Background paper

Automation in transport: how does it affect the labour force?

The European Commission is organising a participatory conference on the impact of automation in transport on the labour force on 20 November 2018 in Brussels.

Automation in transport will affect both transport users and the transport workforce – and possibly other sectors of the workforce (e.g. insurance, manufacturing). As a first step, this conference will focus on the labour force within the transport sector.

This background paper – which makes no claim to completeness – provides an input to the discussions on the most important trends in automated transport and how they affect the labour force. It also looks at policy action at European Union (EU) level addressing the identified challenges.

Automation of work: what does it mean for jobs?

Automation in transport is taking place in the context of a broader transformation of the industry and the world of work. Ongoing discussions about the future of work, the impact of the digital transformation on labour markets, and challenges and opportunities of the 'fourth industrial revolution'[1] attest the need of analysing and anticipating the upcoming changes.

The digital age brings change through a number of developments. A recent Eurofound research report[2] discussed the following three vectors of change: automation of work, digitalisation of processes and coordination by platforms. In its report, Eurofound defined automation of work as 'the replacement of (human) labour input by (digitally enabled) machine input for some types of tasks within production and distribution processes. Although machine automation predates even the Industrial Revolution, the use of digital technologies allows the algorithmic control of machinery and, therefore, offers many more possibilities for automation. With digitally enabled machines and artificial intelligence, all kinds of tasks can be potentially automated.'[3]

Estimates of how many jobs or tasks will be replaced by machines in the future vary significantly. Probably the most worrying scenario was put forward in 2013 for the US labour market, for which 47% of all employment was estimated to disappear due to computerisation in the next 20 years.[4] Using the same methodology – considering computerisation for over 700 different occupations – the projections for Europe lay between 30% and 40%. On the other end, assessments made on the basis of task automation (rather than job automation) came to the conclusion that on average 9% of jobs in the OECD Member countries are susceptible to being automated.[5]

Not all occupations and the tasks related to them are at the same risk of being replaced by machines. Unsurprisingly, routine tasks – be they physical or intellectual – are more easily substitutable than others. However, recent technical developments will make it possible in the future to replace physical non-routine tasks, such as driving. And even intellectual tasks that are not routine may some day be taken over by (digitally enabled) machines.[6]

Based on aggregated data from relevant research, an ETUI working paper[7] provided an overview of jobs that are at greatest or least risk of automation/digitalisation, and of possible new high and low quality jobs. The transport and logistics sector can be found in the list of jobs at greatest risk of automation (see table on next page).

[1] Schwab, K. (2015), *The Fourth Industrial Revolution: what it means, how to respond.*
[2] Eurofound (2018), *Automation, digitisation and platforms: Implications for work and employment*.
[3] Ibid.
[4] Frey, C. and Osborne, M. (2013), *The future of employment: how susceptible are jobs to computerisation?*
[5] Arntz, M., Gregory, T. and Zierahn, U. (2016), *The Risk of Automation for Jobs in OECD Countries*.
[6] Eurofound (2018), *Automation, digitisation and platforms: Implications for work and employment*.
[7] Degryse, C. (2016), *Digitalisation of the economy and its impact on labour markets*, ETUI.

Table 1 **Jobs in the digital economy**

Jobs at greatest risk of automation/ digitalisation	Jobs at least risk of automation/ digitalisation	New jobs
Office work and clerical tasks	Education, arts and media	**'Top of the scale'**
Sales and commerce	Legal services	Data analysts, data miners, data architects
Transport, logistics	Management, human resources management	Software and application developers
Manufacturing industry	Business	Specialists in networking, artificial intelligence, etc.
Construction	Some aspects of financial services	Designers and producers of new intelligent machines, robots and 3D printers
Some aspects of financial services	Health service providers	Digital marketing and e-commerce specialists
Some types of services (translation, tax consultancy, etc.)	Computer workers, engineers and scientists	**'Bottom of the scale'**
	Some types of services (social work, hairdressing, beauty care, etc.)	Digital 'galley slaves' (data entry or filter workers) and other 'mechanical Turks' working on the digital platforms (see below)
		Uber drivers, casual odd-jobbing (repairs, home improvement, pet care, etc.) in the 'collaborative' economy

