

FONCSI

## THE FUTURE OF WORK AND THE FUTURE OF SAFETY IN THE 2030-2040 INDUSTRY

Some Big Picture Elements

- ⊙ Foundation for an industrial safety culture (FonCSI)
- ⊙ Public interest research foundation founded in 2005 in the aftermath of the AZF accident in Toulouse (September 2001).
  - Industrial sponsors (energy, building, transportation)
  - Administrations sponsors (regulators)
  - Ministry of Research
- ⊙ Working as an Int'l think tank
- ⊙ Objective: to take stock of a series of difficult topics relating to industrial safety, both from a practical and theoretical point of view, in Europe and with alternatives visions and contributions from all over world.
- ⊙ Five Year Program with 5 topics

# SpringerBriefs in Applied Sciences and Technology Safety Management



# THE METHOD

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- A two Years approach for each topic
  - With a core group of 10-15 academic and industrial experts
  - Work through literature analysis, expert hearings and international seminars
  - A book published in open access by Springer (Springer briefs)
  - Several open access non-technical documents on practical lessons published on the website of the foundation (English, Spanish, French)

# 2015-2022: TOPICS ALREADY COVERED AND TOPICS IN PROGRESS

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- ⊙ Beyond safety training, what model for what benefits
- ⊙ Safety cultures, safety models
- ⊙ Human and Organizational Factors in Industry
- ⊙ Exploring Outsourcing Practices in High-Hazard Industries
- ⊙ The future of Work and the future of Safety in the 2030-2040 Industry

## Under progress

- ⊙ Regulator-regulatee relationship in high-hazard industries

## Coming soon

- ⊙ How to adjust the balance between Regulated safety Vs Managed safety
- ⊙ Participation in the co-management of industrial safety : what about workers, residents, local authorities, and politicians?

# WORK AND WORKERS IN 2030/40

⊙ A question

- What impacts on safety considering the foreseeable changes occurring in the world by 2030-2040

⊙ A method

- Strategic Analysis...

⊙ Four major changes combining together for unprecedented challenge

- Demographics changes
- Digital revolution
- New skills
- Increasing complexity of the industrial model and safety objectives

Work and workers in 2030/2040

“How will industrial safety evolve in high-hazard industry in 2030/40? How to promote the contribution of human operators to safety? ”

The strategic analysis' mechanics

International experts



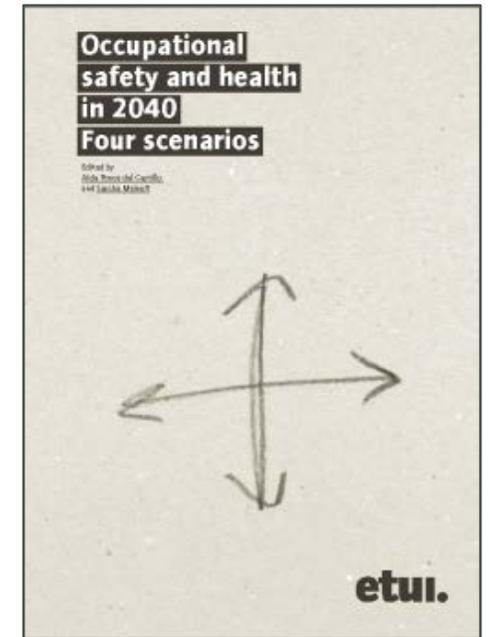
1. Demographic challenge
2. Digital challenge : Technological (r)evolution: digitalization, robotization, autonomous robots (cars, drones, trains, ...), remote control, big data, Big Brother, Artificial Intelligence, augmented intelligence, virtualization (of work, social relations, leisure...), simulation, twin simulation, connectivity (social, economical, political networks...)
3. Skills challenge : Radical and never seen transformation of jobs, hence of skill needs, global redistribution of skills production regions, drastic modification of the map of available skills
4. Industrial model challenge: Continued globalization of value chains, evolution of the structures and nature of companies (financialization, globalization, disaggregation), impact of sustainable development goals (SDG), diversification of stake values & societal demands (safety, security, sustainability, health, environment, ethics, etc.), multiplication of cultural interference, with impacts on safety models and objectives

