BEYOND 4.0

D2.1 Guidance paper on key concepts, issues and developments

Conceptual framework guide and working paper

Version 1.0

Date: November 2019

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File: BEY4.0_WP02_Task_2.1_guidance_paper_FINAL_20191112

Status: Approved by EB on 7 November 2019

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European Commission

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 8222293.

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Executive Summary

This guidance paper provides a common intellectual understanding for the BEYOND4.0 research project. It explains what is to be analysed, why and how. As part of this task, it explains the key developments, issues and concepts that drive the project. It provides a common starting point for the aim of BEYOND4.0 to support the delivery of an inclusive European future by examining the impact of new technologies on the future of jobs, business models and welfare in the European Union (EU).

The main premise for BEYOND4.0 is that technology is not deterministic but socially negotiated by key social actors at various levels: firms, industry, regional, national and EU. This premise opens up the possiblity that the EU can use digital technologies, specifically those related to Industrie 4.0 and Uberisation, to promote the creation of an inclusive digital economy that provides decent work and decent lives for EU citizens.

To date, such integrative research at the EU-level is lacking. In meeting the need for such integrative research, the objectives of BEYOND4.0 are fivefold:

1. Provide new and systematic scientific insight into technological transformation and the extent to which digital transformation is axiomatically disruptive.
2. Provide new and systematic scientific insight into company strategies dealing with technological transformation, examining the variety of strategies and their expected impacts as well as the role of social dialogue with key actors at various levels.
3. Examine the impact of this technological transformation using new, innovative approaches to analyse and predict its impact.
4. Identify the range of policy options to deal with the consequences of technological transformation.
5. Identify the range of social investment approaches and tools that support a form of desired technological transformation that is inclusive.

The new empirical data generated by BEYOND4.0 has three outcomes. The first is new scientific understanding of the impact of the new digital technologies in relation to work and welfare. The second is diagnostic and development tools to lever technological opportunities. The third is evidence-based support for social and competitive EU policy.

With these aims, objectives and outcomes, BEYOND4.0 better addresses the challenges of the putative 4th Industrial Revolution and seeks to provide alternative policy options for the EU. In doing so, BEYOND4.0 provides new insights and measures to help address poverty, equality and decent work.

Bookended by an Introduction and Conclusion, the paper has four main sections. The first outlines BEYOND4.0's focus on Industrie 4.0 and Uberisation. The second explains the empirical research design f the project. The third elaborates debates about technological revolutions,

including the current digital one, and the latter's implications for work and welfare. The fourth presents the key concepts and issues around the four areas of empirical research enquiry for BEYOND4.0: the quality, content, and distribution of work; the skill needs of the labour market; the education and training to support development of these skills; and the creation and capture of value by companies.

1. Introduction

The BEYOND4.0 research project focuses on the evidence-based delivery of an inclusive European future by examining the impact of new technologies on the future of jobs, business models and welfare in the European Union (EU). In this respect, the project is deliberately ambitious in its scope and intent. This guidance paper sets out the general starting point of the project in terms of the key concepts, issues and developments driving the BEYOND4.0 project. It outlines BEYOND4.0's aims and objectives, the digitalisation developments that are the focus of the project and the four areas of enquiry following these developments.

1.1. Aim of BEYOND4.0

The overarching aim of BEYOND4.0 is to help deliver an inclusive European future through an evidence-based examination of the impact of the new ditigal technologies on the future of jobs, business models and welfare in the EU. This examination centres on 'Industrie 4.0' and 'Uberisation' as emblematic of these new technologies.

The main premise for BEYOND4.0 is that technology is not deterministic but socially negotiated by key social actors at various levels: firms, industry, regional, national and EU (Berting, 1993; Bijker et al., 2012; Child, 1972; Noble, 1984). This premise then opens up the possiblity that the EU can use these technologies to promote the creation of an inclusive digital economy that provides decent work and decent lives for EU citizens. To date, such integrative research at the EU-level is lacking. Indeed much of the current debate about the impact of the new digital technologies is hypothetical and speculative, lacking empirical evidence. Moreover, in general, too much social and economic science analyses shy away from displaying any normative interest in improving (working) lives (Grote & Guest, 2017).

1.2. Objectives of BEYOND4.0

The objectives of BEYOND4.0 are fivefold:

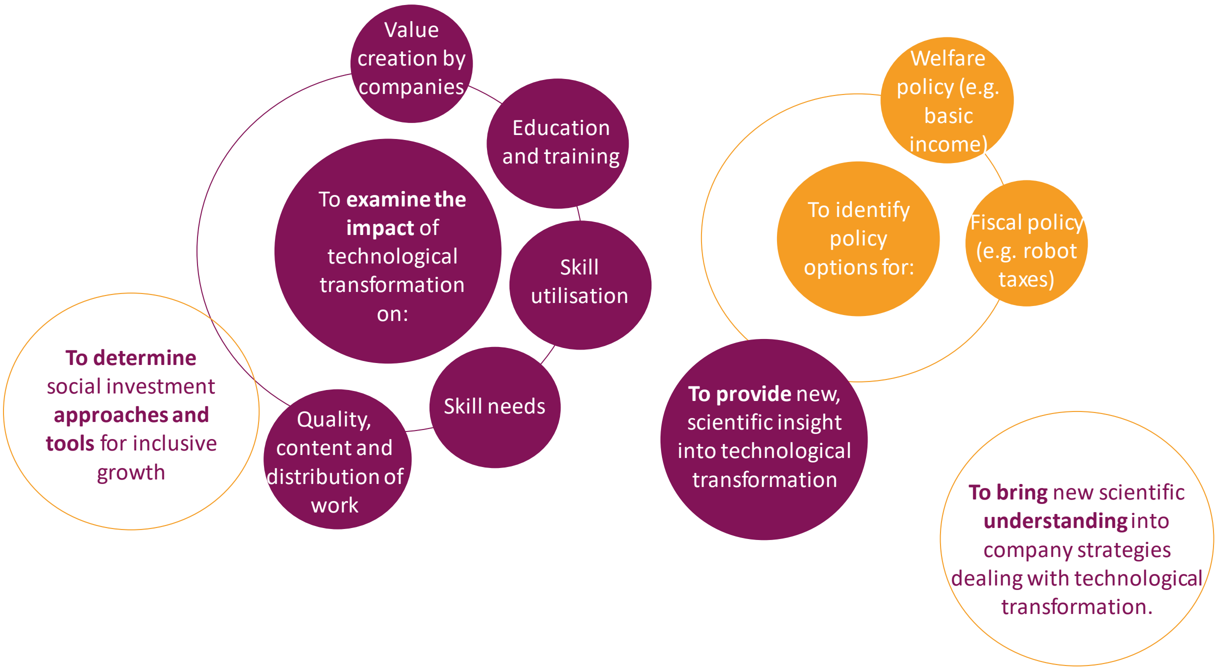
1. Provide new and systematic scientific insight into technological transformation and the extent to which digital transformation is axiomatically disruptive.
2. Provide new and systematic scientific insight into company strategies dealing with technological transformation, examining the variety of strategies and their expected impacts as well as the role of social dialogue with key actors at various levels.
3. Examine the impact of this technological transformation using new, innovative approaches to analyse and take into account:
    - Quality (including occupational safety and health – OSH), content, and distribution of work, as well as the distribution of work amongst different types of workers (e.g. gender, age, skill level, geographic location);

- Skill needs as function of the digitisation of task content rather than occupational activities; Skill utilisation as a function of organisational choices that favour or impede continuous on the job learning and re-arrangements of skill sets;
- Education and training to support skill development, so sustained employability and opportunity for social mobility are enhanced;
- The creation and capture (extraction) of value (and wealth) by companies.

4. Identify the range of policy options to deal with the consequences of technological transformation, in terms of:
    - Fiscal policy (e.g. the introduction of taxes on new forms of rent extraction enabled by 'robot taxes');
    - Welfare policy (e.g. experimentation with basic income and other innovative social security approaches).
5. Identify the range of social investment approaches and tools that support a form of desired technological transformation; that is, policy centred on a 'high road', inclusive approach to growth.

Figure 1 provides a graphical illustration of the five inter-connected objectives.

Figure 1: BEYOND4.0 objectives



With these aim and objectives, BEYOND4.0 better addresses the challenges of the putative 4th Industrial Revolution and seeks to provide alternative policy options for the EU. In doing so, BEYOND4.0 provides new insights and measures to help address poverty, equality and decent work.

1.3. Purpose and structure of the guidance paper

The purpose of this guidance paper is to provide a common intellectual understanding of BEYOND4.0. It explains what is to be analysed, why and how. As part of this task, it explains the key developments, issues and concepts that drive the project. It should be noted that most current policy and academic debate about the impact of digitalisation on jobs uses the term 'future of work'. This terminology is, we argue, simply a shorthand when jobs comprise both work and employment, and it is this dual focus that is undertaken by BEYOND4.0 in its analysis.

After this introduction, the paper has four main sections followed by a Conclusion. Section 2 below outlines BEYOND4.0's focus on Industrie 4.0 and Uberisation. The empirical research design in then explained in Section 3. Section 4 elaborates debates about technological revolutions, including the current digital one, and the latter's implication for work and welfare. Section 5 presents the key concepts and issues around the four areas of empirical research enquiry for BEYOND4.0: the quality, content, and distribution of work; the skill needs of the labour market and the skill utilisation by organisations; the education and training to support development of these skills; and the creation and capture (extraction) of value (and wealth) by companies. The concluding section emphasizes how BEYOND4.0 seeks to go beyond current debates about digitalization, work and welfare, and the need to fill the current evidence vacuum as a means to better informed policy development in the EU.

2. Focus of BEYOND4.0 - Industrie 4.0 and Uberisation

As noted above, the main premise for BEYOND4.0 is that technology is not deterministic but socially negotiated by key actors at various levels: firms, industry, regional, national and EU (Berting, 1993; Bijker et al., 2012; Child, 1972; Noble, 1984). It is recognised that firms' business models and organisational policies and practices can differ greatly (Bloom et al., 2019; Greenan, 2003). Company strategies are central drivers of change. They happen in the context of labour market and welfare institutions, and public policy. Moreover, these different organisational choices shape technological transformation as it is introduced and implemented (Kuipers et al., 2018). It is also recognised that technological transformation is not linear but messy, occuring through economic and political shocks that result in unpredictable socio-economic shifts (McLoughlin & Clark, 1994). These drivers of change generally enable or disable some and not other company strategies.

Given the variety of company strategies and institutional contexts in which they are pursued, and because some policy options are better than others (Jacobs & Mazzucato, 2016), new insights are required about the possible range of innovative policy solutions that might be developed that contribute to a European strategy for socially inclusive and cohesive growth and economic prosperity.

BEYOND4.0 focuses on the two main technological transformations. The first is the the digitisation of production through AI and automation/robotics, also referred to as 'Industrie 4.0', with Germany the first country to formulate policy using this terminology. The second is the digitisation of work through the platform economy, sometimes referred to as 'Uberisation'.

The first is based on AI combined with the emergence of big data, the internet of things and ever-increasing computer power emabling robots to undertake both physical (manual) tasks and, increasingly, some cognitive (mental) tasks currently performed by humans (Manyika et al., 2017; OECD, 2018b). Although there are definitional problems, Industrie 4.0 has become emblematic of the digitalisation of production as it emerged in Germany, applied first to manufacturing but increasingly services (Davies, 2015; Herman et al. , 2016).

The second rests on the emergence of platform companies and the migration of work to these platforms. Whilst different types of platforms exist, platforms are digital networks that coordinate economic transactions – usually matching the supply and demand of goods and services through algorithms. It is perhaps the most publically visible form of digitalisation, in no small part because of the seeming ubiquity, at least in North America and Europe, of transportation services company Uber, to the extent that 'Uberisation' is suggested as the model for the future of work (see discusison in Bernhardt, 2016).

Significantly, both of these technological transformations – Industrie 4.0 and Uberisation – have the capacity to eradicate jobs. The former by substituting jobs with technology and the later by using technology to replace jobs with micro-tasks. In addition, both technological transformations can also make existing skills, tax and welfare systems ineffective. Indeed, the current scientific and policy discourse is dominated by predictions of mass unemployment, hollowed-out government and social upheaval (see for example, Frey & Osborne, 2013; Brynjolfsson & MacAfee, 2014; Streeck, 2015).

However, the consequences of these technological transformations are still hypothetical and/or speculative, based on econometric modelling and value prescriptions, and are as likely to be wrong as right (Dunlop, 2016). For example, contrary to the dominant discourse about massive job losses, many labour markets in Europe are experiencing record levels of employment. Moreover the standard employment relationship, with full-time, permanent work for one employer, is still dominant; though non-standard employment involving part-time, temporary or self-employment has risen slightly (Eurofound, 2018a).

By examining the structures of power, and the conflict, compromises and acquiescences that influence the introduction and implementation of new technologies, BEYOND4.0 seeks to generate new scientific understanding and data on the future of jobs, business models and welfare. More specifically, BEYOND4.0 examines the impact on social inclusion and the types of workers likely to gain and lose in the transformation, most obviously by gender, age, education-level, industry and location. The research also focuses on the types of jobs, and new skill, welfare and tax systems needed to maximize the socio-economic benefits and mitigate the socio-economic costs of the new digital technologies as well as the business models likely to deliver a fairer distribution of the gains derived from new digital technologies. Two specific lines of inquiry are pursued. First, the opportunities and challenges for job content, employment and productivity. Second, the opportunities and challenges for welfare and social security systems.

Gender is an important cross-cutting issue that is embedded in analysis across the project – and for two reasons. First, generally, women experience less employment opportunities, lower pay and worse occupational working conditions than men (Blau & Kahn, 2017). Second, technological transformations offer two possibilities. On the one hand, women workers may be better sheltered from the negative impact of digitalisation because they are more likely to be employed in high-touch, non-routinisable work that is less susceptible to automation (Muro, et al., 2019). On the other hand, with the stress on science, technology, engineering and mathematics (STEM) qualifications for obtaining access to and use of new technologies in companies (Lamb, 2012), women are less represented in such educational programmes and thus at greater risk of being excluded from the benefits of technological transformation.

3. Generating the empirical data

BEYOND4.0 uses a multidisciplinary, mixed methods research approach from which new knowledge is generated to provide state-of-the-art understanding that that combines historical, EU-wide, national, regional and company-level data. The project has a number of different strands of empirical work, each with their own methods and aims. These empirical work strands often link and are integrated into a common framework to provide intellectual and practical coherence to the project.

