worker. For example, a worker who regularly makes business trips over long distances will be very independent and will tend to work more hours than average without resting sufficiently. A home worker, for his part, will suffer from greater social isolation and lack of recognition for the work performed.

5.2 The diversity of profiles on the same site

Many observers assume that, in future, a significant proportion of the work existing at present will be reduced, reoriented in the form of projects and focused on results. In practice, these arrangements will mean that within a given company, a given department and a given work area, workers performing the same work will be remunerated differently and will

have different levels of social protection. This poses new challenges in terms of occupational safety and health and risk prevention in the enterprise.

- The enterprise will have to ensure that all workers perform their work in good conditions, even if they are travelling or on a temporary work contract. It must ensure the health and safety of workers under subcontract and those who work for several companies simultaneously, since this responsibility cannot be left up to the workers themselves.
- It is harder for insurance organizations and enterprises to communicate with flexible workers on risk prevention matters. The actors will now be able to use modern means of communication and occupational safety and health services within the framework of the enterprise's internal network.
- It is harder to measure and monitor the evolution of risk factors, in order to have a realistic picture of the situation in the enterprise.

More generally, occupational risk prevention tends to no longer be confined merely to technical and ergonomic considerations, but to cover all aspects of work: organization, personnel deployment, workplace safety culture, training, working hours and behaviour. The work in progress on definition of an ISO 45001 standard on “Occupational Health and Safety Management Systems” is the most recent example of this development. Moreover, there is also a trend to involve workers in risk prevention and support them during their life in the enterprise, or even throughout their work career.

5.3 Further training of employees

The new digital tools require a high level of skills, and a constantly greater speed of adaptation by workers to avoid deskilling, a “digital disruption factor”. This equipment raises issues of learning, acquisition and recognition of new skills and expertise.

In manufacturing industry, where there are up to 185 different jobs, about 50% are likely to

be automated, according to the *Roland Berger Institute* [17]. And contrary to common belief, skilled jobs are also likely to be very severely affected: "The boundary separating automatable jobs from other jobs no longer corresponds to the "manual-intellectual" distinction. What makes a job automatable in the digital era is above all its *repetitive* nature, whether it be manual or intellectual".

The institute mentions, for example, the jobs of adjuster, fork-lift truck driver, factory quality controller, tool maker and computer-assisted machine operator, which are threatened. Other jobs, based on decision support systems, will emerge in turn: predictive maintenance statistician, *cobot*²⁴ trainer, cyber-testers²⁵ and control system setting experts. All these new jobs are in theory less exposed to occupational risks, but workers have not been trained for them.

Decision makers do not yet understand all the new skills that industrial workers will need to have within the next 20 years. This unknown will change the initial training of students in higher learning courses: rather than focusing on instruction in precise techniques, students will have to be trained "in willingness and potential for training and learning by themselves" (Laurent Carraro, Managing Director of Arts et Métiers ParisTech). This will lead to the emergence of general-purpose profiles and strengthen industry's need for further training.

Several French companies have initiated training campaigns related to the digital economy:

- Saint-Gobain group has launched an online training campaign open to all employees: forums, MOOCs²⁶, e-learning modules, enterprise social network, although allowing for the possibility of continuing to attend conventional classroom training sessions.
- Air Liquide group, which has launched a plan for modernization of its production facilities using digital tools, wants to promote peer-to-peer learning by providing workers with

technologies enabling them to produce immersive videos.

5.4 New management methods

Working efficiently in a flexible environment also requires more suitable management and new human resource management tools. Management skills should now include project management, remote management and community leadership characteristics. These new constraints basically require "hands-on" managers.

Employee supervision is currently faced with two fundamental changes [10]:

- *Indirect management*

In target-setting meetings, managers and workers agree on targets to be reached, which will be monitored by performance indicators. Detailed instructions for everyday work are no longer necessary and managers no longer have to be in direct contact with their personnel. The personnel are assigned more responsibility regarding the means to be used, processes, equipment, and execution and the quality of results.

- *Remote management*

Moreover, managers must adapt to flexible work remote from their workers, because in many cases the two parties will no longer see and speak with one another directly each day: not only for the planning and delegation of work, but also more generally in the way in which they communicate and give feedback²⁷. This evaluation is based more often on the result than on the effort produced or the time worked.

And yet, contact between workers remains essential, and it is recommended that managers should continue to hold face-to-face meetings, organized in advance.

As a general rule, workers are now assigned more responsibility and have to manage their organization, their performance and their

²⁴ *Cobots* are a category of robots dedicated to handling objects in cooperation with a human operator.

²⁵ Cyber-testers perform product tests by simulation.

²⁶ A MOOC (Massive Open Online Course) is an open type of distance training via the web.

²⁷ Feedback is the evaluation that the manager communicates to the worker, in writing or often verbally face to face, on completion of a job.

efficiency themselves. This means that most of them are left to themselves and, without supervision, they could adopt self-endangerment attitudes, in other words endanger themselves by reckless behaviour.

To adapt to these new forms of communication in the enterprise, it is necessary for all the stakeholders to have sufficient knowledge of these new tools: smartphones, agendas, instant messaging services, file sharing, etc. In particular, older workers, often in supervisory and management positions, are the ones most likely not to master them. Some large enterprises therefore organize group sessions in which the younger workers "mentor" older workers and help them become familiar with these tools.