# SOME OF THE 20 EXPERTS HEARD IN THE ANALYSIS

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- ⊙ André Richier, principal administrator at the European Commission, DG for Internal Market, Industry, Entrepreneurship and SMEs
- ⊙ Rigas Hadzilacos, World Economic Forum, project director of *The Future of Work*
- ⊙ John Allspaw (USA), principal founder Adaptive capacity labs, LLC
- ⊙ Michael Baram (USA) Emeritus, Boston University Law School
- ⊙ Akira Tosé (Japan) Professor engineering management, Niiagata Univ.
- ⊙ Stian Antonsen (Norway), research professor at NTNU Social Research, Norwegian University of Science and Technology.
- ⊙ Gérard de Boisboissel (France), St Cyr, Defense Ministry
- ⊙ Steven Shorrock (UK), Eurocontrol
- ⊙ Antonio Casilli (Italy)
- ⊙ Yann Leriche, CEO Getlink (Eurotunnel, eleclink, CIIFCO)
- ⊙ Dominique Riquet, European Deputy
- ⊙ Jean-Hugues Rodriguez, Airbus, director of Learning and Knowledge Management [Global Workforce Forecast]
- ⊙ Sandra Enlart, Université Paris-Nanterre, Dsides (ex-CEO Entreprise & Personnel, ex-president of the CNEFP)
- ⊙ Pierre-Noël Giraud & Thierry Weil professor at the CERNA, Mines ParisTech, Académie des Technologies
- ⊙ Gilles Pison, National Museum of Natural History, INED....

- ⦿ Much literature on the major trends of change and the industrial impact of the 2030-2040 evolution.
  - All the analyses and statement focused on the objectives of sustainable development, digital revolution and factory 4.0, economy, employment, business model, location, but not much on safety.
- ⦿ We found a few contribution on the impacts of changes on occupational health. The literature remains very focused on individuals, the workstation
- ⦿ But almost none study on the impacts on industrial safety



# 1- THE DEMOGRAPHIC CHALLENGE

## GLOBAL DEMOGRAPHICS EVOLVE DIFFERENTIALLY

- In 2100, 11 billion people unevenly distributed on earth (50% in Africa)
- European population will grow until 2050, then decrease until 2100
- UK will be the most populated European country, much larger than Germany and France

# Projection by continent.

Population projection (in thousands) from 2025 to 2100

	2025	2050	2075	2100
Afrique	1 508 935	2 489 275	3 498 757	4 280 127
Amérique latine et Caraïbes	681 896	762 432	749 876	679 993
Amérique Septentrionale	379 851	425 200	461 329	490 889
Asie	4 822 629	5 290 263	5 142 629	4 719 416
Europe	745 791	710 486	657 283	629 563
Océanie	45 335	57 376	67 282	74 916
<b>Monde</b>	<b>8 184 437</b>	<b>9 735 034</b>	<b>10 577 156</b>	<b>10 874 902</b>