3.1. Work strands

1. Creating data for the analysis of the future of work

The aim of this strand of work is to further strengthen and integrate various relevant European databases from which quantitative research methods are employed to generate new empirical evidence about the socio-economic impacts of technological transformation. The activities involve building EU cross-country and multi-level databases, covering the last decades and using existing EU-wide harmonised surveys to allow data exploration at different levels (e.g. country, sectoral, individual).

2. Digital transformation: regional perspectives and prospects

This strand of work identifies the current and future growth-related impacts of digital transformation. The aim of this work strand is to identify how the EU can help support regions and entrepreneurial ecosystems in adapting and changing course, in terms of policy pointers for an EU-level strategy at the regional level. Both qualitative and quantitative research methods (i.e. mixed methods) will be employed to generate new empirical evidence about the economic and social impact – in particular, the inclusive-growth related impacts- of digital transformation on six regions and selected ecosystems within the EU. The activities will include the development of a regional comparative analytical framework to assess the economic and social impacts of digital transformation at the regional level, with a focus on Industrie 4.0 and digital platforms. An ecosystems approach is used to assess the impacts along three dimensions: work and human capital; social inclusion; and (re)distribution. A recent historical analysis of digital transformation on inclusive growth is also conducted to assess the evolution of regional leading entrepreneurial ecosystems in relation to digital transformation and its effects on the wider regional economy and society.

3. Analysing the socio-economic consequences of technological transformation

This strand of work analyses and assesses the socio-economic consequences of technological transformation through evaluation of the existing empirical literature and datasets prepared in the first empirical work strand outlined above. Taking into account the social embeddedness of technology, quantitative research methods generate new empirical evidence, Europe-wide and comparatively, on the effects of technological transformations. Using advanced statistical techniques from econometrics and data mining, the work includes the mapping of country-level, sector-level and company-level diversity of structural transformation, as well as forecasting the future of work over the last two decades at the sector level and company level. Analysis also draws upon ecosystems analysis at regional level in the second work strand above.

4. Understanding the future skills: empowering groups

This strand of work aims to provide new insights to better understand the skills needed for future workplaces, including analysis of the skills actually used in these workplaces. Both qualitative and quantitative research methods (i.e. mixed methods) are employed to generate new empirical evidence and, from it, enrich policy debate on skills. Expected skills demand is identified through a review of existing literature plus the secondary data develop in the first work strand above, the primary data generated at the regional and company levels outlined in the second strand of work outlined above and the sixth work stand outlined below respectively. Expected skills demand is then compared with the supply side of vocational and education training (VET) systems and training providers in order to clarify gaps, identify areas for possible improvements, and to provide knowledge for better inclusion of disadvantaged employees and unemployed people.

5. Understanding technological transformations: A comparative historical perspective

This strand of work provides an historical and theoretical background to the project's understanding of technological revolutions and applies that understanding to policy prescription in the present. Primarily, qualitative methods are used to generate new empirical evidence in order to understand the effects of previous technological transformations on employment and labour markets, particularly the cycles of unemployment and inequality, and of skilling and de-skilling.

6. Company strategies for leading economic performance and social performance

This strand of work provides state-of-the-art examples of European approaches to technical transformation (adoption, integration, diffusion), including how stakeholders have responded to these changes. The research also generates understanding of what elements of an inclusive economic policy are considered important for stakeholders. Here, the focus of analysis shifts from the regional level, as in the second work strand outlined above, to the company level. Both qualitative and quantitative research methods (i.e. mixed methods) are employed to generate new empirical evidence about the economic and technological effects at the company level of technological transformations on both qualitative aspects (i.e. tasks, skills, competences, occupational safety and health) and quantitative aspects (i.e. vacancies, job openings, types of contracts, job mobility, polarisation, labour market target groups, gender effects) of employment. Through a business-oriented survey and interviews an indicator is developed for this task. Results from the analysis in the second work strand are used to identify two companies in each region to survey both employees and HR/management, with qualitative comparative analysis (QCA) as a research technique used to identify leading indicators and dominant business strategies. This company level analysis also explores economic and social policies related to smart skill specialisation and OSH issues. This information is then used to assess how the companies experience the competitive environment both within and outside the EU. A smaller number of companies are also selected to participate in foresight discussions and scenario building at the EU-level about the future of work.

7. Welfare, taxes and the creation of inclusive wealth

This strand of work examines how 'inclusive' wealth is generated by economic processes, national welfare systems, and taxation policies. Both qualitative and quantitative research methods (i.e. mixed methods) are employed to generate new empirical evidence. Qualitative (desk-based) research methods are employed to map how value created by platform economy firms can be better captured by those who create the value (i.e. users, employers, wider public). Quantitative research methods are used to analyse national and international (mainly OECD) tax statistics to identify and analyse trends in income inequalities between and within countries; and between and within sectors as well as to analyse the distribution of wealth in society. National and international (again, mainly OECD) data is used to investigate the functional distribution of income between capital and labour in EU Member States and the US and the impact on the concentration of wealth in these countries, and to evaluate trends and trajectories in taxation. EUROMOD microsimulation models are used to evaluate different policy options to extract financing for 'welfare state 4.0'. Additionally, a systematic review of the advantages and disadvantages of basic income models (or models mimicking basic income) is undertaken, including comparisons of results from experiments in Finland, the Netherlands, Canada and some developing nations (e.g. Kenya) in order to develop policy recommendations around the effectiveness of basic income models. A similar exercise is undertaken on participation income models as alternatives to basic income models. Data for these exercises is collected through interviews with managers of these experiments as well as desk-based analysis of the welfare consequences of the models. This work strand also analyses national policies and development trends in social security programmes to identify the possible gendering impacts of new approaches to social policy.

3.2. Outcomes

This new empirical data generates three new outcomes for BEYOND4.0. The first is new scientific understanding of the impact of the new digital technologies in relation to work and welfare. Currently too much debate is framed by assumptions rather than evidence. The understanding generated by BEYOND4.0 fills this evidence gap. The second is diagnostic and development tools to lever technological opportunities. The third is evidence-based support for social and competitive EU policy.

4. The Age of Revolutions?

As Figure 1 above shows, at the heart of BEYOND4.0 is technological transformation. Sometimes this transformation constitutes a revolution, which in the case of putative '4th Industrial Revolution' results in 'digital disruption'. BEYOND4.0 recognises the potential disruptive impact of the new digital technologies on both work and welfare. This section starts with a discussion of technological revolutions. It then evaluates the degree to which the digital transformation can be seen as a new technological revolution. The question is then to what degree our current policy repertoire to deal with impacts of industrial development, is suited to deal with this revolution.

4.1. Technological revolutions

Following Schumpeter's (1911), it has been recognised that technologies do not evolve in isolation but are usually connected in technology systems. Every important radical innovation requires a whole range of additional – often new – services, supplies and even infrastructures both up- and down-stream. Systems are based on a combination of radical and incremental innovations, together with organisational innovations (Freeman & Soete, 1997). Technological revolutions involve successive technology systems. The building of a technology system sees the creation of positive context factors or synergies, as the socio-economic context gradually adapts to facilitate the flourishing of the new technologies. This adaptation is aided by the establishing of adequate business arrangements and institutional context, including support facilitators such as regulations and education (Perez, 2010).

The mass production revolution (diffusing from about 1908 to 1974) had systems around the automobile and radio and later air travel, plastics and the so-called 'green revolution' (which enormously increased agricultural productivity with successive petrochemical pesticides, herbicides, new seeds, etc.). The current Information and Communication Technologies (ICT) revolution (from the mid-1970s) has manifest successive systems around the microprocessor, personal computer, internet and mobile phones and is now experiencing an evolution in artificial intelligence, robotics and the internet of things.

Popularised by Schwab (2016) via the World Economic Forum, the notion of the '4th Industrial Revolution' is now often taken as a given and used as shorthand to describe the digitisation of the economy and society. However, it is important to note that there are multiple ways of defining technological revolutions. Schumpeter (1939) associated each of them with long waves in economic growth, which would be the result of a technological revolution and the absorption of its effects. Usefully, the neo-Schumpeterian school shifts the emphasis from 'big bang' innovations to a historical sequence of successive interconnected clusters of new and dynamic inputs, processes, products and industries, together with related organisational and institutional innovations. Such multi-faceted analyses of technological change attempt to understand how and by what means the new technologies diffuse and how their socio-political shaping profoundly changes our economies and societies, not just the production processes and the jobs.

From BEYOND4.0's perspective, a technological revolution can be defined as 'a powerful and highly visible cluster of new and dynamic technologies, products and industries, capable of bringing about an upheaval in the whole fabric of the economy and of propelling a long-term upsurge of development' (Perez, 2002, p. 8). Moreover, a technological revolution can be characterized as 'a strongly interrelated constellation of technical innovations, generally including an important all-pervasive low-cost input, often a source of energy, sometimes a crucial material, plus significant new products and processes and a new infrastructure', where the latter 'usually changes the frontier in speed and reliability of transportation and communications, while drastically reducing their cost' (op. cit. p.8).

This definition of a technological revolution demands a particular structure in order for a set of complementary technologies to be seen as a 'revolution' (see Table 1 below). In turn, such a structure must be assimilated by the economy and society in a complex process that requires major policy changes, so it is a socio-institutional – and indeed socio-political – transformation, as well.

Table 1: The industries, infrastructures and paradigms of each technological revolution

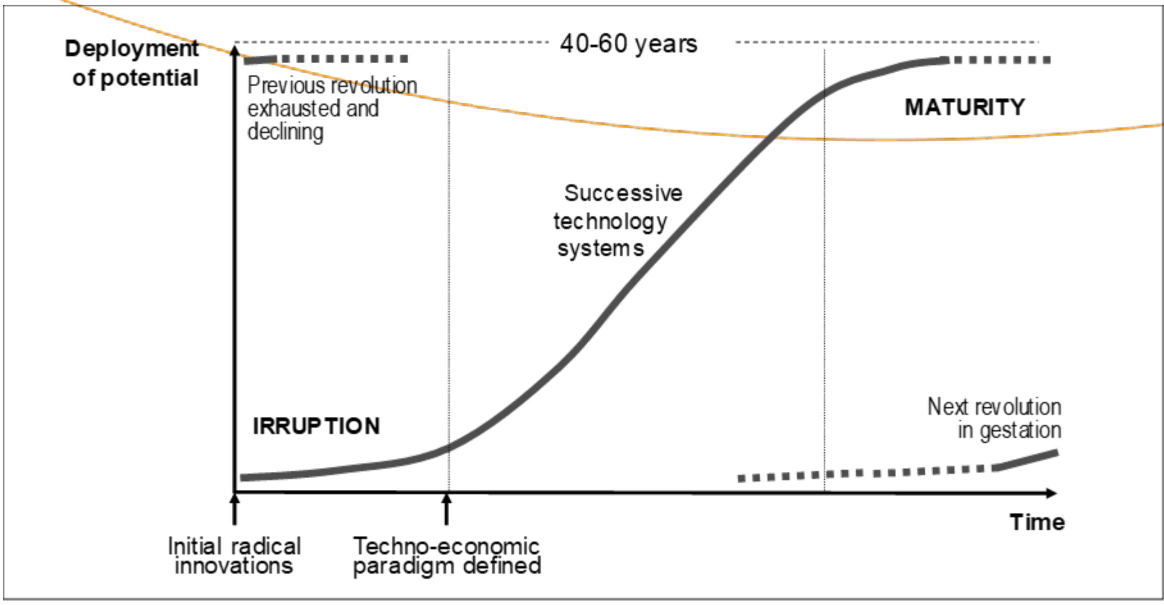
Technological revolution	***New technologies and new or redefined industries***	***New or redefined infrastructures***	***Techno-economic paradigm 'Common-sense' innovation principles***
FIRST: From 1771 *The 'Industrial Revolution'* Britain	Mechanised cotton industry Wrought iron Machinery	Canals and waterways Turnpike roads Water power (highly improved water wheels)	Factory production; division of labour; efficiency Mechanisation Productivity/ time keeping and time saving Fluidity of movement (as ideal for machines with water-power, for transport through canals and other waterways and for human work on products from task to task) Local networks
SECOND: From 1829 *Age of Steam and Railways* In Britain and spreading to Continent and USA	Steam engines and machinery (made in iron; fuelled by coal) Iron and coal mining (now playing a central role in growth)* Railway construction Rolling stock production Steam power for many industries (including textiles)	Railways (Use of steam engine) Universal postal service Telegraph (mainly nationally along railway lines) Great ports, great depots and worldwide sailing ships City gas	Economies of agglomeration/ Industrial cities/ National markets Power centers with national networks: decentralised centralisation Scale as progress Standard parts/ machine-made machines Energy where needed (steam) Interdependent movement (of machines and of means of transport) Free markets as ideal context
THIRD: From 1875 *Age of Steel, Electricity and Heavy Engineering* USA and Germany overtaking Britain	Cheap steel (especially Bessemer) Full development of steam engine for steel ships Heavy chemistry and civil engineering Electrical equipment industry Copper and cables Canned and bottled food Paper and packaging	Worldwide shipping in rapid steel steamships (use of Suez Canal) Worldwide railways (use of cheap steel rails and bolts in standard sizes). Great bridges and tunnels Worldwide Telegraph Telephone (mainly nationally) Electrical networks (for illumination and industrial use)	Giant structures (steel) Economies of scale of plant/ vertical integration Distributed power for industry (electricity) Science as a productive force Worldwide networks and empires (including cartels) Universal standardisation Cost accounting for control and efficiency Great scale for world market power/ 'small' is successful, if local
FOURTH: From 1908	Mass-produced automobiles	Networks of roads, highways, ports and airports	Mass production/mass markets

Age of Oil, the Automobile and Mass Production In USA and spreading to Europe	Cheap oil and oil fuels Petrochemicals (synthetics) Internal combustion engine for automobiles, transport, tractors, airplanes, war tanks and electricity Home electrical appliances Refrigerated and frozen foods	Networks of oil ducts Universal electricity (industry and homes) Worldwide analog telecommunications (telephone, telex and cablegram) wire and wireless	Economies of scale (product and market volume)/ horizontal integration Standardisation of products Energy intensity (oil based) Synthetic materials Functional specialisation/ hierarchical pyramids Centralisation/ metropolitan centers–suburbanisation National powers, world agreements and confrontations
FIFTH: From 1971 *Age of Information and Telecommunications* In USA, spreading to Europe and Asia	The information revolution: Cheap microelectronics. Computers, software Telecommunications Control instruments Computer-aided biotechnology and new materials	World digital telecommunications (cable, fibre optics, radio and satellite) Internet/ Electronic mail and other e-services Multiple source, flexible use, electricity networks High-speed physical transport links (by land, air and water) Artificial intelligence, Robotics, Internet of Things	Information-intensity (microelectronics-based ICT) Decentralised integration/ network structures Platforms Knowledge as capital / intangible value added Data as raw material Heterogeneity, diversity, adaptability Segmentation of markets/ proliferation of niches Economies of scope and specialisation combined with scale Globalisation/ interaction between the global and the local Inward and outward cooperation/ clusters Instant contact and action / instant global communications

* These traditional industries acquire a new role and a new dynamism when serving as the material and the fuel of the world of railways and machinery
Source: Adapted from Perez (2002), Tables 2.2 and 2.3.