5.5 Worker supervision by digital tools

Apart from the issue of protection of privacy, the European Trade Union Confederation warns against the dangers represented by the new possibilities for monitoring and surveillance. The French data protection agency CNIL has started work thinking about the changes in work relationships [18]. The tension in links between work and digital technology is due to the fact that digital technology not only allows individuals to be more autonomous and flexible in relations with their work sphere, but also allows organizations to better control them. The challenge is to "succeed in providing agility via the new digital tools while avoiding the replication in the working world of permanent situations of transparency and tracing".

This risk is marked by the trend to BYOD²⁸): the owners of smartphones, tablets and laptop computers bring their personal devices in and use them in their workplace; 50% of French owners of a smartphone say that they manage their agenda using it and only 44% say they use it strictly for personal purposes. However, the flow of corporate data in uncontrolled terminals could be a source of risk. And the organization could be tempted to limit them via intrusive surveillance.

²⁸ "Bring Your Own Device"

MDM or MAM (*Mobile Device Management / Mobile Application Management*) is an option allowing employers to remotely monitor the declared terminals of their employees. It is therefore hard for employees to keep their personal data away from the eyes and actions of their supervisors. However, an alternative solution is emerging in devices for "containerization" of data and space on the telephone. A sealed compartment can be arranged on employees' personal devices in order to receive business applications and uses. In this case, the organization cannot monitor the terminal as a whole but merely the compartment dedicated to business activities.

Several firms have specialized in these technologies, e.g. the French group Thales which proposes its *Teopad* solution, or the American *Good Technology*. It is also the specialty of the *Divide* start-up, which was acquired by Google in May 2014.

However, this phenomenon of surveillance is expanding and constitutes a risk in the enterprise: tension and conflict with the employer, and employees' feeling of insecurity and stress when using digital tools. In 2015, the French data protection agency CNIL recorded a significant increase in complaints concerning the use of personal data: 7,908, or 36% more than in 2014. In particular, 16% of this increase concerned "employee surveillance".

5.6 New performance indicators

Some start-ups use the new tools available to put in place activity measuring indicators [19]: sending emails, adding contacts, document revision, preferred time for working (on the assumption of flexible workdays). Grouped in a single platform, these data are supposed to facilitate improved circulation of information. Data concerning the physical activities of employees, measured by means of a connected bracelet or pedometer, could in future also be included there. Employees' "well-being" is presented as a source of productivity by the players in the connected objects market.

Some firms already use sensors and Big Data processing to optimize efficiency in the workplace. A few years ago, Bank of America

asked 90 volunteer employees to wear badges in order to record their movements and their social interactions (in particular the tone of their conversations) for several weeks. The test showed that the most productive employees were those belonging to closely knit work teams which exchanged the most information with their colleagues²⁹.

Like *Bank of America*, *Cubist* noted a correlation between productivity and face-to-face interactions, and a decline in social activity during the lunch hour, because many employees stayed in their offices to consult their personal emails rather than chat with their colleagues. In response, the company decided to make its cafeteria more welcoming, redoing the lighting and offering better food to encourage its employees to have lunch together.

After the consumer, it is therefore directly the employee who will be placed under the scanner of algorithms in charge of managing their well-being and productivity. But this activity poses new questions, notably regarding data collection and analysis, because so far there exists no equivalent role in the corporate structure. Ultimately, these issues will help the CDO (*Chief Data Officer*³⁰) emerge as an essential member of the firm.

6. Conclusion

Social protection, and in particular occupational risk insurance, is eventually likely to be very profoundly affected by the digital transformation, on the issues of coverage of the new forms of work, the new possibilities available to employees, and the use of technological tools and the dangers they entail.

The new flexibility of everyday work is the common factor in all these new activities. In absolute terms, this is a benefit for all workers,

²⁹ Ben Waber, CEO of *Sociometrics Solutions*, has himself theorized this new approach in a book called "People Analytics" (FT Press, 2013).

³⁰ The Chief Data Officer (CDO) is a strategic position like the CEO (*Chief Executive Officer*), CFO (*Chief Financial Officer*) and CTO (*Chief Technical Officer*).

who have a better balance between private life and working life, but in return they must cope with greater insecurity and social and professional isolation. This leads them to work ever more intensely, in the hope of advancing if they prove that they are high-performing, and exposes them to mental disorders in particular. The number of reported cases (job burn-out, stress) is on the rise in all developed countries, while their causes, often multifactorial, make it complex to objectivize the link between the disease and occupational exposure.

While all the commentators note the lack of social protection for the new digital economy workers, *Eurofound* also emphasizes the issue of the representation of these workers, too fragmented and isolated to defend their rights.

Changing job types and statuses are creating alternative needs to traditional occupational injury insurance, which is for the time being reserved, in the case of the general Social Security regime, for salaried workers only.

As a result of these changes, workers with different social protection, compulsory or optional, taken out directly or via an intermediary, increasingly rub shoulders with one another and, in light of the principle of the universality of social protection, this suggests that forward-looking thinking should be carried out on the occupational risk insurance of tomorrow.

Moreover, insurance organizations must take into account all the changes observed in the field and adapt occupational risk prevention to the new technologies which will soon enter the workplace: robots, autonomous production systems, virtual reality environments, etc. allowing as of the design stage for risk prevention principles faced with new occupational risks, as is being done for standardization.

For their part, enterprises will inevitably have to move in step with the changes in their businesses, by developing further training in new technologies and taking greater responsibility regarding the collection and use of their workers' data.

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