Source: Christophe Degryse (ETUI 2016) on the basis of data from Frey & Osborne, Ford, Valsamis, Irani, Head, Babinet

As pointed out in a recent OECD working paper, 'the risk of automation is not distributed equally among workers … The occupations with the highest estimated automatability typically only require basic to low level of education. At the other end of the spectrum, the least automatable occupations almost all require professional training and/or tertiary education.'[8]

Automation in transport: where are we heading?

Remotely-controlled vessels, driverless trucks and subway trains, autopilot on airplanes – this already is, or will soon be, a reality in transport. There are, however, **different levels of autonomy and automation** across different modes and tasks.

For instance, the International Maritime Organization (IMO) has, for the purpose of their ongoing scoping exercise, defined different degrees of autonomy for 'Maritime Autonomous Surface Ships (MASS)' – ships which, to a varying degree, can operate independently of human interaction (see box on next page). In this classification, only fully autonomous ships work without any seafarers on board or remote control.

As for on-road motor vehicles, SAE International, an international association of automotive engineers, provides a widely accepted taxonomy[9] with detailed definitions for six levels of driving automation, ranging from no driving automation (level 0) to full driving automation (level 5) – see box on next page. In this taxonomy, only levels 4 and 5 describe fully automated driving; the ITF estimates that contrary to the lower levels, these two upper levels would have significant labour implications.[10]

[8] Nedelkoska, L. and Quintini, G. (2018), *Automation, skills use and training*, OECD.
[9] https://www.sae.org/standards/content/j3016_201806/
[10] ITF (2017), *Managing the Transition to Driverless Road Freight Transport*.

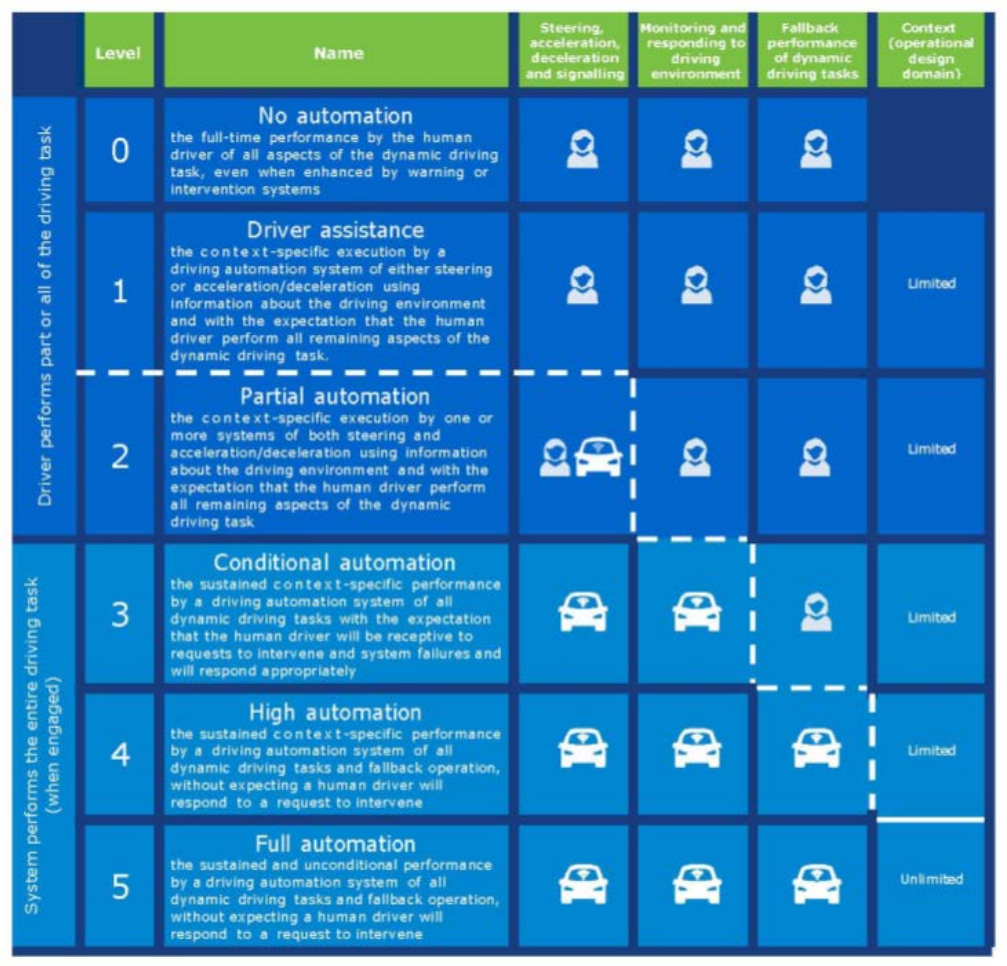
Preliminary definitions of Maritime Autonomous Surface Ships (MASS) and degrees of autonomy