As individual technologies and systems, the diffusion of technological revolutions can be represented as an epidemic curve, from the introduction of the first radical innovations to the exhaustion and maturity of its potential for increasing productivity, for adding new products or processes along the same trajectory and for expanding the market for its products and services (see Figure 2 below).

Figure 2: The life trajectory of a technological revolution

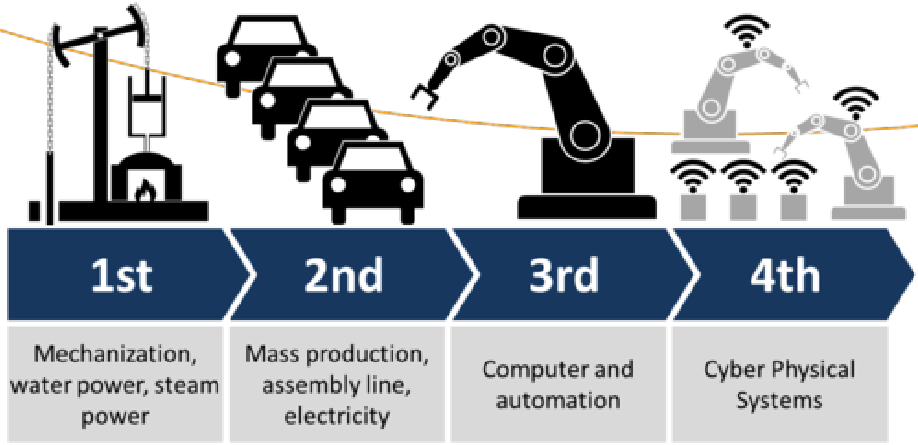


Source: Perez, 2002

What Table 1 above also highlights is the long disagreement within academia on the periodisation and number of technological revolutions: two, three, four, five and even six. For example, Brynjolfsson and McAfee (2014) focus on the replacement of muscle power and brain power with machines in *The Second Machine Age*, ascribing the latter to our present moment; Rifkin (2012) on changes in energy and infrastructure in *The Third Industrial Revolution* and which was initially popular with both the EU and UN. Gordon (2012) concentrates primarily on 'inventions' and regards the present moment as the third 'Industrial Revolution'.

History is an unwieldy mass of information that can be interpreted in multiple ways depending on the analytical lens used and the notion of a technological revolution often represents a concept in search of theoretical validation and so becomes a framework for empirical analysis. BEYOND4.0 explores these differences and their implications in detail. Nevertheless, because of its current dominance in EU policy parlance, the starting point of BEYOND4.0 (and reflected in its project title) is Schwab's (2016) 4th industrial Revolution as represented below in Figure 3.

Figure 3: Schwab's four industrial revolutions



Source: Schwab, 2016

Industrie 4.0 is grounded in the perception of there being four 'industrial revolutions': water and steam power mechanisation in the late 18th century; electricity and mass production at the turn of the 20th; microchips and computers from the late 1960s; and the emergence of 'cyber-physical systems' in manufacturing today. Used foremost to analyse the consequences of technological change on the nature of work rather than on the profound socio-economic and political dimensions involved in such technological transformations, it is accompanied by a structuring effect of technology as if the nature of the technologies imposed inevitable adaptation on society.

The Schwab articulation of industrial revolutions corresponds to Perez's (2002) first three revolutions. The second is similar to Perez's fourth; and his third and fourth are two stages of Perez's fifth given that his fourth as the latest systems of the computer and automation revolution. Significantly, for history to illuminate rather than obscure, it is important to study the full period from the exhaustion of the previous revolution through the emergence of the new and its initial disruptive consequences, its gradual deployment across the economy and society and finally its exhaustion and the reiteration of the cycle. Key to this analysis is the observation of the historical regularities in the process of social and economic assimilation of each new surge of technology:

> A great surge of development is [...] the process by which a technological revolution and its paradigm propagate across the economy, leading to structural changes in production, distribution, communication and consumption as well as to profound and qualitative changes in society. The process evolves from small beginnings, in restricted sectors and geographic regions, and ends up encompassing the bulk of activities in the core country or countries and diffusing out towards further and further peripheries, depending on the capacity of the transport and communications infrastructures. (Perez, 2002, p. 15).

This concept is different from that of long waves – or Kondratiev waves (1935) – as used by Schumpeter (1939). Rather than see the process of absorption of a technological revolution as inducing long term upswings and downswings in GDP, it focuses on the diffusion of the new technologies and their socio-institutional absorption and shaping. This leads to different dating and to moving away from the pure market and paying attention to the role of the socio-institutional actors including that of government.

Each surge of development presents a regular pattern of propagation and it is these commonalities that are the lessons that history provides. The early decades of diffusion of a revolution – the installation period – are of creative destruction, led by finance. They have historically ended in a bubble and collapse. The following period (such as the 1930s and now) reveals all the ills that underlay the bubble prosperities, including regional and job destruction and inequality. They tend to produce divisions in the traditional parties, between those that stick to past ideas and those that think ahead, understanding the new circumstances. They also give rise to new movements and new alliances, often of a populist sort, reaping the anger and resentment of the victims of the installation period. It can be called the 'turning point' because it requires a change of policies and a shift of control from finance to production, achieved by the policies of an active state. When that occurs, the following 'deployment' period tends to reverse the ills and shape the technologies so there is a positive sum game between business and society. It is in deployment that capitalism has experienced the 'golden ages' such as the Victorian boom, the Belle Époque and the post-war boom.

For while the intrinsic nature of the technologies and the specific historical context are new each time, the recurring pattern of their assimilation – or lack of – reveals the nature of organisations and of behavioural habits that either resist or promote the social change processes required by each technological revolution. The key to setting a policy course for a win-win outcome is to understand that every previous revolution presents a wide range of potential directions. It is only by examining the options that were available in each historical moment that the narrow view of technology imposing an inexorable logic on society can be overcome, and policymakers and business alike encouraged to take control of the shaping of economic growth, employment, inequality, regional disparities, environmental problems, and all such issues that are often presented as beyond the control of the main actors, including government.

4.2. The Digital Revolution

Digitalisation is the application or increase in the use of digital technologies by an organisation, industry, country or region. The 'Digital Revolution', manifest in the 4th Industrial Revolution, is defined as 'a general acceleration in the pace of technical change in the economy, driven by mass expansion of our capacity to store, process and communicate information using electronic devices' (Eurofound, 2018b, p.1). Transforming the social organisation of economic activity, this digitisation will impact jobs and, with it, skill, tax and welfare systems. Digitalisation is not new. Indeed, it is based on micro-processing, the introduction and diffusion of which in the 1970s was heralded by some at the time as a 3rd Industrial revolution (Jenkins & Sherman, 1979). What is new is its pace and scope of technological change and its transformative potential (Meil & Kirov, 2017; Katz, et al., 2014) – hence the claim that its drives a 4th Industrial Revolution.

The general acceleration in the pace of technological change in the economy has been driven by a massive expansion of the capacity to store, process and communicate information using electronic devices. New developments in robotics (cobots), Internet of Things, 3D printing, but also in the field of big data, machine learning and artificial intelligence and the possible combinations of all, are considered as powerful drivers for changes in living and working conditions, and mobility. The digital transformation deeply modifies many aspects of our lives: the way we buy, sell, network, communicate, participate, create, consume and, of course, the way we work (Meil & Kirov, 2017).

For some scholars, digitalisation has a disruptive character; for others it is a question of incremental change or continuous evolution. For those scholars in the first camp, digitalisation opens up new and unknown technology application potentials that will portend epochal social and economic transformation (Avent, 2014). The counter claim from the second camp is that the new technologies are simply like "pouring 'old' wine into 'new bottles'. They argue that previous debates about automation and computerisation can inform current debates. According to them, it will be useful to connect today's reshaping with what has already happened and to moderate the technological assumptions of digitalisation as a disruptive factor (Beuker et al., 2019). Despite their differences, across both camps, there is a general consensus that digitalisation will increasingly impact work and employment in Europe, which can have consequences for the welfare systems into which this work and employment is embedded (Degryse, 2016; Valenduc & Vendramin, 2016; Warhurst & Hunt, 2019). However, what is also apparent is that there is an urgent need to improve the evidence base on the actual effects of digitalisation on work and employment (Hunt et al., 2019), with a particular weakness being the paucity of good datasets (OECD, 2018a).

4.2.1 The digitalisation of production in Industrie 4.0

The key example of the digitalisation of production is the smart industry of Industrie 4.0. *Industrie 4.0* features companies using automation coupled with advanced robotics (connected to artificial intelligence, AI) to dramatically reconfigure how goods and services are produced. AI combined with the emergence of big data, the internet of things and ever-increasing computer power can result in 'clever robots' undertaking both physical (manual) tasks and, increasingly, some cognitive (mental) tasks. Such tasks, to date, have been undertaken by humans (Manyika et al., 2017; OECD, 2018b). These robots do not just work continuously, they are able to learn, including from machine-to-machine information exchange, and so adapt to be more efficient at these tasks. Digitalisation thus makes production of goods and services more efficient and more productive (World Economic Forum, 2017).

Although there are definitional problems – other labels include the 'smart factory' and simply 'advanced manufacturing' (Davies, 2015), Industrie 4.0 offers an integrated production system that, through the new digital technologies, links not only functions within companies but also links those companies with suppliers and customers. It offers increased production flexibility, reduced production time, enhanced product quality and enhanced productivity. It also provides customers opportunity to offer their own product modifications, which can then be quickly and cheaply produced, Davies notes. It is this digital integration of conception, production and consumption along the value chain that offers a new business model.

Whilst even in Germany the prevalence of such integrated systems is still relatively low, perhaps 20 per cent or even less of manufacturing companies (Davies, 2015), it is its potential to eradicate jobs that has generated concern amongst policymakers in Europe. Improved computing power, AI and robotics will replace the paid work of humans on a scale not previously seen, claims Autor (2015). While Frey and Osborne (2013) predict that nearly half (47%) of all US jobs being at risk, estimates vary, with some estimates lower, at around one-third (35%) of jobs (Deloitte, 2014) – others are much higher (90%) (see Lever, 2017). Underneath these headlines figures, there will be country, regional and industry variations plus different impacts upon different types of workers (Yong Kim, 2016; Wilson, 2017; Muro et al., 2019).

Often, as Muro et al. point out, the impact upon workers is a function of regions' industry specialisation so, for, example, those regions with a heavy manufacturing base are more prone to lose jobs and jobs which are typically male. The OECD (2018c) has developed a regional typology based on employment trends and risk of jobs automation. It then identifies regions within countries that are most at risk. The policy imperative will be to help regions at most risk by encouraging lower risk job creation. There will also be a need to manage the risk to workers through the provision of wrap-around welfare support by, for example, supplementing no and low incomes and ensuring the maintenance of employability through training, education and lifelong learning to cope with more scarce jobs.

4.2.2 The digitalisation of work in the platform economy

Part of the digitisation of work rests on the migration of work to platforms. Platforms are digital networks that coordinate economic transactions – usually matching the demand for and supply of resources through algorithms. The use of platforms for the delivery of an increasing range of goods and services is one of the most pervasive and visible forms of digitalisation and Uber has become the posterchild (Walker Smith, 2016) of the putative 'platform economy' and 'Uberisation' suggested as the model for the future of work (see Bernhardt, 2016).

Such platforms can be seen to provide a more efficient or cost-effective service to citizens and consumers (e.g. HM Government, 2015). It should be noted that different types of platform exist: those for the exchange of goods (e.g. Ebay and Amazon Marketplace) and those for the exchange of services (e.g. Uber and TaskRabbit). The digitisation of work centres on the latter - services. Clients or customers purchase services, usually in the forms of a prescribed task, from a provider. Sometimes providers bid for these tasks, sometimes they are allocated them. Services can be routine and non-routine, local or global. Tasks can be physical (e.g. TaskRabbit), intellectual (e.g. Upwork) and social (e.g. Bubble). Work in these platforms could be done online or mediated by the platform, and executed offline (Meil & Kirov, 2017). Workers can register their services on the platform and then 'requesters' post tasks on the platform that they want completed and an algorithm is used to match workers to tasks based on parameters such as location, availability, skills/features and, perhaps most importantly, user ratings. While ICT has presented this possibility for a number of years (e.g. Amazon Mechanical Turk as a platform for micro-programming tasks was launched in 2005) it is the integration of digitalisation that enables both a better matching of requesters and providers the possibility of remote monitoring of work by the platforms companies that has led to the increase in this form of working. In this sense online digital platforms represent a new business model and also enable the delivery of services in a new way, even if some of the services provided through the platforms are not new.

The introduction of platforms also allows the massive evolution of online or crowd employment, as a new form of organising the outsourcing of tasks, which would normally be delegated to a single employee, to a large pool of 'virtual workers' (Felstiner, 2011). In fact, crowd employment uses an online platform to enable organisations and individuals to access an indefinite and unknown group of other organisations and individuals to provide – upon payment – specific services or products (Barnes et al., 2015). In this perspective, platforms contribute to the geographical spread of work and employment and can create and the possibility for work to be carried out anywhere around the world at any time in a 'truly global, digital assembly line' (OECD, 2017).