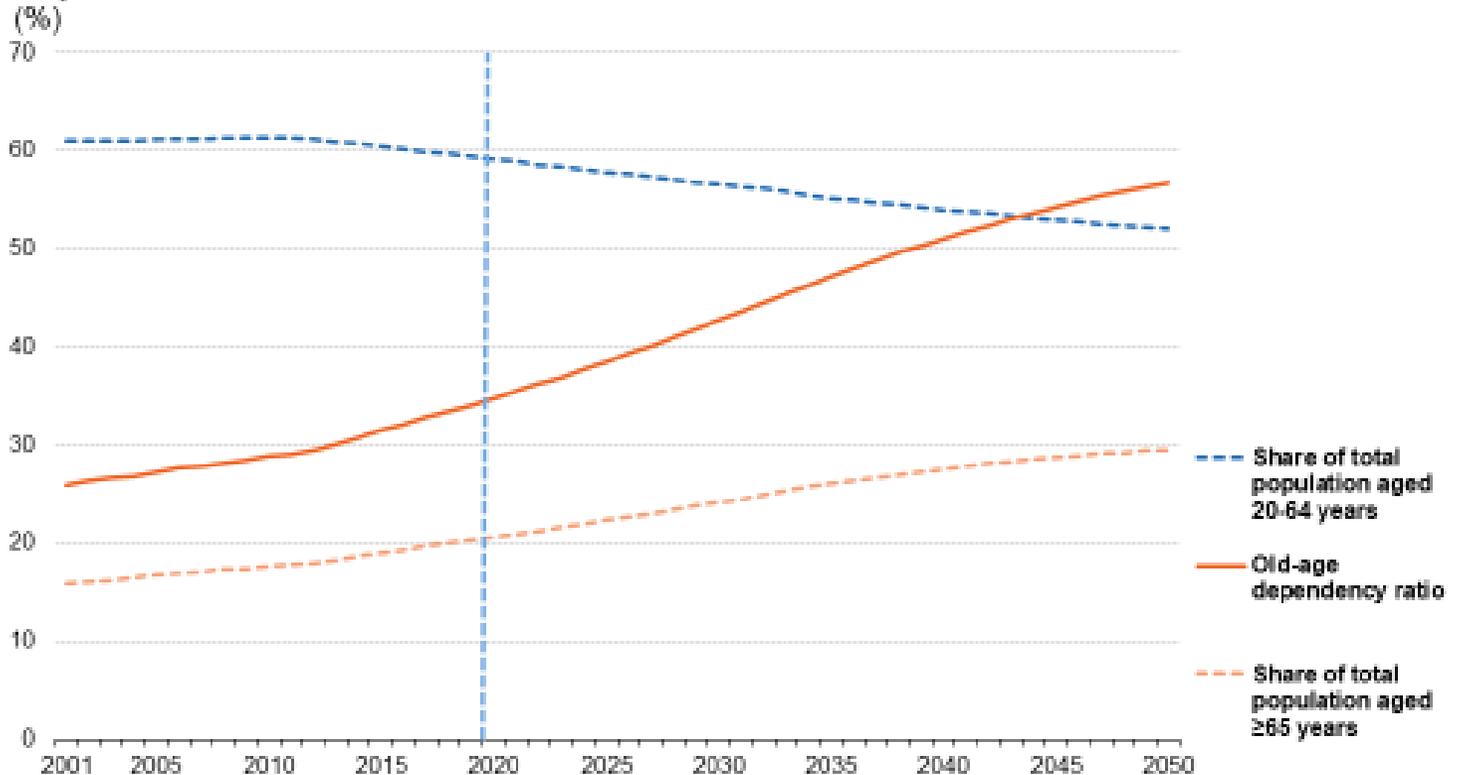
	2 020	2 030	2 040	2 050	2 060	2 070	2 080	2 090	2 100	% différence entre 2020 et 2050	% différence entre 2020 et 2100
UE à 28 avec UK	514 292 912	520 712 470	524 655 224	523 708 357	517 098 344	509 548 113	504 019 027	498 789 751	492 945 555	1,8	-4,3
France	67 204 763	69 116 880	70 926 211	71 587 879	71 673 255	72 032 320	72 605 730	72 939 502	72 876 673	6,5	7,8
Allemagne	83 159 604	83 823 479	83 525 424	82 672 493	81 467 826	80 620 373	80 000 620	79 474 024	79 098 669	-0,6	-5,1
UK	67 086 777	71 468 174	75 294 576	78 290 066	80 311 998	82 132 803	83 644 641	84 365 480	84 698 365	16,7	20,8
Italie	60 233 172	58 940 837	57 710 684	55 859 604	52 995 452	50 156 210	48 186 055	46 433 206	44 585 890	-7,3	-35,1
Espagne	47 054 924	48 071 225	49 245 586	49 932 997	49 376 897	48 391 357	47 968 015	47 844 654	47 341 529	6,1	0,6
Pologne	37 968 244	37 397 916	36 174 048	34 861 135	33 462 408	31 669 769	29 841 357	28 479 116	27 523 771	-8,2	-37,9
Paysbas	17 342 709	17 778 363	17 954 081	17 787 300	17 536 537	17 395 184	17 259 021	16 995 422	16 708 598	2,6	-3,8
Grèce	10 691 204	10 367 846	10 032 362	9 622 242	9 052 676	8 477 995	8 054 104	7 748 398	7 453 044	-10,0	-43,4
Irlande	4 943 466	5 286 004	5 610 321	5 899 815	6 059 309	6 142 116	6 220 658	6 276 401	6 273 711	19,3	21,2