The Maritime Safety Committee (MSC) of the International Maritime Organization (IMO) endorsed a framework for a regulatory scoping exercise, as work in progress, including preliminary definitions of Maritime Autonomous Surface Ships (MASS) and degrees of autonomy. The degrees of autonomy are organised (non-hierarchically) as follows (it was noted that MASS could be operating at one or more degrees of autonomy for the duration of a single voyage):

- **Ship with automated processes and decision support:** Seafarers are on board to operate and control shipboard systems and functions. Some operations may be automated.
- **Remotely controlled ship with seafarers on board:** The ship is controlled and operated from another location, but seafarers are on board.
- **Remotely controlled ship without seafarers on board:** The ship is controlled and operated from another location. There are no seafarers on board.
- **Fully autonomous ship:** The operating system of the ship is able to make decisions and determine actions by itself.

Source: http://www.imo.org/en/MediaCentre/PressBriefings/Pages/08-MSC-99-MASS-scoping.aspx

Levels of driving automation: Who does what?



Source: ITF (2017), *Managing the Transition to Driverless Road Freight Transport* (adapted from SAE and ITF)

Grades of automation (GOA) – train operation

	GOA	Train Operator	Description
GOA1	**Non-automated train operation**	Train driver in the cabin	The train is driven manually; but protected by automatic train protection (ATP). This GOA can also include providing advisory information to assist manual driving.
GOA2	**Semi-automated train operation**	Train driver in the cabin	The train is driven automatically, stopping is automated but a driver in the cab is required to start automatic driving of the train, the driver can operate the doors (although this can also be done automatically), the driver is still in the cab to check that the track ahead is clear and carry out other manual functions. The driver can take over in emergency or degraded situations.
GOA3	**Driverless train operation**	Train attendant on-board the train	The train is operated automatically including automatic departure, a train attendant operates the train doors (although this can also be done automatically) and can assume control in case of emergency or degraded situations.
GOA4	**Unattended train operation**	No staff on-board competent to operate the train	All functions of train operation are automatic with no staff on-board to assume control in case of emergencies or degraded situations.

Based on *International Standard IEC 62267:2009 Railway applications - Automated urban guided transport (AUGT) - Safety requirements*

In the rail sector, unattended train operation is the highest grade of automation, which will be notably used for specific high-density connections. Below this grade, there are the semi-automatic train operation and driverless train operation.

When preparing projections on the number and type of jobs that will be threatened by automated transport, it has to be clear which degree of automation is meant. (Remember that Eurofound's definition of 'automation of work' as quoted above refers to the replacement of some types of tasks and thus does not require the full replacement of a job.)