For workers, previously secure employment (in the case of Uber, taxi jobs) is transmuted into a series of work tasks (with Uber, providing a client with a ride). There is an increasing consensus that one of the most dramatic developments in European labour markets in recent years has been the job shifts or the introduction of online platforms using 'crowd work' (Huws et al., 2016). Digitalisation influences labour supply through the introduction of new technological intermediaries or 'platforms' that lower barriers to labour market entry and thus include more people in the market (European Commission, 2019a). This phenomenon alone would lead to significant disruption of traditional industries and existing businesses, even pipeline businesses at the top of the Fortune 500 rankings (OECD, 2017). One feature of this disruption is its impact on jobs. It is platforms companies' potential to create new forms of work which come under considerable public scrutiny (e.g. Taylor, 2017). However, it is not just that jobs are de-bundled into tasks, the employment status of task providers remains unclear. Platform companies such as Uber insist that their drivers are self-employed, refereeing to them as 'partners' for whom they have no responsibility to provide health insurance, holiday pay, (paid) sickness leave or a minimum wage. Nonetheless, some evidence suggests that the control exerted upon workers by the platform companies in terms of how work is undertaken is reminiscent of employment (Warhurst et al., 2020f). Others argue that neither status reflects the business model and that a new third status might be needed, such as 'dependent contractor' (Taylor, 2017) or 'independent worker' (Harris & Krueger, 2015).[1]

Whatever its legal status, there are forecasts that growth of this type of working will continue; Standing (2015) predicts that one third of all labour transactions will pass through online platforms by 2025. Again, however, some argue that platforms are simply exacerbating existing non-standard employment or atypical work that has increased since the 1970s (Cappelli & Keller, 2013). As with Industrie 4.0, the prevalence of atypical work is still limited – most workers (66%) in the EU have a standard employment relationship (Eurofound, 2018a), characterised as full-time, permanent and with a single employer, and engagement with platform working as a main income is low. Only around two per cent of the adult population can be regarded as earning their main income from platform working according to the COLLEEM survey[2] of 14 EU Member States (Pesole et al., 2018). However it remains the case that measuring the prevalence of platform work is notoriously difficult, because it encompasses self-employment and informal work activities. A more precise view can only be developed using a multi-pronged approach (Dhondt, 2019). Nevertheless, recognising that the outcome for those workers experiencing atypical and gig working is precariousness, low wages, poor prospects and social inclusion, with workers insufficiently covered by labour laws, collective bargaining arrangements and welfare support (Kalleberg, 2009; Standing, 2011), a policy response

[1] For critiques, see Eisenbrey & Mishel (2016) and Stewart & Stanford (2017).

[2] The Collaborative Economy and Employment (COLLEEM) survey of 32,409 internet users undertaken in 2017 covered: Germany, Netherlands, Spain, Finland, Slovakia, Hungary, Sweden, UK, Croatia, France, Romania, Lithuania, Italy, and Portugal.

is needed, even if only to recognise the need to update social protection policies (OECD, 2018a; EPSC, 2016).

4.2.3 Favouring inclusive and empowering technological environments

Digital technologies are not simply tools for tasks. They shape work and employment, with major reconfigurations in the ways of doing, thinking, organising or collaborating. Thus, while digital technologies can enhance the value of work and contribute to skills development, they can also distort activity by interfering with operational leeway or removing from professional practices and relationships what is meaningful to the people who do the work.

The dematerialisation of the activity can occur to the detriment of employment and work and employee/worker wellbeing. This happens when new technologies are put in place to replace humans or when they involve reconfigurations and requirements that destabilise work collectives, or when goods and services resulting from them exclude some of the components of society from the outset or do not contribute sufficiently to human development.

Thus, the development of emerging technologies must be informed by knowledge about the work as it is really done by the workers (Kaptelinin & Nardi, 2006). Indeed, the work prescribed by an organisation (including what is embedded in technologies), regardless of the level of formalisation and standardisation achieved, never covers all human work. Humans keep on interpreting what is going on in their ever-changing work environments and adjusting to it. This creation of meaningfulness is never achieved by machines, however ‘intelligent’ they may be, since they only retroact with their environment according to the models/expectations of the designers ‘incorporated’ into the machine. Moreover, these machines only work in addition to human expertise that is obtained through deep knowledge and often long learning.

Taking this into account is essential in order to obtain two important outcomes from technological development: inclusiveness and empowerment. Inclusive technological environments allow all segments of society to become active users of the technology, in particular more vulnerable groups as unskilled, ageing or handicapped groups. In empowering technological environments, organisations and work situations have been designed to transform emerging technologies into resources for work, allowing employees to flourish by performing work that is both meaningful and efficient and thus contribute to the development of well-being and health.

Across the diversity of routes followed by companies in the digital transformation, it is important to identify those where technologies are used as a resource complementing human work and those where humans come as an appendix to the machines. The organisational options taken by companies when they develop and implement technologies are crucial. They determine the relationships between digital technologies and work content, between skill developed and skill utilisation and hence contribute to shaping evolutions on the demand side of labour markets. New policies are needed in order to favour the development of inclusive and empowering technological environments in the era of digital transformation. Innovation and industrial policies would need to be reviewed with this target in mind as well as their interactions with skills and employment policies.

4.3. The impact on welfare policy

The core of welfare policies is to provide minimum standards for the most vulnerable in society. However, in most welfare states social policy comprises much more. In most cases social insurance compensates the loss of income, i.e., the provisions are income-related and not targeted only to the poor. Hence, provision can be wide: medical care, housing, pensions etc. Linked to employment, welfare systems in each country can provide a range of support relevant to BEYOND4.0 including education and training, unemployment assistance and income support for example. EU Member States have their own welfare systems, which, to the point of EU enlargement, were argued to cluster into distinct models or regimes – most famously by Esping-Andersen (1990):

- Liberal, with commodified, market-delivered provision;
- Conservative, organised around traditional family structures and values;
- Social Democratic, (high) standards based with heavily socialised provision.[3]

There is, nonetheless, also a European social model intended to ensure at least minimal, combining commitments to full employment, social protection and social inclusion. Regardless of Member State and including the European social model, Europe's welfare systems were devised in an era that emphasized the need for or at least desirability of, full and standard employment – even in periods of high unemployment. It was also very male-centric in focus (Wright, 2015). This approach continues, manifest in both 'work first' and 'flexicurity' policies and practices: the first directing the unemployed and long-term economically inactive back *into* work and the last is a means of ensuring that safety nets and interventions exist to enable any necessary transitions *between* work. Even whilst women (re)entered the labour market in the latter quarter of the twentieth century, often juggling care responsibilities with employment, welfare policy was implicitly, if not explicitly, geared to the standard employment relationship (SER).

National social protection systems developed to protect people in standard employment. This provision is particularly the case for insurance-based schemes, i.e. those based on social contributions from the employee and the employer. People in non-standard employment have always been in a more insecure and precarious situation regarding access to schemes and receipt of insurance-based benefits (ILO, 2016). Even in the most generous welfare states, those in atypical employment are lagging behind 'typical' employees' (Spasova, et al., 2017).[4]

In part, this positioning of welfare was governmental response to employer practice. Developed out of the factory system, mass production involved large-scale organisations with strong internal division of labour reliant on a consistent and dependable workforce. Attendance and performance requirements along with the job-specific skills requirements could be achieved more effectively by developing a stable workforce and providing permanent employment (Stanford, 2017; see also Beynon, 1973). In this respect, as Kerr et al. (1960, pp.41-56) explained, this era of industrialism had

[3] This typology has been extended and adapted, see, for example, Bonoli et al. (2000), Castles et al. (2010), and Greve (2018).

[4] We acknowledge that benefits and services financed by taxes (e.g. family allowances, some forms of healthcare and long-term care) and certain means-tested benefits (e.g. social assistance and minimum income provisions for older people) are granted in many European countries regardless of the employment status of an individual.

a 'logic'. It needed: a non-discriminatory, 'open society' in order to enable occupational and geographic mobility within the labour market; a workforce both educated to a general level and a specialist level related to that type of (mass production) technology and which featured both continual training and retraining for workers; 'structured' workplaces and jobs 'subject to a set of rules' that formalise the management and employment of workers and prevent arbitrariness; an understanding that such rules emerge from and are administered on a 'shared' basis involving government, employers and workers, what was then termed 'tripartism'; and that, regardless, of party-political orientation, all governments had 'large role' in delivering these needs.

As Stanford (2017) notes, this 'Golden Age' of employment was already beginning to fade in the 1970s because of macroeconomic and political changes – as the rise in atypical employment from that time identified by Cappelli and Keller (2013) illustrates. The digital revolution potentially not just exacerbates this trend but accelerates it. If fully realised, with the eradication of human labour, the digitalisation of production could lead to the death of many jobs, resulting in significant and structural unemployment. Similarly, if it becomes more pervasive, the digitalisation of work will also lead to the death of jobs, though human labour will continue but with what is now atypical work becoming mainstreamed. Based on the SER, current welfare systems would no longer be fit for purpose.

How welfare linked to employment can be re-fitted around the new world of work is still a moot point, though it is clear that the focus of debate is shifting. This shift is most obvious in the OECD (2018d). In the 1990s, the OECD advocated labour market flexibility. In the 2000s it advocated full employment. Now, worried about the existential threat to jobs, it advocates the creation of more and better jobs and labour markets that are more inclusive and resilient. A range of suggestions for welfare reform have been made that seek to variously remedy and prevent the death of jobs, some of which will require 'a fundamental rethinking' of existing welfare provision (Annunziata & Bourgeois, 2018, p.18). Training and education, including lifelong learning, it is suggested, needs to be better aligned with the new skills required in the digital era, it might even be skewed more to STEM subjects; social protection needs to be enhanced, including the provision of a universal solid floor or safety net; workplace rights and responsibilities need to be clarified and strengthened including legal determination of employment statuses; wages, taxes and benefits need to be combined to protect workers rather than jobs, with benefits becoming portable, attached to workers rather than jobs; social partnership and collective bargaining need to be made more effective to support inclusivity and equal opportunities (e.g. Annunziata & Bourgeois, 2018; Forde et al., 2017; OECD, 2018d; Taylor, 2017).

Kerr et al.'s (1960) logic of industrialisation was both descriptive and prescriptive. It both purported to explain how industrialism did work and how it should work in what Schwab (2016) would describe as the 2nd Industrial Revolution. A similar logic for the current transformation is absent but needs to be developed. Even before the current debates about the future of work, Esping-Andersen's (2009) update was arguing that welfare states need to be reconfigured and made more sustainable. One of the biggest challenges for all welfare states in the face of digitalisation is to what extent social policy, established during the industrial era, can recognise and properly respond to new social risks, evolving from the emerging mode of production. There is a number of alternative policy options suggested in this context. At one end of the continuum there is universal and unconditional basic income (UBI). At the other end, there is strongly conditional and punitive universal credit. Moreover, there is a variety of alternative option in between these two extremes (Van Parijs & Vanderborght, 2017).

- Universal basic income (UBI) is an unconditional income transfer scheme that is meant to cover human basic needs. Sometimes these needs are defined broadly, with other income transfer programmes becoming obsolete as result. This kind of 'full' basic income would simplify the transfer system. The problem is that the full UBI would be expensive and to be financed would require high tax rates, which might make it difficult to legitimate. An alternative is 'partial' basic income. In the partial UBI the needs the benefit would cover are more limited and the UBI would replace only the minimum level of income protection schemes. The model would be cheaper to finance but there would be a need for other income-related transfer schemes in addition to the partial UBI. Although the UBI is paid also to the 'rich', there is a claw-back effect: the benefit is taxed away from the high-income earners.

- The idea of participatory (basic) income (PI) was advocated by the late Tony Atkinson in the 1990's. The difference between the BI and the PI is that the PI is conditional. To receive the basic income, people would need to be participating in society. The participation could take different forms. It could be formal work, it could be unpaid work such as care and volunteering in the third sector organisations, education. Thus, some kind of contribution to society is a condition to be eligible to the PI.

- It is also possible to combine the partial basic income – a rather small unconditional provision to guarantee a tight basic safety net – with the PI option. Whereas the former would be unconditional without work requirement the latter would be conditional to different kind of participation and activities.

- With negative income tax (NIT), the lowest taxable income is defined and all individuals whose income is below that minimum level receive a 'tax return', i.e., they are paid negative income tax until they will reach the accepted income level. The NIT will be gradually reduced with increasing income form employment. All taxpayers whose income is higher than the agreed minimum level pay income tax. NIT has some similarities with the UBI and from the beneficiaries' point of view the distributional consequences may be the same. However, there are important differences. Whereas the UBI is unconditional, the NIT can either be unconditional or conditional, and it is tested against all other income.

- If the NIT would be conditional and the eligibility to benefit would be conditioned by the claimant's labour market behaviour or other activities, the model comes close to the universal credit (UC). In the UC a number of basic security benefits (e.g., unemployment, housing allowance, social assistance, etc.) are merged into a one benefit which diminishes according to a certain percentage when income from employment increases. Those who do not show proper activity, will lose their benefits for a period of time that can vary from a couple of weeks to couple of years.

There are advantages and disadvantages with all the main models debated. Whereas the UBI safeguards a solid and tight safety net, enhances freedom of choices and self-determination, there are some problems. First, freedom of choice is a viable option only for those who have skills and knowledge to freely choose. Second, there may be problems in combining the unconditional UBI with activation programmes that are important for acquiring new skills needed in the digital economy. Thus, the dilemma is to have adequate social security for all forms of employment and simultaneously preserve incentives to work and to participate in skill-formation activities and life-long learning. Third, it may be difficult to politically motivate the unconditional UBI. The 'money-for-nothing' political frame may appear to be too persuasive. The NIT would be easier to motivate: benefits are not paid to 'rich' people as in the UBI. The flip side of the NIT is to decide whether it is an individual income or a household's income that should be taken into consideration when defining the amount of the NIT. Furthermore, the NIT would need an income register that is updated on monthly basis. Conditional models demand bureaucratic screening and monitoring to establish eligibility. The more there are conditions, the more extensive is the bureaucratic screening. Furthermore, there is the difficult moral question whether it is right to leave those who do not behave properly totally without social security.

In the early 2000s a new concept – the social investment state – appeared in policy debates about the welfare state (e.g., Esping-Andersen, et al., 2002; Morel, et al., 2012; Hemerijck, 2013; Cantillon & Vanderbroucke, 2014). The central demand in the investment paradigm is that the emphasis in social policy must be shifted from the 'old' income transfer-oriented 'compensating welfare state' towards a new, more proactive and preventive social investment state. In such a welfare state, activation and capacity building are the main strategies. The European Commission (2013)[5] defines social investments as policies designed to strengthen people's skills and capacities and support them to participate fully in employment and social life. Thus, the social investment-based welfare state also is an inclusive welfare state. Key policy areas include education, quality childcare, healthcare, training, job-search assistance and rehabilitation.

An effective integration between policy areas is the crucial precondition for the social investment welfare state. This integration ensures coherence between income transfers – guaranteeing basic safety net and income-related benefits – and social, educational and employment services. The central aim is to produce a well-educated labour force that is prepared to meet the challenges of the emerging digital economy.