- ⊙ A continued, and uneven, growth of the world population
  - In 2100, 11 billion Humans, unequally distributed
    - Half in Africa
  - The European population will increase until 2050 and then decrease until 2100
- ⊙ An inexorable aging in the most economically advanced countries where the demographic transition is old
  - France 2070: + 11M , (+10,7 of 65+ ): about all the population increase will be made of seniors!
  - On the basis of current principles of production and distribution of wealth, working life will have to increase to 75 or more
  - New forms of work suitable for older people will have to be invented,
  - as well as new forms of cohabitation at work (between grandfathers and grandchildren)
- ⊙ All this will continue to resonate with globalization and generate a huge transfer of available manpower in all categories of jobs

## EUROPE IS AGING MASSIVELY

- Retired/ active population ration will increase
- Aging of a part of the workforce

Population structure indicators, EU-27, 2001-2050



Note: the old-age dependency ratio is calculated as the number of people aged ≥65 years divided by the number of people aged 20-64 years, expressed as a percentage.

2008, 2010-2012, 2014-2015 and 2017: breaks in series. 2018 and 2019: provisional. 2020-2050: population according to the 2019 projections, baseline variant (EUROPOP2019). The vertical dotted line marks the divide between official historical data and EUROPOP2019 population projections.

Source: Eurostat (online data codes: demo\_pjanind and proj\_19ndbi)

# MORE THAN 50 YEARS OF CAREER...

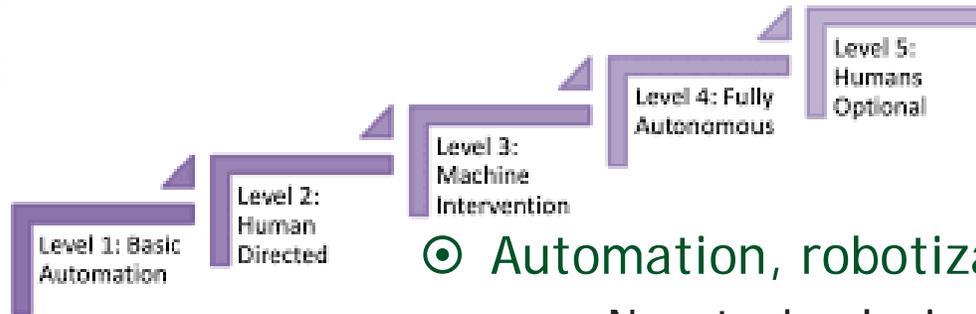
## THE CASE OF JAPAN

- Retirement age at 70 in 2021 and 75 in the near future in Japan
- Mix of generations: grandfather and grandson in the same company at the same time
- Japan has launched a vast retraining program for executives from the age of 55 to work as trainers without salary increases or special promotions.
- Raising the retirement age without a real strategy is causing serious problems on the ground and will have an impact on security



*Akira Tosé, Niigata University (Japan)*

## 2- THE DIGITAL CHALLENGE



Source: Constellation Research, Inc.