When it comes to the **timeline towards (full) automation**, there is no certainty given the dependence on a number of parameters, such as the remaining technology challenges and necessary adaptations to the regulatory framework. There are many probabilistic scenarios. For its study *Managing the Transition to Driverless Road Freight Transport*, the ITF has developed four different scenarios which 'are not probabilistic forecasts for the future of driverless trucks, but instead indicate possible pathways'. [11] They are presented here by way of illustration (see box on next page). Despite the fact that there are still a number of challenges to be addressed, the ITF assumes that fully driverless operation on the open roads can be deployed in the coming decades.

[11] Ibid.

Summary of scenarios for uptake of driverless trucks

The four scenarios are distinguished by the degree to which existing and future road freight transport would be undertaken using driverless trucks.

- The **Baseline scenario** involves zero adoption of driverless trucks on public roads in the next 20 years.
- The **Conservative scenario** assumes that driverless technology is slowly introduced from 2030 onwards, initially in a few long-distance markets, and (from 2033) a few cities in Europe and the US.
- The **Regulated scenario** assumes that driverless technology is allowed on all long-distance routes from 2028 and in cities from 2030. In long-distance freight the technology is ubiquitous within three to five years, whereas in cities the take-up is less strong.
- The **Disruptive scenario** assumes that driverless technology is rolled out on half of the long-distance routes from 2021 (and progressively expanded) and similarly in cities from 2022.

Source: ITF (2017), *Managing the Transition to Driverless Road Freight Transport*

Although there are predictions that the first fully crewless maritime vessel could be in service by 2020[12], fully autonomous vessels with no crew on board are likely to become reality gradually. It is expected that during a period of 30 to 40 years there will be a mixed situation with 'traditionally' crewed vessels sailing at the same time as autonomous vessels are starting to come to the market. Automation and digitalisation in maritime transport will not only reduce burdens and costs but also reduce the number of maritime accidents – the human factor is among the most common cause for such accidents.[13]

In the rail sector, the Automated Train Operation (ATO) is expected to dramatically change the interaction between infrastructure, the traffic management system, and an ever more intelligent on-board unit. The benefits of ATO are linked with more predictable running times and more capacity, energy optimisation (20-30% energy savings), automated and computerised failure detection and response, and enhanced safety. Timewise, in specific networks (metro but also dedicated railway lines) ATO is already operational; ATO over the EU signalling and control system (ERTMS) up to GOA2 (semi-automated train operation) is currently being tested and a full set of specifications is expected to be formalised by 2022. The first levels of ATO are considered to assist train drivers to have better performance in terms of speed profiles, easier interfaces with the infrastructure and dispatch, and to assist train drivers in further increasing the safety of the rail operations.

Automation is not a new concept for the aviation sector and already well advanced (e.g. autopilots on airplanes). One development that will have a significant impact on the labour force in civil aviation is the wide scale deployment of drones. In air traffic control, automation is gradually being introduced. In June 2018, for instance, air traffic controllers, air navigation service providers and manufacturers came together to discuss virtual centres, a solution under development by the SESAR Joint Undertaking.[14] With virtual centres, Europe is breaking away from the conventional architecture for air traffic management (ATM). These centres aim to decouple the physical controller

[12] Nautilus Federation (2018), *Future proofed? What maritime professionals think about autonomous shipping.*
[13] HSBA Hamburg School of Business Administration (2018), *Seafarers and digital disruption - The effect of autonomous ships on the work at sea, the role of seafarers and the shipping industry.*
[14] https://www.sesarju.eu/

working position (CWP) from the remote provision of ATM data and technical services, such as flight data distribution and management, as well as surveillance data.[15]

Impact on jobs and skills in transport

The transport sector is a significant job provider (1 out of 20 jobs in the European Union). But it is also an ageing sector (one third of its workers are above 50 years old) and generally lacks attractiveness.[16]