The OECD (2018d) recognises that the success of any new welfare initiatives that seek to respond to social and economic change as an outcome of the new digital technologies will require the building of public support. An important factor in building this support will be the generation of an evidence base about digitalisation that goes beyond current assumptions and predictions to instead provide data on what is happening and why and how it is happening. Only with this evidence base can effective policy be developed. At the moment, however, that evidence base – across the digitalisation of both production and work, and at company, regional, national and EU levels – is still to be generated, and policy development hampered as a consequence.

In this respect, what Meil & Kirov (2017, p.4) state about work and welfare in the platform economy also resonates with the coming of the robots, currently 'there is no clear approach to the direction that policy should be taking' and the challenge is twofold: to identify the policy challenges and then

[5] https://ec.europa.eu/social/main.jsp?catId=1044&langId=en.

develop policy options. BEYOND4.0 responds to these challenges. It counters the technological determinism that infuses much current predictions and policy about the impacts of digitalisation. It examines not just what impacts occur to work and welfare through the putative 4th Industrial revolution but how those changes occur and identifies the policy options that can be pursued, particularly by the European Commission and its agencies.

5. Key concepts and issues informing the four areas of enquiry

As noted above, in examining the impact of new digital technologies, BEYOND4.0 has two areas of enquiry for BEYOND4.0: first, the opportunities and challenges for work and employment; second, the opportunities and challenges for welfare and social security systems. BEYOND4.0 investigates these areas with four particular issues:

- The quality, content, and distribution of work.
- The skill needs of the labour market.
- The education and training to support development of these skills.
- The creation and capture (extraction) of value (and wealth) by companies.

5.1. This section of the Working Paper provides exposition of these issues, outlining key concepts and issues in each case. This overview guides the further development of the work in the different work packages of BEYOND4.0. The quality, content and distribution of work

Creating better not just more jobs is an important goal in the EU's *Europe 2020 Strategy* for economic growth and competitiveness. Improved job quality will help address the EU's challenges with innovation and inclusion for example, and is positioned as a potential missing link in that strategy (European Economic and Social Committee, 2011). This sub-section outlines job quality and highlights some of its key features with respect to BEYOND4.0 analysis, including OSH.

5.1.1 Jobs, work and employment

Talk about the future of 'work' can be misleading, when the focus is jobs. Whilst 'work' is often used as a catch-all term (e.g. Halford, et al., 2016), jobs comprise both work and employment. *Work* is defined as any mental and/or manual activity performed by persons to produce goods and services for own or others' use (International Conference of Labour Statisticians, 1993 [ICSE-93]). Work can be paid and unpaid and comprises a bundle of tasks requiring skill and knowledge. With paid work – the focus of BEYOND4.0 – these tasks are put together for an employee by an employer and applied to some form of technology. *Employment* is a relationship between two parties within which the work performed by one party is paid for by the other. Employment has terms and conditions under which that work is undertaken for the employer, and which are typically made explicit in a contract. These contracts are governed by employment laws, regulations and guidelines, and typically state employment status and payment. Any contract, however, is incomplete. With a right to manage, employers have scope for different job design and employees may find themselves in jobs that may or may not meet their needs and preferences (Knox, et al., 2015). Within this scope, room for adjustments and trade-offs between employers and employees remain which can affect employee engagement, performance and well-being.

The new digital technologies can impact both work and employment as well as unemployment. Unemployment or joblessness is a situation in which a worker is actively looking for employment but is not currently employed. In the EU some forms and level of income for some specified period is allocated to workers in this situation through welfare and social security support.

The digital transformation may destroy businesses and jobs, displace workers and occupations, accelerate the obsolescence of skills and hence favour unemployment. Classical schools of thought in economics have identified several mechanisms that are likely to compensate, at least on the long run, technologically produced unemployment. Indeed technological transformations also spur new businesses, new occupations and skills shortages, with no certainty about that the compensating mechanisms will offset the initial labour saving effect. Indeed, possible hindrances to compensation mechanisms may only allow partial compensation, depending on institutional settings and on the values of crucial parameters, such as demand elasticity, degree of competition, capital labour substitution, demand expectations, and others (Vivarelli, 2014). Furthermore, the transformations observed on labour markets over the last decades, challenge the definition of un-employment. While being in employment was traditionally understood as being employed permanently on a full-time basis, since the 1980s western economies have experienced the emergence of new forms of employment such as temporary – and often with it often short duration contracts-, part-time and self-employment. In particular, the development of the platform economy with its digitisation of work compounds this development, with suggestions of third status employment between employment and self-employment.

5.1.2 How job quality is defined and measured

As yet, there is no consensus about what constitutes *jobs quality* or how it should be measured. A consistent, unifying definition of job quality remains elusive (Findlay, et al., 2013). A plethora of terms or concepts are used, for example, 'quality of working life', 'meaningful work', 'fulfilling work'. Each are distinct (see Warhurst et al., 2017b). For example, the ILO prefers 'decent work', which tends to focus on poverty reduction in developing countries. Sometimes these terms are used interchangeably. For example, the European Commission and its agencies use 'decent work' and 'fair work', sometimes even in the same policy document. Warhurst et al., suggest that a 'family of concepts' exists that can be captured within the generic term 'job quality'.

An addition problem is measurement, which varies by discipline, approach and form. Different disciplines typically focus on different indicators – economists favour pay for example, while psychologists job satisfaction and sociologists tend to favour skill. The subjective and objective traditions about measurement create further complications. The subjective approach derives quality from the utility that a worker obtains from fulfilling his or her work. The objective approach determines its measurement from collectively agreed amenities or dis-amenities. In terms of form, some measures of job quality favour a single indicator, pay for example is used as a proxy in Eurofound's (2012) assessment of job quality trends in the EU. Currently, to measure upward convergence of working conditions in the EU, Eurofound (2018c)[6], uses seven dimensions, each with sub-indictors: physical environment; social environment, work intensity; skills and discretion; working time quality; prospects; and earnings .

Generating an agreed and operationalisable definition of job quality requires drawing upon and encompassing these multi-disciplinary and multi-dimensional approaches, and which reports job quality using an easy to understand method and which focuses solely on the work and employment

[6] Having revised its conceptual framework of job quality several times over the past two decades,

that comprises jobs and omits labour market noise. Two influential attempts to do so are provided by Muñoz de Bustillo et al (2011) and Erhel & Guergoat-Larivière (2010). The resulting six dimensions, again with sub-indicators, developed for the QuInnE research project are: terms of employment; pay and benefits; health and safety; the nature of work; work-life balance; and voice and representation. These dimensions are not hugely dissimilar from those used currently by Eurofound (2018c), in part, because they draw on the same data source, the European Working Conditions Survey. Indeed this survey is the key data source for measuring job quality in the EU (e.g. Green et al., 2013; Greenan et al., 2013; Greenan & Seghir, 2017; Holm & Lorenz, 2015; Holman, 2013). These QuInnE dimensions were also influential in the development of measures of 'good work' in the UK following the 2017 UK Government's Taylor Review of Modern Working Practices (Measuring Job Quality Working Group, 2018) and underpin the new *UK Working Lives Survey* (CIPD, 2018).

5.1.3 The Quality of Working Life

One of the family of concepts within job quality is the Quality of Working Life (QWL). Its significance lies in its early rejection of technological determinism and recognition that workplaces combine human and non-human elements which best work when there is a 'fit' between them.

QWL emerged in the late 1940s in the context of productivity and efficiency problems in the UK coal industry despite the introduction of new technology. The source of the problem, Trist and Bamforth (1951) surmised from their research, was the design of work and the lack of fit between the new technology and worker needs as humans. Their solution was to make the technical and social systems in workplaces fit together better, with the outcome being the optimisation of organisational efficiency.

As Warhurst, et al. (2017b) note, whilst seeking solutions in work design, QWL had an emancipatory intent. It evolved to extend to a drive for industrial democracy and wider social change in which good work could be the lever to a good society (Walton, 1974; Cherns, 1976). As it evolved and became more complex it also began to suffer from definitional ambiguity (Burchell, et al., 2014). By the mid-1970s, with macro political and economic changes, interest in it waned but did not disappear. Interest and workplace interventions continued for example in the Netherlands and later Flanders (Belgium) (Van Hootegem, 2016).

The Dutch variant of sociotechnical theory (modern socio-technics), stimulated by Sitter et al. (1997), states that when organisations are confronted with an environment of increased (and increasing) complexity, the solution is not to restore the fit with the external complexity by increasing internal complexity. Instead the organisation should respond to this external complexity by reducing the internal complexity. In other words, simple organisations and complex jobs. This outcome occurs through a series of choices about structural design, job design and work processes. In other words, whilst recognising the externalities and path dependencies, these outcomes are largely depending on strategic choice, and managerial preferences for a top down approach versus a bottom up approach. Another important idea in Dutch sociotechnical theory is that organisations are not composed of two systems, technical and social systems. Organisations should not be viewed as a balancing effort between the two systems. Instead organisations should be seen as systems with control and operational processes. Technology and job design are means to react to environmental demands. In this respect, digitalisation generates new requirements to which organisations need to respond. If digital transformation is in line with market changes. In that case, organisational design needs to follow (Kopp et al., 2019).

The original and updated socio-technical approaches offer a number of important lessons. First, that workplaces should be regarded as sociotechnical configurations. Second, that change at work should align with the goals of the organisation rather than be driven by technology hopes or expectations.. Third, that innovation is an emergent practice from the interaction of the social and the technical. Fourth that the relationship between the social and technical dimensions impact both organisational productivity and employee wellbeing. Fifth, that the introduction and use of new technology must be inclusive and empowering for workers. Sixth, that organisations have and make choices about why and how new technologies are implemented, operated and extended (Badham, 2006; Kuipers et al., 2010; Oeij et al., 2017).

Interestingly, as a challenge to the current technological determinism around the digital revolution, and the gig economy and increasing labour market precarity, there is a call for a renewed QWL (Grote & Guest, 2017). In addition, socio-technical thinking has explicitly been applied to digitalisation and Industrie 4.0, stressing the joint optimisation of technology, people and organisation (Dregger et al., 2016; Hirsch-Kreinsen, 2016; Ittermann et al., 2016). Scope exists therefore for alterative theorising about technology and organisations that is not deterministic.

5.1.4Occupational Safety and Health (OSH)

There is significant conceptual conflation and confusion between wellbeing as an outcome of job quality and health and safety at work as a feature of job quality. **BEYOND4.0** adopts this last approach and recognises that health and safety, specially, psychosocial risks, is often overlooked within job quality (Eurofound, 2016) and that, cast as OSH, it has an important role in delivery the successful outcomes from digital technology.

OSH is an interdisciplinary activity concerned with the prevention of occupational risks at work. According to the ILO, OSH encompasses the physical and psycho-social wellbeing of workers. OSH research needs to address a wide range of potential problems (Bundesanstalt für Arbeitsschutz und Arbeitsmedizin, 2010; EC, 2009) from mechanical, physical, thermal and biological hazards through to fire and explosion risks to physical working environment factors to physical strain (e.g. workload, lifting, awkward postures etc.) through to psychosocial hazards (e.g. work design and work organisation, and social conditions).[7]

A distinction can be made between work-related disease and occupational health. The concept of a *work-related disease* includes diseases in which work plays a role. The concept of a work-aggravated disease is one which is made worse by work, regardless of the original cause (Eurostat, 2004). The EU LFS ad hoc module of 2007 lists respondents' most serious work-related health problems (Eurostat, 2010): musculoskeletal disorders; stress, depression or anxiety; breathing or

[7] ILO Occupational Safety and Health Convention (C155), 1981; Resolution concerning statistics of occupational injuries (resulting from occupational accidents) adopted by the 16th International Conference of Labour Statisticians, 1998; European Commission, European Statistics on Accidents at Work (ESAW) Methodology, 2001; European Council, 'Council Directive 89/391/EEC of 12 June 1989 on the introduction of measures to encourage improvements in the safety and health of workers at work (Framework Directive)', Official Journal L 183, 29/06/1989, 1989, pp. 0001-0008.

lung problems; heart disease or attack, or other problems in the circulatory system; headache and/or eyestrain; infectious disease; hearing and skin problems. *Occupational health* principally means the absence of occupational diseases (Eurostat, 2010). However the WHO adopts a wider perspective, defining health as 'a state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity'.[8] This approach aligns with the joint ILO/WHO Committee's definition (Pintelon & Muchiri, 2009, p.613):

> Occupational health should aim at: the promotion and maintenance of the highest degree of physical, mental and social well-being of workers in all occupations; the prevention amongst workers of departures from health caused by their working conditions; the protection of workers in their employment from risks resulting from factors adverse to health; the placing and maintenance of the worker in an occupational environment adapted to his physiological and psychological capabilities; and, to summarise: the adaptation of work to man and of each man to his job.

While it is difficult to define, safety means free from harm or risk. In practice this state is impossible to achieve. As a consequence, safety must be seen as a value judgment regarding the level of risk of being injured which is considered to be acceptable (Harms-Ringdahl, 2001). In this respect, safety is traditionally seen as accident prevention but can also be seen as a basic value in the workplace.

From an employer perspective, poor OSH can be detrimental to organisational performance. Evidence shows that stress at work leads to an increase in accidents (Clarke, 2010), longer periods of sickness absence and greater staff turnover (Coomber & Barriball, 2007). The combination of high job demands and low control has been shown to lead to mental health problems (e.g. Madsen et al., 2017). Musculoskeletal problems can lead to workplace absence (Duijts et al., 2007; Steensma et al., 2005) and even labour market withdrawal into disability benefits (e.g. Canivet et al., 2013) or to coronary heart and vascular disease which may result in hospital admission or mortality (e.g. Kivimaki et al., 2012) – all of which, of course, are also detrimental to workers and also creates health and welfare costs for EU Member States Alli's (2008) point about the need to adapt work to workers and adapt workers to his or her job in the context of digitalisation is therefore crucial.