# THE OPERATOR - MICRO LEVEL

## ⊙ Automation, robotization, Augmented man ...

- New technologies will not be able immediately
  - No Level 5 in most industrial systems, persistence of human control therefore operator / machine interactions, on the intermediate levels, L3, L4
  - Rediscovery of the literature on automation (joint cognitive systems, difficulties related to automation in the past)

## ⊙ New issues related to AI, autonomous systems

- AI "black box" effect, explicability at interfaces ...
- Loss of sense-making skills and no longer just in skills
- Worker responsibility / machine autonomy

## ⊙ Virtualization of work, remote work

- Remote control / command:
  - Virtualization and situational awareness: loss of certain channels of coupling to reality
  - Evolution of trades, in particular control / command: more monitoring, expert role

# THE COLLECTIVE, THE ORGANIZATION - MESO LEVEL

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- ◎ Strong predictable impact of widespread and sustainable remote work
  - Evolution of relations within collectives, evolution or loss of the "social bond"
  - Evolution of the feeling of belonging to the company, of loyalty?
  - Evolution of operator-manager roles and relationships
  
- ◎ Lack of social and political vision, necessary contributions from the sociology of work, sociology of organizations, management sciences
  
- ◎ Safety impacts difficult to anticipate

## ⊙ Self-learning systems: pb of "certification"

- Evolution of the role of authorities and authority-industry relations
- Evolution of the nature of regulation? From prescription to authorization? Regulation / deregulation?

## ⊙ Big Data: more data produced and used for safety management and governance

- Access to strategic data concerning detailed operation of the systems
- Access to skills to deal with them
  - Power imbalance between data holders and others
  - Potential conflicts between designers, operators and authorities

## ⊙ Evolution of societal values

- Growing negative image of several industrial sectors (oil and gas, chemicals, aviation)
- Growing importance of Sustainable development goals

- ⊙ Humans must remain in control of the action because, unlike machines, they are able to make sense of the action and take responsibility for it.
  - le: At all times the military leader must be able to regain control of the system and get out of autonomous mode.
  
- ⊙ Yes, but...
  - Will the decision maker really be able to? Taking back control puts a cognitive and emotional strain on the decision-maker
  - Will the decision maker really want it? The decision-maker may as well be afraid of engaging his personal responsibility and prefer to leave the responsibility for errors to the machine

- ⊙ In order for humans to trust autonomous systems, they must make their decisions explainable and understandable to humans. They must behave in a consistent and predictable manner at different times and circumstances.
  
- ⊙ Should we develop an art of explanation?
  - A "good" explanation is neither algorithmic, nor exact, nor complete ...
  - It results from the interaction between the explanation and the speaker.
  - It is the one that suits the interlocutor.
  - Training and security: the areas of "common background" and the principles of synchronization must be defined.

- ⊙ **Ie: The military leader, responsible for using the self-learning system in the field**
  - Supervise the learning carried out by the autonomous system before its use
  - With the operators, being able to train and practice equipped with the system, with the system in degraded mode, and without the system
  
- ⊙ **Longer learning courses**
  - The costs induced by intensive learning must lead to rethinking the methods of safety training

- ⊙ Questions from the Military forces : Autonomous systems imply an increase in the capacities of operators. But systems can be designed so that the military commander can regain control of the system at any time.
  - What would have happened to Fukushima Daichi if Tepco and the Prime Minister had been able to take direct control of the operations?
  - This makes it easier for rulers to fall prey to the illusion of control.
  - Confidence in men will remain a major problem.

# THE SKILLS CHALLENGE

Robotization: business transformation Old /  
new technologies coexistence

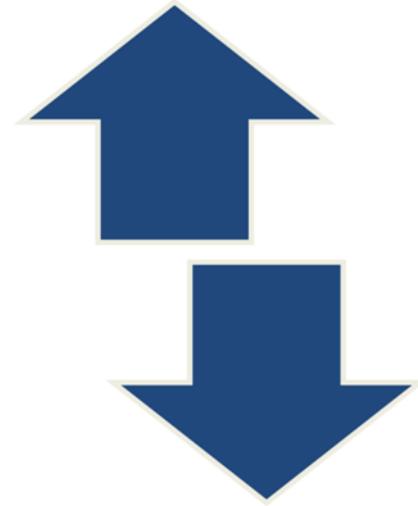
**1 - Human resources**  
Availability and mix of talents,  
skills Quality of skills Adaptability of skills  
End of career management