Given the uncertainty regarding the exact pace and scope of automation in transport, the impact on jobs and skills in the sector is difficult to assess. Specific studies on this aspect are rare and often focus on automated and connected road vehicles.[17]

Cooperative, connected and automated mobility (CCAM) presents clear opportunities for value-added creation and benefits to society. Regarding the impact on the labour force and on skills, it is concluded that 'important labour challenges lie ahead for professional drivers, decreasing driving responsibilities towards the acquisition of new and more technical roles. Some of these jobs will disappear in the long-term and anticipatory actions remain a crucial mechanism to ensure that workers receive support and retraining opportunities. Concerns around inequality might also exist. At the level of skills, ICT competences will be increasingly demanded in the future, e.g. in manufacturing, maintenance and transport-related jobs. The skills required for driving a vehicle will also change as automation gains full control of the vehicle, e.g. requiring more supervision and selective skills.' [18]

Estimates of the future driver job losses (road freight transport)

According to an ITF study, the adoption of driverless trucks is likely to reduce demand for drivers at a faster rate than a supply shortage would emerge. Of the 6.4 million driver jobs forecasted for 2030, between 3.4 and 4.4 million would become redundant if driverless trucks are deployed quickly. Even accounting for prospective truck drivers being progressively dissuaded by the advent of driverless technology, over 2 million drivers across the US and Europe could be directly displaced by 2030 in some of the scenarios examined for this study.

Source: ITF (2017), *Managing the Transition to Driverless Road Freight Transport*

[15] https://www.sesarju.eu/news/keeping-it-real-air-traffic-controllers-share-their-views-virtual-centres

[16] European Commission (2017), *Study on a Pilot project: Making the EU transport sector attractive to future generations*.

[17] The Commission has already carried out a comprehensive review of existing studies on the expected socio-economic impacts of automated and connected vehicles on the EU economy and jobs: Alonso Raposo, M. et al. (2018), *An analysis of possible socio-economic effects of a Cooperative, Connected and Automated Mobility (CCAM) in Europe - Effects of automated driving on the economy, employment and skills*. Still in 2018, the Commission will launch a study on the social effects of digitalisation in the maritime sector and a Horizon 2020 study on 'Exploring the possible employment implications of connected and automated driving'.

[18] Alonso Raposo, M. et al. (2018), *An analysis of possible socio-economic effects of a Cooperative, Connected and Automated Mobility (CCAM) in Europe - Effects of automated driving on the economy, employment and skills.*

The Horizon 2020 research project 'Skillful – Skills and competences development of future transportation professionals at all levels'[19] defines future trends, needs and scenarios for transport jobs across Europe. This project identified jobs/positions that will change or disappear (for instance drivers) and others that will emerge (for instance automated vehicles operators, remote flying object operators).

Looking at the impact on jobs, it is indeed not sufficient to consider job destruction and job creation alone. With the nature of jobs, the quality of work (skills, autonomy and social support) as well as employment and working conditions may change, as described in the ETUI working paper: 'Job change: new forms of worker/machine interaction; new forms of jobs – for instance the so-called "uberisation" – which result in new risks (work intensification, health and safety, increasingly porous private/working life boundary, training mismatches, discrimination, etc.); effects at managerial level (new digital management).' [20]

As a consequence, the number of low-skilled jobs in the transport sector[21] is expected to decrease, while the development of new technologies and services will require new skills and highly paid jobs (such as engineers, researchers) together with medium-skilled jobs to maintain these technologies. The transport sector is likely to compete with other sectors of the economy for this labour force, which is already in high demand.[22] At the same time, older workers and low-skilled workers tend to lack IT-skills that are increasingly needed in the labour market.

Conversely, new jobs (such as in remote-control centres or on shore) could benefit women or physically impaired persons since physical strength will be no recruitment criterion and improve the work-life balance for workers in general as they must not necessarily be mobile. It is expected that digitalisation will make the transport sector more attractive to young women and men.