Indeed, discussion of OSH has changed because of the technological transformations. High-tech systems hold the lure of preventing all accidents and creating inherent safe work situations (Parmiggiani et al., 2014). It seems that the goal of Zero Accidents is finally achievable, provided by the robots and cyber-physical systems (Reardon et al., 2015; Zwetsloot et al., 2017). Experiments in OSH in the field of technology are driven by the idea that inherently safe robot systems are possible, with technology solutions that prevent harmful contact scenarios occurring with operators (Guiochet, 2016) and OSH regulations and the EU Machinery directive seeking to ensure 'risk-free' design. However, in practice design choices are technology driven and do not include the OSH analysis from the operator perspective. **BEYOND4.0** identifies the health and safety approaches used in Industrie 4.0 and Uberised work settings. Resonating with the socio-technical systems approach, **BEYOND4.0** seeks to develop a new, more operator-centred OSH approach to cyber-physical

[8] WHO (1946) *WHO definition of Health*, Preamble to the Constitution of the World Health Organization as adopted by the International Health Conference, New York, by the representatives of 61 States (Official Records of the World Health Organization, no. 2, p. 100) and entered into force in 1948.

systems based on new approaches such as systems thinking (Leveson, 2011) and the Zero Accident Vision developed by TNO (Zwetsloot et al., 2017).

5.1.5The distribution of work

The point about the importance of the inclusiveness of technology resonates with EU policy concerns. The technical division of labour relates to the fragmentation of the production process into specialised or at least discrete tasks undertaken by different workers. Relatedly, the division of work is sometimes used to refer to the division of a large task, contract or project into smaller tasks. It is increasingly recognised that it is these tasks that can colonised by the robots (Industrie 4.0) or allocated as gig work (Uberisation) and so affect the distribution of future work. Whilst worker allocation to these tasks is, in theory, predicated on specialized skills and therefore assumption about their productive capacity, in reality, sorting by type of workers is influenced by other factors such as sex, race and skill possession.

In microeconomic terms, the distribution of work results from the production process and more precisely, from how the inputs relate with one another in the production function. Two concepts are important in the economic analysis of how technological change interferes with productive interdependencies: capital-skill complementarity and technological bias. Two factors are complementary: when the quantity used by one increases then the price of the other decreases. The partial substitution elasticity is, in this case, negative. Griliches (1969) has analysed capital-skill complementarity in order to explain the continued growth in the relative wages of skilled workers in the US despite the growth in the supply of this category of labour. He carried out an empirical test on a cross-section of sectors for 1954 that confirmed the hypothesis of complementarity between capital and skilled labour. Subsequently, a large number of studies have confirmed the Griliches result. According to Hamermesh's synthesis (1993), the partial elasticity of substitution between skilled labour and capital is generally negative; the partial elasticity of substitution between capital and unskilled labour is always positive and there is no consensus on the partial elasticity of substitution between qualification categories. A technological bias is a distortion in factor shares in the presence of technological change. When a capital-skill complementarity is a property of a given production function, a technological bias relates to shift in the production function due to an external shock.

Using French company-level data for 1986-1991, Duguet and Greenan (1997) find an overall innovation bias favouring skilled labour. A second effect reinforces the former: unskilled labour is a stronger substitute to capital than skilled labour. However, they also show that not all innovation types reduce the unskilled labour share. Incremental product and process innovations tend to increase it. The skill bias results from the aggregation of several impacts depending on innovation types. In total, the distortion of factor shares in the presence of technological progress depends on productive interdependencies that are very seldom looked at precisely in empirical studies. This is because not many datasets provide direct measures of technological progress as well as measures of factor shares and costs but which would be needed to identify what is happening in the production function. Second, the way firms innovate, and in particular whether this innovation is incremental or radical and whether it encompasses organisational changes, probably generates different regimes of productive interdependencies.

The concept of technological complementarities exposed in Brynjolfsson and Milgrom (2013) identifies another type of productive interdependencies. Technological complementarities refer to a discrete choice organisational design function. When there is a complementarity between several pairs or organisational design decisions, then these decisions should cluster. This occurs is because when a set of organisational features or practices are complements, implementing then together yields higher productivity gains than implementing each of them separately. The existence of productive complementarities therefore encourages radical innovation since organisations will benefit more from a joint change in multiple dimensions than from a partial implementation. At the beginning of the millennium, the management science and economic literature has highlighted the complementarity between the adoption of ICT and the implementation of changes in work organisation (Ennen & Richter, 2010; Bresnahan et al., 2002). The assessment of productivity impacts of digital transformations should rely on a production function augmented by an organisational design function. Such a frame is likely to explain the great heterogeneity in the productivity impacts of technological transformations.

A recent empirical study by Hunt et al. (2019) sheds light on the effects of AI with automation in UK organisations. It shows that the occupations most impacted are professional and higher technical staff, and managers, administrators and intermediate managerial staff. Whilst job elimination, job creation and job change occurred across the organisation, the jobs eliminated by AI substituting for physical tasks tended to be at the low-skill level, with jobs created at a range of skill levels. By contrast, AI substituting for cognitive tasks tended to eliminate jobs at a range of levels and create jobs at the high-skill level. Overall a general upskilling of tasks was therefore apparent, with employees needing more skills and knowledge in three-fifths (60%) of organisations introducing AI. If this trend holds for other countries, it would mean that employers in the future are likely to require more higher-skilled workers. This research also showed that the introduction of AI for physical tasks was more common in organisations where the workforce was mainly low skilled. The introduction of AI for cognitive tasks was more common in organisations with a predominantly younger or high-skilled workforce. Adoption of both of these forms of new technology was lowest among organisations that had a mostly female or a mostly older workforce. A deeper understanding of productive complementarities associated with digital transformation would give stronger foundations to the analysis of structural changes in workforce composition.

Similarly, US industry level rather than organisational level analysis reveals differential impacts by types of worker. Male workers appear more vulnerable to technological unemployment because they work more in manufacturing and transport, whilst women are safer because of their clustering in the health and education sectors. Hispanic and black workers in the USA are more vulnerable than white or Asian workers due to Hispanic workers' over-representation in the construction and agricultural sectors and black workers in transport (Muro et al., 2019).

Other EU-wide research (Hunt et al., 2018) has attempted to examine employment participation rate outcomes for the type of workers identified as vulnerable in the labour market – female, older, younger, migrant and low-skilled workers (EC, 2010) in EU countries classified as high on technological innovation. The findings show that reduced inequality, as measured by higher employment participation, is not comprehensive for vulnerable workers within a high innovation regime. Indeed, there is no clear evidence that high innovation can be expected to inevitably reduce inequality for these workers. However, there are again variations. For example, compared to non-vulnerable workers – that is, male, prime age, middle and high skilled and native born – employment participation for low-skilled workers is worse but better for female, older and migrant workers. It is vital therefore that any analysis of the impact of digitalisation is sensitive to the uneven distribution of work that might follow and whether it compounds, improves or simply continues existing labour market inequalities and exclusions.

5.2. The skill needs of the labour market

Any understanding of the future of work needs to examine the impact of the new digital technology on skills, and how the supply and demand for skills, particularly digital and specialist IT skills, are changing. Indeed, the European Commission believes that 'the future of work is all about skills' (EPSC, 2016, p.7). This sub-section defines skills, indicates what skills might be needed and the important issue of ensuring that supply meets demand in the labour market.

5.2.1 Defining skill

A task is a unit of work activity that produces output (Autor, 2013). All paid (and unpaid) work comprises a bundle of tasks: physical, intellectual and social (Fernandez-Macias et al., 2016). The balance of these tasks can vary by job but each of these tasks is underpinned by skills and knowledge. Whilst skill and knowledge can be conceptually separated, in practice they can be hard to disentangle, particularly if the exercise of skill requires knowledgeable practice (Thompson, 1989).

Skill level is assessed through the complexity and range of tasks associated with a job and skill specialisation associated with the field of knowledge required, the tools and machinery being used, the material being worked on or with and the kinds of goods and services being produced (Elias and Day, 2017). With respect to specialisation, skills are often designated as domain-general and domain-specific. The former skills are transversal across occupations, the latter confined to particular occupations. For example, the former can include punctuality, the latter technical capabilities such as being able to write a computer programme. At this point, however, any potential scientific or policy consensus on what constitutes a 'skill' quickly evaporates. Punctuality, to return to that example, could be regarded as a skill or a personality trait (Grugulis et al., 2004) and, if regraded as a skill, might only be so for political reasons in the power play between employers and unions over pay (Warhurst et al., 2017a).

To compound the definitional problem, understanding of skill is dynamic, changing over time (Grugulis et al., 2004; Warhurst et al., 2017a). To return again to the above example of punctuality, what might once have been regarded as personality traits can now be cast as skills. It can also be spatially specific. In some countries, 'skill' still refers to having and being able to apply accredited vocational knowledge acquired through a mixture of formal and on-the-job learning. In other countries it now means whatever employers want it to mean (Lafer, 2004; Warhurst et al., 2017a) However, if tasks are underpinned by skills then it is possible to suggest that there are technical, behavioural/social, cognitive and basic skills (Mournier, 2001; Green, 2011), with the last of these skills consisting of reading, writing and computer literacy skills (EC, 2019b).

To complicate matters further, the concept of 'T-shaped' skills is a metaphor used in job recruitment to describe the abilities of workers. The vertical bar on the T represents the depth of related skills and expertise in a single domain, whereas the horizontal bar is the ability to collaborate across domains with experts in other areas and to apply knowledge in areas of expertise other than that of the particular workers. Other shapes have also been proposed, for example 'X-shaped' (leadership), 'I-shaped' (individual skill depth without communication skills) and 'Tree-shaped'. The tree-shaped worker has more rhizomic skills with depth in many areas, not just one, and being able to reach many heights of accomplishments in many different fields or many different branches of a domain. Finally, Gamma- (Γ) and Mu- (M) shaped individuals have been described by Fiore-Gartland and Tanweer (2018) based on ethnographic research of data science research communities and which characterises workers with supporting strengths in computationally- and software-intensive fields.

Being broadly and variously defined, skills consequently lack common measurement internationally (Cedefop, 2017). In the absence of definitional consensus, what gets counted as a skill is that which can be measured – skills that are credentialised with qualifications (Felstead et al., 2017) and become so-called 'hard' skills as opposed to soft skills, which, in the melee of types of skill have come to constitute everything else. One consequence is that qualifications and skills tend to be conflated, even treated as synonymous.

Whist accepting the problems with definitions and measurement, there are two key reasons for continuing to attempt to focus on skill. First, skills (in the form of qualifications), along with the training needed to acquire those skills, characterise occupations and, indeed, are used, to hierarchise occupations in occupational classifications systems e.g. ISCO. If new jobs with new tasks emerge, workers will need the skills to perform these tasks. Understanding these skills is important so that, at the very least, appropriate education and training provision can be designed and delivered. Second, whilst debate about the future of work is currently dominated by the death of jobs, past evidence (e.g. Levy and Murnane, 2004) suggests that it is equally likely that the tasks and so underpinning skills of jobs will change as much as jobs will disappear and emerge. How the balance of skills within those residual jobs changes will thus equally need to be understood. Indeed, there is a discernible turn in debate about the future of work to acknowledge that, along with job destruction and creation, tasks will change within existing jobs (Eurofound, 2016).

5.2.2 Skills for the future

In terms of what skills will be needed in the future, comprehensive empirical data is still lacking on the impact of digitalisation on EU jobs. This problem is compounded by skill being poorly analysed and conceived in current debates about the digital economy. The problem starts with Frey and Osborne's (2013) influential calculation of US future skills needs based on occupational level analysis. They expect many occupations to disappear. However, occupation is not the right observation level for changes in the labour market. Atkinson and Wu (2017) point out that 'occupational churn' – that is, the constant creation and destruction of jobs – is at an historic low in the US.

Moreover, Frey and Osborne (2013) treat jobs as non-replenishable goods. However, jobs change constantly, and that it is important to create environments that help job occupants shape their jobs and have jobs that improve their skill sets. This is called the 'AMO' approach; workers having the 'ability', 'motivation' and 'opportunity' to expend the discretionary effort that supports company innovation and competitiveness (Appelbaum et al., 2000).

Another weakness is that Frey and Osborne's analysis centres on a crude distinction between routine and non-routine tasks within occupations (Pfeiffer, 2016). Another approach recognises that the experience of employees plays a dynamic role in shaping tasks within jobs. The operator of the future needs to have knowledge of many topics and knowledge areas to make appropriate interventions in high-tech environments. Both criticisms fundamentally shift the focus of analysis onto task- rather than occupation-based approaches for estimating the impact of digitation on skills. Pfeiffer proposes an index based on labouring capacity to describe automation-resistant components of human work action as a multi-dimensional interplay of complex challenges in specific work situations and the action dimensions necessary for adequately responding to these challenges. However, progress has stalled because a thorough analysis of the connection between both is missing.

In the absence of good data, debate exists about how new technologies in general shape the stock of skill (see Hunt, at al. 2018). On the one hand, the theory of Routine Biased Technological Change argues that technological change in production processes[9] leads instead to job polarisation, with decreased demand for workers with intermediate skills and relative increases in low and high-skilled occupations. With digitalisation, routinisable, intermediate technical (Industrie 4.0) and managerial (Uberisation) skills can be replaced by robots and algorithms. These intermediate jobs then disappear, substituted by technology. The stock of remaining or new jobs then polarises, with the expansion at the top and bottom of the occupational hierarchy of high-touch service jobs that are non-substitutable by technology (Appelbaum, 2012) as well as, at the top of the hierarchy, jobs growth in higher-skilled jobs that require complex skills (see also Goos et al., 2009, 2014; Acemoglu and Autor, 2010). On the other hand, the theory of Skill Biased Technological Change argues that technological change tends to increase demand for skilled workers and decrease demand for low and unskilled workers (Levy and Murnane, 1992, 2013; Violante, 2008). Digital technology will thus replace lower-skilled jobs on the one hand, while creating high-skilled occupations on the other. Within the *New Skills Agenda for Europe* stress is placed on developing 'digital skills', though the nomenclature changes depending upon the discourse: '21st century skills' and 'T-shaped skills' being the most obvious. The main argument in the *New Skills Agenda for Europe* is that digitisation requires a higher level of skills than ten years ago. What these skills are in practice is difficult to discern and there is need for European Frameworks (e.g. EQF, ECVET, EuroPass, EQUARF) to be able to make these skills transparent and comparable to enable appropriate education and training. EU-wide recognised skills and occupational profiles need to be refined. Doing so reduces existing skill mismatches between labour demand and supply. This is a particularly important task given that mismatches have higher incidence in polarised labour markets in Europe (Sarkar, 2017).

Notwithstanding this need, the anticipated result is an upskilling of the workforce rather than polarisation. In this respect, there is a strong policy emphasis currently on STEM. The US Department of Labour, for example, has identified 14 industries with projected jobs growth or which will or will affect the growth of other industries or are being transformed by technology). Notwithstanding the lack of consensus about what constitutes a STEM occupation (Elias and Day, 2017), it is assumed that STEM skills will be crucial for what are called the Key Enabling Technologies.