- Aging workforce,
- massive retirements in the Western world
- Young talents in Africa, Asia immigration
- talents business emigration generational
- / cultural mix at work

- Image deficit of certain sectors (fossil fuels, transport, etc.)
- Loss of attractiveness of training, jobs

## PROBABLE SHORTFALL OF HIGH-SKILLED WORKERS IN EUROPE

- Most large companies will have to renew 20 to 30% of their workforce by 2030
- Job destruction/job creation balance will vary depending on the field
- Jobs polarisation:
  - Too many low-skilled jobs
  - Lack of high-skilled workforce (present mostly in Asia)



**Technology:** Mathematics, Computer and Engineering

**Demography:** Care and Health

**Environment:** Green jobs

**Technology:** Administration and Office, Services, Sales, Textile, Clothing, Footware, Electrical and Eletronics, Agriculture

**Environment:** Non-renewable energy

Source: ILO (2018), *The future of Work, a litterature review*

- *Migrations might compensate for skills shortage in Western countries, but this might be less than expected, and companies may be encouraged to settle in emerging countries where qualified worforce is available. [ILO (2018), *The Future of Work: a litterature review*]*

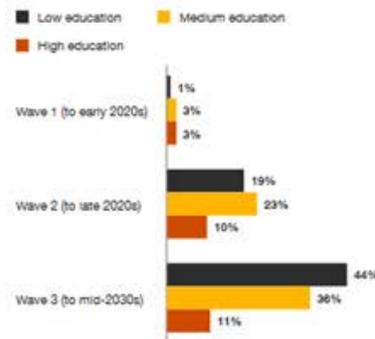
# SKILLS FOR 2030: MAJOR CHALLENGES

- Robotization, digitization and AI
- Transformation of jobs
- 1 billion people to be requalified by 2025
- 50% European workers will need professional reskilling
- Poor adaptivity of the current training model to new stakes

## Four key forces are driving the upskilling imperative

### 1. Increasing job automation

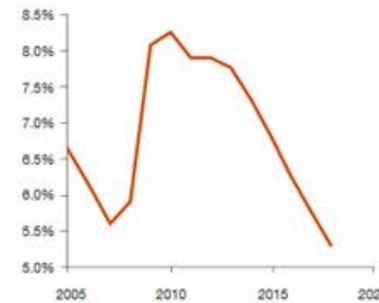
Percentage of existing jobs at potential risk of automation by education level across waves



Source: PwC, Will robots really steal our jobs? An international analysis of the potential long-term impact of automation

### 2. Decreasing talent availability

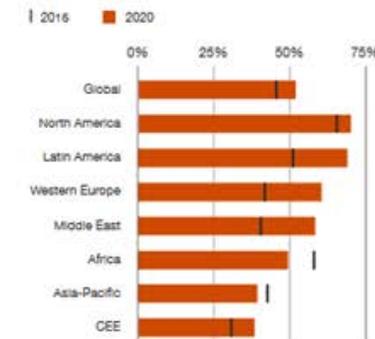
OECD unemployment rate (% of total labour force)



Source: OECD

### 3. Decreasing mobility of skilled labour

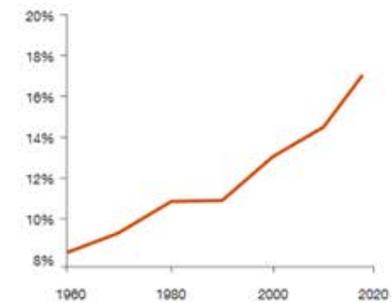
Is cooperation among gov'ts and businesses leading to greater movement of skilled labour between markets? (showing only 'no')