In the rail sector, the main focus of Automated Train Operation (ATO) is not on removing staff from the trains but rather on achieving gains in customer service and safety. More staff will be available for passenger service jobs and thus the presence of staff could easily be increased at platforms and onboard trains. Demand for new and advanced skills will be manifold in all future scenarios. Moreover, given that the ageing of workers in the rail sector is a significant concern, the opportunities offered by the technological innovation could help identifying ways to attract young people to the sector.

[19] skillfulproject.eu

[20] Degryse, C. (2016), *Digitalisation of the economy and its impact on labour markets*, ETUI.

[21] In freight transport, 90% of the workers does not have a high education level (ISCED <4: Post-secondary non-tertiary education) and 28% have low education level (ISCED <2: less than lower secondary education). In passenger transport, the situation is similar (87% without high education level, 25% with low education level. For both freight and passenger transport, the proportion of highly educated workers is higher in the younger age groups. Source: Alonso Raposo, M. et al. (2018), *An analysis of possible socio-economic effects of a Cooperative, Connected and Automated Mobility (CCAM) in Europe - Effects of automated driving on the economy, employment and skills.*

[22] The number of vacancies in ICT-related sectors is expected to increase up to 500 000 vacancies by 2020. Source: European Commission (2017), *High-Tech Leadership Skills for Europe*.

In the maritime sector, it is expected that there will be a need for skilled seafarers and lead to more employment opportunities on shore[23], both for today's officers and ratings and for those graduating in the future. This will indeed facilitate life for many seafarers who often spend a lot of time at sea away from their families. Gradual transfer to employment opportunities on shore should also lead to a more gender-balanced sector which, coupled with initiatives to prevent harassment and other social problems as well as enhancement of digital communication, offers a modern workplace that corresponds to the demands of the seafarers of tomorrow.

Given that a number of transport professions are regulated at European or international level, one major challenge will be to keep pace with technological development and adapt the legal framework regarding training and certification.

Policy action at EU level

The social dimension of the transition to automation was addressed at the Digital Transport Days[24] (Tallinn, November 2017), where panellists discussed the impact of digitalisation on the transport workforce and users. The main conclusions of the relevant session were that the societal dimension should be put at the heart of the transition process (technical standards are not sufficient) and that policy makers should be proactive and provide guidance considering the major societal disruption digitalisation/automation will shortly cause.

The Council, in its conclusions on the digitalisation of transport[25] of 5 December 2017, emphasised the importance of wide societal dialogue on these issues and called on the Commission to 'assess the socio-economic and environmental impact of automation and digitalisation in the field of transport taking into account the new skills needed in that sector, and, if necessary, to propose measures to address those impacts.'

As part of the third Mobility Package[26], the Commission adopted a dedicated communication on Connected and Automated Mobility (CCAM) to make Europe a world leader for autonomous and safe mobility systems. It contains a section on anticipating effects of automated mobility on society and the economy.

In order to manage the transformation, workers whose jobs are changing or may disappear due to automation must have every opportunity to acquire the skills and knowledge they need, to master new technology and to be supported during labour market transitions. National schemes will be essential for providing up-skilling and training with support from the European Social Fund[27] and other dedicated projects.

[23] HSBA Hamburg School of Business Administration (2018), *Seafarers and digital disruption - The effect of autonomous ships on the work at sea, the role of seafarers and the shipping industry.*
[24] https://ec.europa.eu/transport/modes/road/news/2017-11-10-digital-transport-days-declaration_en
[25] http://data.consilium.europa.eu/doc/document/ST-15431-2017-INIT/en/pdf
[26] https://ec.europa.eu/transport/modes/road/news/2018-05-17-europe-on-the-move-3_en
[27] The European Social Fund – and in the future the European Social Fund Plus – invests in the enhancement of skills and education levels of people, including digital skills.