[9] Supplemented by expanded opportunity to offshore labour also enabled by technology.

In the US, the Committee on STEM Education of the National Science and Technology Council has a five-year strategic plan to raise investment in STEM-related technical education programmes.[10] Similarly, in the EU, the High-Level Expert Group on the Impact of the Digital Transformation of EU Labour Markets (EC, 2019a) warned against creating polarised labour markets and urged the European Commission to ensure that it encouraged inclusive labour markets by the promotion of digital skills. A dual approach results: the promotion of basic digital literacy skills to address current deficits in these skills amongst some segments of the workforce, and promotion of advanced digital skills to plug potential skills shortages in industries with high performance computing needs (EC, 2019b).

Part of any modernisation of VET systems within the EU requires recognition that, whilst important, workers having digital skills alone will be insufficient. There are digital skill deficits amongst some workers. However, there are other skill needs too. The different tasks identified by Fernández-Macías, et al. (2016) map onto different skill sets, all of which are relevant to the digital economy. As a consequence, whilst working with the *New Skills Agenda for Europe*, BEYOND4.0 seeks to refine it, widening the perspective towards the range of skills requirements that foster innovation and adaptability (Barnes et al., 2016; Howaldt & Hochgerner, 2018). These skills might be job-specific and/or generic and acquired through formal and/or informal learning processes (James et al., 2013). A re-assessment of the basic skills-measurement approaches is needed. BEYOND4.0 builds on the suggestions of Pfeiffer (2016) and others to offer a new assessment of future skills needed to help workers gain, maintain and progress within employment. Importantly, this assessment will explicitly make distinctions between the different levels of skills needed from the unemployed through to management levels. To do so effectively again requires that the occupation perspective be connected to the task and the organisational level. Companies need to know how to help individuals expand their skillset during their working career. This skill acquisition requires companies not reducing work to specialized small tasks but creating real T-shaped organisations. Team environments are needed that integrate individuals with overlapping high-tech skill profiles (Dhondt & Van Hootegem, 2015).

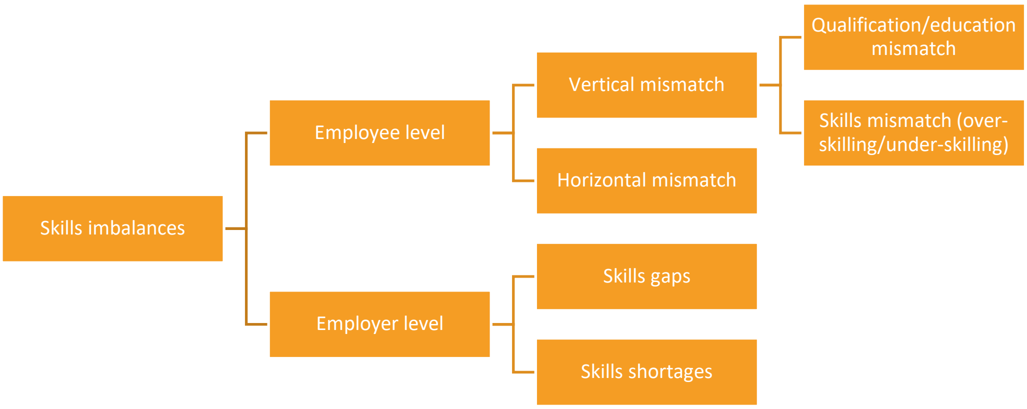
5.2.3 Skills mismatch

The point about wanting to avoid skill shortages in the labour market as the future of work unfolds looms large in EU policy thinking. These shortages are one form of skills mismatch or imbalance (Gambin et al., 2016; McGuinness et al., 2018). The OECD (2015) defines a skill mismatch as sub-optimal allocation of workers to jobs resulting in over- or under-qualification. This definition uses qualifications as the proxy of skills and measures skill mismatch at the level of the employee level. When measured at the employee level, skill mismatch refers to the extent to which the skill level possessed by a worker does not match the skill required to do the job. It is also referred to as vertical skill mismatch. Horizontal mismatch refers to a mismatch between the employee's field of study and field of study required in the occupation. When the skill level possessed by a worker corresponds to skill level required by job, the worker is well-matched. When skill level possessed by worker is higher than that required by job, the worker is over-skilled and a skill surplus exists. Finally,

[10] https://www.aip.org/fyi/2013/national-science-and-technology-councils-committee-stem-education-releases-5-year-strategic

when the skill level possessed by a worker is weaker than that required by job, the worker is under-skilled and a skill deficit exists, see Figure 4 below.

Figure 4: The impact of skills imbalances at an employee and employer level



Source: McGuiness et al. (2018)

As Figure 4 also shows, mismatches however can occur for organisations in relation to both internal and external labour markets. The first is called a skills gap and refers to a situation in which an employer believes that existing employees do not possess the skills to successfully perform their tasks. The second is called a skills shortage and refers to aggregate supply in the labour not meeting demand, and is manifest for employers in recruitment problems due to a lack of suitably qualified candidates (Gambin et al., 2016; McGuiness et al., 2018).

The concept of skill mismatch thus requires measures of both the skills possessed by workers and skills required in work. Caution however is needed at this juncture for two reasons. First, because employers can, and often do, complain of skill shortages whilst scaling back their own workforce training provision and can have recruitment difficulties not because too few suitably skilled workers exist but because the reward package offered is unattractive to suitable skilled workers. Hard-to-fill vacancies then exist rather than pure skills shortages (Gambin et al., 2016). Second, because employer skill demand has two facets: the skills workers are required to possess in order to get a job and skills to do a job (Warhurst and Findlay 2012). As Warhurst and Luchinskaya (2018) reveal, most analyses are driven by data availability and most skill surveys focus on the first type of demand but the two are not always the same. Investment in human capital, in the form of higher education, has expanded in the developed economies in anticipation initially of emergent knowledge economies and now the emergent digital economy. Faced with a supply of better-qualified applicants, employers simply hire workers with better qualifications, viewing the possession of qualifications as a signal of capability (Rothschild & Stiglitz, 1976). However, this employer behaviour leads to 'qualification inflation' with the skilled (proxied by qualifications) need to get a job exceeding the skills need to do the job. The problem, as James et al. (2013) note, is that, for a number of reasons, employers might not recognise or deploy these higher-level skills resulting in workers having a skill surplus and being under-utilised in work. In this respect, skill surveys are both valuable and limiting and mixed methods are useful in generating a more rounded understanding of employer skill demands – a point manifest in BEYOND4.0's research design.

This point is important. With a rapid expansion of higher education provision in the advanced economies, there are concerns that a structural over-supply of skilled workers now exists and that too many workers' skills are under-used in their work. This skill under-utilisation matters for both forms and their employees for four inter-related reasons. First, it means that firms are not maximising the human resources available (OECD, 2011). In this respect, Livingston (2017) identifies skill under-utilisation as a cause of under-performance for firms. Second, it creates employee disaffection, with consequent employee recruitment and retention problems (Skills Australia, 2012; Okay-Somerville & Scholarios, 2013). Third, for employees, if firms are under-performing as a result of skill under-use, it reduces the possibility of wage mobility. Firms with higher productivity still typically pay higher wages (Bosworth et al., 2019). Fourth, and also related to the sub-section below, it can disincentivize workers form investing in skill development when they are increasingly being asked to take on the financial risk of investing in that development (Gambin & Hogarth, 2017) – whilst at the same time digital transformation will require new or at least reconfigures skills amongst the workforce and potential skill shortages are signalled. If the digital transformation is to be inclusive then ensuring effective skill use needs to be a priority for Europe.

5.3. Education and training to support skill development

This sub-section examines vocational education and training (VET) to support the development of skills deemed necessary in the digital economy and to sustain employability and enhance social mobility amongst EU workers. It outlines the importance of VET and the skills systems that deliver VET. It also highlights the important role of lifelong learning in the development of the skills that are needed before raising a number of general and digital-economy specific challenges to (re)configuring VET in the EU.

5.3.1 The importance of vocational education and training

VET systems need to be able to provide a skilled labour force prepared for the digital transformation. The *New Skills Agenda for Europe* already includes measures to support the modernisation of VET. Whilst responsibility for skill development lies with Member States, the European Commission has identified the need for change in the way skill systems adapt to the digital revolution (EC, 2015a & b). Demand is growing for digitally-skilled workers in Europe and, as noted above, there is concern about future skills shortages unless remedial action is taken. The European Commission has called for digital skill levels to be raised among employees in all industries and amongst job seekers in order to improve their employability (EC, 2015a & b). However these digital skills will need to be complemented by both a higher level and a broader range of skills to ensure that employability is maximised. While empirical evidence is currently lacking, there is a concern that digitalisation will widen existing inequalities, creating or at least compounding job polarisation in the labour market (Autor et al., 2015). Skills development must therefore address both employability and social mobility if it is to ensure that workers can gain, sustain and progress in employment, and in addressing progression opportunities, avoid any potential 'bad jobs trap' that might create political disaffection within the EU and towards the European project (Eurofound, 2018c).

As Behle (2016) notes, the concept of employability has evolved. At the start of the twentieth century, it centred on a duality of being employed and being unemployed. By mid-century it had shifted to focus on supply-side factors, principally the skills required to be employed, Behle states. However what is regarded as skills for employability can vary by country and their transferability across industries can be over-stated (Wheelahan, 2017). Now, it is recognised that employability involves analysis of demand not just supply-side factors and, so, most obviously employer skill requirements and the state of the labour market generally (Nickson et al., 2012). Similarly, there is debate about what constitutes social mobility and how it should be measured. Economists tend to use income (e.g. Blanden et al., 2005) while sociologists tend to focus on class (e.g. Goldthorpe & Mills, 2008). Typically in the first approach, movement in an individual's wage levels constitutes mobility; in the second approach, intra- or inter-generational occupational movement denotes mobility. In each case, however, skills are important in enabling access to higher level jobs with better pay. The education and training that delivers these skills consequently has demonstrable effects on labour market inclusion and social mobility (as well as productivity and innovation, see below).

5.3.2 Skill systems

Skill development or 'formation' systems involve a number of institutions; the state, the market, firms, business associations and, outwith these formal institutions, a number of informal ones such as communities (of practice), clans, clubs and networks (Crouch, 2006) to which should be added families and friends (James et al., 2013). The state has two interests in skill development: first, a general responsibility for ensuring for basic and advanced levels of education for their citizens; second, as a means of underpinning, if not driving, economic development in which case the emphasis is on vocational skills. Ultimately however it is individuals who need to acquire and possess these skills and employers who require them, either ate the point of hire of the point of use..

If once company product market and national business systems were regarded as drivers of skill development, the importance of negotiated or at least mediated choices by key actors is increasingly being recognised as a factor (Ashton et al., 2017; Warhurst and Luchinskaya, 2017). In this respect, skill development systems are not determined by technology rather they consist of configurations of institutions representing 'social settlements' between civil society (employers, labour and occupational groups), the state and VET providers (Domanski & Kaletka, 2018). Each national system is therefore the outcome of consensus, compromise and conflict, and within each national settlement the balance of power in the relationships between civil society, state and providers varies (Bosch, 2017; Wheelahan, 2017).

Skills development can also vary: skills can be acquired in different ways and acquired at different life stages, work tasks can be vertically or horizontally distributed and organisations can modify their skill needs through work design, including technology use. Actions related to each of these four strategies come with costs and benefits, and strategic choices are made (Keep, 2017).

Moreover, although much of the skills system analysis focuses on formalised VET provided through qualification awarding bodies, informal workplace leaning also matters because it links with workplace innovation (Lundvall, et al., 2008). Workplace innovation regards employee engagement as a condition for successful technological innovation that simultaneously supports business performance and good quality of work; in other words it seeks the joint optimisation of business and employees. For Oeij and Dhondt (2017, p. 66), workplace innovation is defined as 'an integral set of participative mechanisms for interventions relating structural (e.g. organisational design) and cultural aspects (e.g. leadership, coordination and organisational behaviour) of the organisation and its people with the objective to simultaneously improve the conditions for the performance (i.e., productivity, innovation, product quality) and the quality of working life (broadly defined as wellbeing at work.

What calls for workplace innovation also underline is that much current thinking about skills acquisition is premised on a 'unitary' assumption that there exists opportunity to deploy these skills in work – an assumption that is problematical empirically (Wheelahan, 2017, p.644). Workplace innovation signals that the benefit of skill development can only be realised in work environments that offer that opportunity and also motivation for their exercise – the Ability-Motivation-Opportunity (AMO) framework signalled as creating more productive workplaces by Appelbaum et al. (2000; and of which more below). Preventing a biased attention for HR-related interventions, the basis of skill development is, according to workplace innovation, rooted in the structural design of organisations and jobs. Structural design is a root cause for good quality of work, whereas HR-related interventions merely mitigate negative effects of such design (Oeij & Dhondt, 2017).

Encouraging organisations to adopt these organisation and management approaches requires locating the skill system within a wider 'skill ecosystem' consisting of a range of interdependent political and economic institutions and which has adaptive capacity to changing conditions and can be directed to delivering more progressive and shared skill outcomes. Importantly, there is an emphasis on system-wide capacity-building to plan and manage VET, with stakeholders recognising and committed to a broad agenda of individual, business and local economic interests (Anderson & Warhurst, 2012).

The skill ecosystem approach is more complex and dynamic than the 'one-stop, quick-fix' supply side focused thinking of much current policy (Anderson & Warhurst 2012, p.119). It requires a more and closer interaction between the different institutions and actors in the relevant sector or regional ecosystem (Warhurst, 2017). It takes understanding of VET needs for the future of work beyond the usual market or state dichotomy and in the direction of a coordinated approach that might result in a new skill settlement.

5.3.3 Lifelong learning

The call for higher level skills to overcome the future employment disruption caused by digital transformation also connects to renewed discussion about the role of life-long learning to help foster workers' adaptability to changing labour markets over their working life (Barnes et al., 2016).

The European Commission (EPSC, 2016) believes that continuous skill development best guarantees life-long resilience in the uncertainties surrounding the future of work. Key to this continuous skill development is lifelong learning and adult education. The idea that education should be extended throughout life was inspired in the 1970s by UNESCO under the slogan of lifelong education. In the mid-1990s the concept of lifelong education gave way to the concept of lifelong learning. While the paradigm of lifelong education assigns a central role to the state in ensuring wider educational opportunities for all citizens, the lifelong learning paradigm shifts this duty mainly to the individual.

It is a multidimensional concept which refers to different kinds of knowledge and skills (formal and informal, planned and ad hoc, purposeful and unintended) within different perspectives (personal and social; employment and citizenship; leisure and work). Adult education is the most important form of lifelong learning.