Source: PwC, 23rd Annual Global CEO Survey  
Base: Global respondents (2020=1,581; 2016=1,322)

### 4. Ageing talent

OECD population ages 65 and above (% of total population)



Source: World Bank Group

## EMPLOYMENT AND WORK MODELS EVOLVE

- Rationalization, robotization, digitization, virtualization
- “Project” versus “career” point of view
- Flexibility, distant work, autonomy
- Self-entrepreneurship
- Multi-jobs, platform economy
- Precarity, increase of inequalities



Source: ILO (2018), *The future of Work, a literature review*

## THE SKILLS CHALLENGE - THE DEMAND

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- ⊙ Jobs and work situations change very quickly
  - ⊙ Multiplication of trades in professional life
  - ⊙ Challenges of digitization: remote control, AI "black box", "sense-making" challenge, explicability at interfaces ...
  - ⊙ Broken collectives, restructuring into networks, new forms of cooperation, new forms of communities of practice
- ⊙ Big challenge of skills in the design of future operator-technology interactions
  - ⊙ Redistribution of operator / supervisory authority / designer skills
  - ⊙ Cultural / generational mix Agility, "train", prepare for jobs that do not exist (yet)
  - ⊙ The management of "surprises": exceptional situations rarer, more difficult to control

# THE SKILL CHALLENGE : THE OFFER

- ⊙ An expected skills gap (insufficient number of graduates)
- ⊙ An outdated initial training system (quantity, agility)
- ⊙ A challenged professional training system
- ⊙ Essential and urgent massive retraining and skills transformation plans
- ⊙ A normative and managerial approach to GPEC Organize support for employees and their expectations course logic, participatory techniques good prospects at work, motivation: investment opportunity for safety older workers: risks and opportunities



# FRANCE AND EUROPE ARE NOT EQUIPPED IN TERMS OF SKILLS TO FACE THE DIGITAL CHALLENGE THAT ARISES, ALSO IN THE SAFETY DOMAIN

- ⊙ Organizations will face a huge skill maintenance and transformation challenge while the lack of high skilled workers will become more and more obvious. This should lead to increased recourse to Asian subcontracting for digital safety and security issues.
- ⊙ In the same time, global industrial recompositing with a shift of strong markets towards Asia and Africa may fragilize European markets by reorienting their priorities at the prism of Asian and African demands
- ⊙ Safety consequences: will there be a cultural shift in dominant safety models and therefore safety tools? What impact on the European specificities of the safety debate notably in terms of dialogue with unions and control authorities? What impact on the role of State administration?

## IMPACTS ON HEALTH AND SAFETY ARE AT THE CORE OF CONCERNS

- Automatization, robotization, HMI, augmented humans
- AI and worker's autonomy
- Work virtualization, distant work
- Time flexibility, work / life boundaries are blurring



- Numerous studies on health, safety and working conditions by 2030/40:
  - impact of technological advancements
  - impact of changes in modalities and forms of work
- Improvements, opportunities (distance from hazardous environments, tedious tasks transferred to machines...)
- AND increase in some risks (musculoskeletal disorders, psychosocial risks, burnout, demotivation), emergence of new risks
- Evolution of risk governance at work, relation with social partners and labour law issues

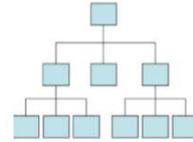
# THE CHALLENGE OF THE INDUSTRIAL SAFETY MODEL

## INDUSTRIAL AND ECONOMIC MODELS EVOLVE

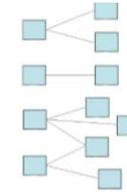
- Increase of corporate disaggregation:
  - External disaggregation: outsourcing, spin-offs, franchising, joint ventures...
  - Internal disaggregation: subsidiaries, market-like coordination mechanisms
- Globalization of the value chain, fragmented but interconnected and interdependent economic sectors
- Financialization, shareholders logics
- Rise of multisector heavyweights of global industry according to a GAFAM-like model