The Commission, with its Digital Single Market Strategy[28] and Skills Agenda for Europe[29], is putting priority on digital skills at all levels, from basic to high-end. In order to deliver sector-specific skills solutions, the Blueprint for Sectoral Cooperation on Skills was launched as part of the skills agenda.[30] The blueprint is a framework for strategic cooperation between key stakeholders such as business, trade unions, research, education and training institutions, and public authorities, in order to overcome skills shortage and prepare for digital transition. Five pilot sectors have been selected for the first wave of calls and automotive[31] is one of them. Maritime shipping is part of the second wave; the project will start in 2019.

Moreover, the European Pillar of Social Rights[32] provides a comprehensive policy framework to assist in labour market and social transitions. Setting out principles and rights for well-functioning labour markets and welfare systems, the framework considers – among others – access to effective employment and social services, access to training, transparent and predictable working conditions and adequate income support. In this respect, the Commission has adopted a proposal[33] setting out new rights, in particular for those in the most flexible non-standard and new forms of work and a proposal[34] to strengthen access to social protection – in particular for the self-employed and atypical workers.

Ethical issues are an equally important topic for automated mobility. Automated vehicles will have to be safe, respect human dignity and personal freedom of choice. The Commission has recently set up the European Artificial Intelligence Alliance[35] tasked to develop draft ethics guidelines for artificial intelligence, which will provide a horizontal approach on ethical issues for autonomous systems. Members of this forum can interact with the experts of the High-Level Expert Group[36] on Artificial Intelligence, whose general objective is to support the implementation of the European strategy on Artificial Intelligence. This will include the elaboration of recommendations on future-related policy development and on ethical, legal and societal issues related to Artificial Intelligence, including socio-economic challenges.

Another high-level expert group is expected to deliver, by the end of February 2019, a report with policy recommendations on the impact of the digital transformation on EU labour markets. The group shall, amongst others, break down the potential effects of digitalisation by industry and sector of the economy (see box on next page).

[28] http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM%3A2017%3A228%3AFIN. It targets digital skills for all (developing digital skills to enable all citizens to be active in our digital society).
[29] http://ec.europa.eu/social/main.jsp?catId=1223
[30] http://ec.europa.eu/social/main.jsp?catId=1415
[31] https://www.project-drives.eu/
[32] https://ec.europa.eu/commission/priorities/deeper-and-fairer-economic-and-monetary-union/european-pillar-social-rights_en
[33] http://ec.europa.eu/social/main.jsp?catId=1313&langId=en
[34] http://ec.europa.eu/social/main.jsp?catId=1312
[35] https://ec.europa.eu/digital-single-market/en/european-ai-alliance
[36] https://ec.europa.eu/digital-single-market/en/high-level-expert-group-artificial-intelligence

Activities of the High-Level Expert Group on the Impact of the Digital Transformation on EU Labour Markets

Acting in a personal capacity, independently and in the public interest, the members of the high-level expert group shall provide advice to the Commission and, as appropriate, other parties, including:

- Analysis of how to shape the transformation and what framework conditions to be put in place to make it smooth and human-centric;
- Identification of the potential social impacts (risks and opportunities) of digitisation, in particular the large-scale application of artificial intelligence, and the expected job losses and gains;
- Developing responses to the impact digitisation has on skills requirements;
- Exploring viable ways to manage digitisation's impact on labour law and working conditions;
- Identifying ways to use digitisation (in particular Artificial Intelligence) to make labour markets more inclusive;
- Assessing the impact of digitisation on income distribution and existing inequality and ways to respond to it;
- Defining ways to adapt social security systems to ensure a high level of social protection for all forms of employment;
- Evaluating mechanisms to adapt the tax and benefit system to ensure that fair contributions are paid and loopholes are avoided e.g. revision of taxation models;
- Breaking down the potential effects of digitisation by industry and sector of the economy.

https://ec.europa.eu/digital-single-market/en/high-level-expert-group-impact-digital-transformation-eu-labour-markets

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