## • Evolution of structural organization

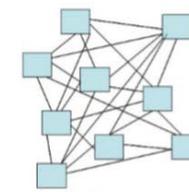
Hierarchy



Market



Network



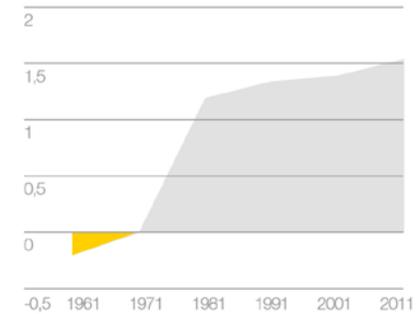
Source : Powell (1990), *Neither Market nor Hierarchy: Network Forms of Organization*. *Research in Organizational Behavior*

- Disaggregation and globalization: impacts on regulation and liability, also in safety
- Can industry remain in line with this global movement? Will deindustrialisation and industrialisation of services keep increasing?
  - Prospective elements arguing for continuing delocation as much as for relocation
  - What test of the French/European safety logics relying on labour dialogue centralized by control authorities in this global movement?

# TECHNOLOGY, ENVIRONMENT, RISKS... SOCIETAL EXPECTATIONS EVOLVE

- Climate change and ecological transition
- Technological (AI-driven) and organizational acceleration
- Rise of the concept of corporate agility
- Strong societal expectations: environment, sustainable development, ethics, citizen involvement

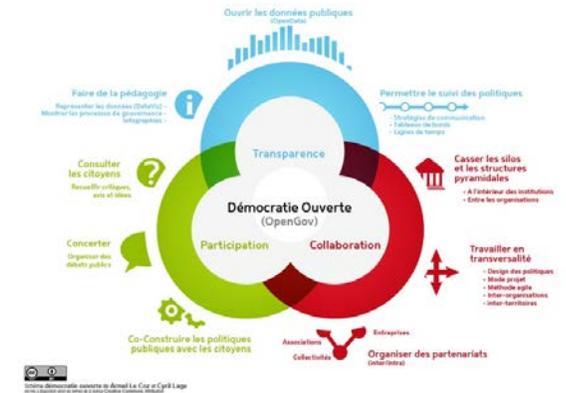
In 2017, an equivalent of 1.7 Earth is needed to satisfy human needs.



With a warming of  
**3-4°C**



**200 million people** could become permanently displaced due to rising sea levels, flooding and droughts.



**Principes et objectifs du collectif citoyen  
Démocratie Ouverte**

- Rise of participative democracy
- *"Innovation leads, regulation follows"*: [Deloitte (2016), *The future of risk-new game, new rules*]

# GROWING COMPLEXITY OF OUR "SYSTEMS"

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- ⊙ Global growth and geographic extension
- ⊙ More and more interactions between the components of society: companies, regulators, public authorities, organizations, associations, media, citizens ...
- ⊙ More and more connections, a structure in networks, in networks of networks, in interconnected layers of networks of networks
- ⊙ Hybridization of technologies, organizations
- ⊙ More and more information stored and circulating, local autonomy and global dependence, "artificial intelligence" in technology
- ⊙ A global behavior of the system which no longer results from the properties of its components, but from their only interaction
- ⊙ "Emerging" behaviors: unexpected, unpredictable due to knowledge of the properties of the components, non-linear (butterfly effect, cascade, avalanche, resonance, etc.)

# STRATEGIC CHOICES FOR THE FUTURE OF SAFETY MODELS

- ⊙ Develop and "increase", thanks to digitization & digital twins, the current dominant strategy strongly based on the anticipation of all situations and scenarios, the predetermination of appropriate behaviors and responses, and compliance with these predeterminations
- ⊙ Bet on the fact that his objective success will make his failures acceptable (the unforeseen loss of control)
- ⊙ Go beyond the current safety strategy, which is essentially incapable of dealing with the unpredictable
- ⊙ To exceed it does not mean to abandon it but to encompass it in a "stronger" theory, which explicitly supports the effects of complexity and of which it would constitute a simplified version