Lifelong learning refers to a radical and all-encompassing change in education and learning, which implies a quantitative growth of education and training opportunities, a constant rethinking of the contents of education and training activities, the unfolding of new forms of education and training, significant changes in the status of the individuals and institutions involved in the education process, and qualitative change in the lifestyle of individuals (Milana et al., 2018).

Lifelong learning and adult education have been simultaneously highly valued and strongly contested. The processes of globalisation, rapid economic and technological change and an aging workforce call for a permanent updating of knowledge and skills. Recent studies have found a positive association between adult learning on the one hand and labour market outcomes, trust and social justice on the other (Blossfeld et al., 2014; Boyadjieva & Ilieva-Trichkova, 2017; UNESCO et al., 2015). However, there is also a criticism both of the epistemological status of the concept and of the goals of European lifelong learning policies and practices. Whilst a lifelong learning typology of regimes has been identified, which again includes a corporatist model controlled by the social partners, and a market-based model based on competition (Verdier, 2013), lifelong learning has been argued to be part of the neo-liberal project for which all that matters is the economy and the market (Borg & Mayo, 2005). In this perspetcive, lifelong learning is a form of social control and a mechanism promoting the marginalisation of the excluded and reasserting the social-reproductive functions of education (Crowther, 2004; Jarvis, 2001).

Several studies have focused on identifying the factors at macro, meso and micro levels that affect participation in different types of adult learning (Boeren, 2016). A reoccurring finding is that educational advantages have cumulative character and advantages (or disadvantages) in early adulthood continue to influence lifelong learning capability throughout life. Data also show that there are big differences across countries in participation in lifelong learning. The practices of lifelong learning are always produced by concrete historical circumstances related to the existing links and interaction between specific national institutional systems, such as the educational system, the labour market and social policies (Blossfeld et al., 2014; Rubenson & Desjardins, 2009).

In a world that is being transformed by the new digital technologies, the major challenge for policy-makers and employers is to go beyond the instrumental and economised understanding of lifelong learning, to acknowledge both its instrumental and substantial transformative/empowering value at individual and societal level and to develop inclusive educational policies and practices.

5.3.4 The challenges ahead

Attempting to (re)configure skill systems to support the VET and workplace learning needs of the digital economy is not easy. As the European Commission already implicitly recognises, whilst there might be skill shortages in advanced digital skills in the future, the absolute number of jobs requiring such skills will be very small, even if they extend from leading edge employers to cross into industries not traditionally perceived as digitally-infused, for example farming and construction (Curtarelli and Gualtieri, 2017). Moreover, given that it is difficult to predict what new jobs will emerge from the digital economy, and in the context of an already widening spectrum of forms of work and employment relationships, it will be consequently difficult, first, for the skills system to identify future work's skill types and levels and, second, for identifying responsibility within the ecosystem for paying for and providing VET. As a consequence, matching supply with demand becomes even more fraught than it is currently. The other challenge is that there are varying relationships across EU countries between education, employment and work. In some countries the links are tight, in other countries the relationship is loose (Bosch, 2017). Whether the links between education, employment and work tighten or loosen as a consequence of digital transformation is an open empirical question for the moment but will have consequences for the efficacy of skill ecosystems within the digital economy. The (re) configuration of the systems needed to develop the skills of the future also comes at a time when there are already pressures on national skill systems. Any potential demand for new skills will have to compete against the Great Recession-induced squeeze on some Member States' public finances that has created a zero-sum competition between different education and training stakeholders, most obviously schools, colleges, universities and even employers, who have reduced their training budgets in some European countries. In addition, more welfare spending will likely be directed to supporting the needs of an ageing population in Europe. Thus some already 'depleted welfare regimes' will likely have extra demands make of them in Europe (Keep, 2017, p.674; see also Gambin & Hogarth, 2017). Those Member States' companies and workforces that are already lagging behind in the digital transformation may fall further behind – a situation that the European Commission is keen to avoid EC, 2015).

Extending to the digital economy the general point made by Keep (2017) about skill systems, policymaking will need to recognise that there are new as well as existing challenges and that there may be no easy one-size fits all approach to future skills development through VET and workplace learning. Any new skills settlement will be the outcome of accommodation between the competing as well as sometimes overlapping interests of existing and new actors.

5.4. The creation and capture of value by companies

This section focuses on how value is currently created and captured and how **BEYOND4.0** seeks to develop alternative approaches to both. It starts by outlining current broad and narrow understandings of value creation and capture before outlining **BEYOND4.0**'s exploration of how alternatives might be developed.

5.4.1 Understanding value creation and capture

The broad understanding of value creation and capture relates to various concepts of ecosystem: business, entrepreneurial and innovation. All three types of ecosystem are closely interrelated yet have subtle distinctive differences. As with the skill ecosystem concept, all three use and build on the natural ecosystem analogy, defined as a biotic community, its physical environment, and all the interactions possible in the complex of living and non-living components (Acs et al., 2017; Tansley, 1935). The use and application of the ecosystem analogy to business, entrepreneurial activity and innovation started in the early 1990s and became popular in business and policy circles as from the early 2000s onwards.

The concept of business ecosystems was first coined by Moore (1993) studying co-evolution in social and economic systems, in particular networks of organisations that together constitute a system of mutual support and co-evolving contributions. Moore saw the business ecosystem as a form of organisation distinct from but parallel to markets and firms. More recent interpretations frame business ecosystems as a form of economic coordination in which a firm's ability to create and appropriate value critically depends on different groups of actors that produce complementary products or services (Acs et al., 2017; Iansiti & Levien, 2004). Following Adner (2017) business ecosystems refer to the set of partners that need to be brought into alignment in order for a value proposition to materialise in the marketplace.

The business ecosystem concept soon found its way into the innovation literature, with an innovation ecosystem defined as 'a network of relationships through which information and talent flow through systems of sustained value co-creation' (Russell, et al., 2011, p.2). This network comprises interacting, learning and innovating firms – with stronger or weaker links between these firms and science and technology institutions (such as universities and research labs) and with technology firms. Within these systems, there is both a core and a wider setting. Some researchers define systems of innovation narrowly as only comprising institutions explicitly involved in the generation and diffusion of science and technology, with the bridge between research and industry at the centre, and innovation viewed primarily as technological, whether product or process centred (see Nelson, 1994). The broader approach – and that adopted by **BEYOND4.0** – understands innovations more broadly: large or small; product, process or system; radical or incremental; technological or organisational. All institutions and practices that affect the introduction or diffusion of innovations are included, and the learning firms are placed at the core of the system (see Freeman & Soete, 1997; Lundvall, 1992, 2007).

Closely related is the concept of entrepreneurial ecosystem, defined as 'a set of interdependent actors and factors coordinated in such a way that they enable productive entrepreneurship within a particular territory' (Stam & Spigel, 2017, p.407). The entrepreneurial ecosystem concept shares its focus on aggregate value creation within a particular region with the regional development and regional ecosystem literature. More pronounced is its emphasis on the role of (individual) entrepreneurs in creating value and a longer-term commitment to the region, with a less prominent role for competition and value capture than in the business ecosystem concept (Acs, et al., 2017).

The narrow understanding of value creation and capture focuses on company-level practices – even if those practices provide demonstration effects for other companies in the same industry or come to be systemwide for companies across industries. For BEYOND4.0 the obvious examples of the former are Industrie 4.0 and Uberisation. Each in their own way offer examples of new business models for value creation and capture. Business models are conceptual tools that express the business logic of a specific firm and the way it operates to create value (Casadesus-Masanell & Ricart, 2010; Pisano et al., 2015). As noted above, Industrie 4.0 offers companies an integrated production system that, through the new digital technologies, links not only functions within companies but also opens up these companies to suppliers and customers. Value can be created by generating efficiency savings throughout the supply chain and by having direct links to customers and being able to provide bespoke or customised goods and services. This digitisation of production contrasts with companies that have hitherto used robotics and advanced automation for production because those companies were 'closed' organisations, with internal production only enveloped (see Clark, 1995). Likewise noted above, with Uberisation, platforms are digital networks that coordinate economic transactions – usually matching the supply and demand of goods and services through algorithms in which platforms companies claim to be brokers between supply and demand. In this crowdsourcing of labour business model, through digital technology, a company externalises but coordinates production of a good or services to previously unconnected, unorganised workers, states Pisano et al. (2015). These authors claim that this model grows the value of 'surplus' (p.19) – that is, hitherto underused resources, citing the 'share-riding' of Uber as an example.

This value creation does however rest on the erosion of the standard employment relationship. Relatedly, it is an approach to business that contrasts with the notions of the 'classic' firm, which internalises resources and production to create vertically integrated enterprises. Importantly, this internalisation reduces transaction costs and enables managerial improvements that thereby help better value creation (Chandler, 1977; Coase, 1937).

In both cases – Industrie 4.0 and Uberisation, there is an expectation that these business models will be adopted and diffused across companies in the manufacturing and services sectors.

Beyond digitalisation (but which is increasingly supported by diigitlaisation), there is also another business model that is company-centric that is already pervasive and, some would argue, has been hegemonic for the past 30 years, setting the benchmark for how value should be created and captured: maximizing shareholder value (MSV) or, more prosaically, 'financialisation'. Financialisation focuses on increasing shareholder value, profits and flexibility, and is a form of value creation and capture based on squeezing labour costs and revenues. It reinforces market discipline and market attitudes within companies, whilst at the same time, promoting investors (shareholders) as sovereign (Appelbaum, et al., 2013). As a business model it operates at three levels. At the macro level value creation shifts way from human capital as its source. Instead, profits are derived from financial assets driven by capital markets rather than product markets and production processes. At the meso level of firm behaviour, financial engineering means that organisational restructuring occurs trough delayering, disaggregation, mergers and acquisitions. At the micro level, the result is work intensification, income and job insecurity for workers and, with pressures to turn quickly generate profits, the squeezing of costs through redundancies and outsourcing (Cushen & Thompson, 2016; see also Appelbaum, 2012). In requiring managers to 'disgorge cash rather than invest it' (Jensen, 1986, p.323 quoted in Findlay, et al., 2017), and focus on value extraction rather than value creation (Lazonick & Mazzucato, 2013), this business model overturns the operation characteristic of the classic firm noted above. As a consequence, work and employment are negatively impacted (Findlay et al., 2017). Moreover, Findlay et al. continue, there are wider impacts that link work and welfare:

> … many of these practices impose significant externalities on individuals on whom organisational risk is heavily loaded; on families and communities disrupted by work insecurity, unstable work patterns and low pay; and on the wider society, for example, in necessitating welfare transfers to address low or variable pay, reducing tax revenue opportunities, increasing health care demands and specifically health spend, as well as limiting the return on public investment in education, learning and skills and in driving or sustaining inequality, constraining growth at national level … (p.34)

Alternatives exist, for example stakeholder models. These models are based on collective interests and social context in that they are sensitive not just to shareholders but the relationship between firms and the wider institutional context. In this business model, all stakeholders have some type of claim in relation to the operation and outcomes of firms. Advocacy of this model is often associated with the 'triple' bottom line: economic, social and environmental. In this respect there is resonance with the ecosystems approaches outlined above. However theory is currently undeveloped. There is, as yet, no consensus on who constitutes the relevant stakeholders and the relationship between these stakeholders and shareholders. In other words, 'there is little specification in the literature … as to how these multiple objectives are weighed relative to each other' according to Findlay et al. (2017, p.13).

Two points follow. First, once again, choices can and are being made about the adoption of particular business models and which have implications for value creation and capture. Second, that theoretical development of alternatives to the current dominant model of maximising shareholder value is required. This task is better enabled through the empirical evidence gathering of **BEYOND4.0**.

5.4.2 A different route to value creation and capture

The 'high road' to inclusive growth requires more investment into the definition of what better future jobs need. The discourse of Industrie 4.0 centres on an automated high road producing high-valued-added goods and services. Emerging research by Hunt et al. (2019) on the impact of the digitalisation of production in the private, public and voluntary sectors indicates that a key reason that organisations introduce it do so to be able to develop new goods, services and processes (e.g. predictive maintenance) or improve the quality of existing goods, services and processes and which is more often than not realised. Moreover, whilst this digitalisation's propensity to create and destroy jobs is higher than for any other types of technology, with as many organisations reporting job creation as job destruction (43% vs 40% respectively). Significantly, digitalisation had a positive effect on some dimensions of job quality: increasing skills, and task complexity and control, and improving work-life balance, pay and job security. Based on a single employer survey in the UK, how pervasive these findings are across Europe is an open empirical question that BEYOND4.0 explores.

By contrast, Uberisation is a 'low road' strategy, a model for producing cost-driven services. As Wilson and Hogarth (2003) have pointed out, there is nothing wrong with some companies choosing the low road.[11] However, long-term difficulties arise for Europe as a whole if too many companies choose this option. In the context of an over-educated workforce (Sarkar, 2017), and as noted earlier, it represents a waste of human resources (OECD, 2011) and creates a 'performance gap' in companies between what workers do and what they are capable of doing within different business models (Livingstone, 2017). High road companies allow greater discretion from better skilled employees (Milkman, 1998), which has morphed into 'High Performance Work Systems' (HPWS) (Appelbaum et al., 2000). These HPWS are defined as an 'approach to managing organisations that aims to stimulate more effective employee involvement and commitment to achieve high levels of performance' (Belt & Giles, 2009: 17). Appelbaum et al. (2000) argue that HPWS provide the optimal environment to elicit discretionary effort, underpinned by AMO. This AMO approach fits with the workplace innovation movements and agendas that already exist at EU level and within Member States (Oeij et al., 2017).

[11] Osterman (2018) points out that there is a confusion in terminology. There are companies operating in sectors with low wages and low profits. This does not mean that all companies follow 'degrading' policies for their employees. It is necessary to identify if companies can follow 'high road' strategies in low pay sectors. The same applies in high pay sectors: here companies can still follow 'low road' strategies. In such an approach. 'low' and 'high road' are more strategies that reflect the preparedness of companies to look at their organisational practices and the way income is redistributed.

The EU can decide to block off the low road through legislation and/or pave the high road by encouraging environments that generate better jobs (cf. Carré et al., 2013). The introduction of the new Directive on is one attempt to block off the low road and, in part, aimed at the worst examples of the gig economy. A key task of **BEYOND4.0** is to develop evidence-based recommendations as to how to pave the high road.

BEYOND4.0's focal point for value creation is the entrepreneurial and the business ecosystem. Such value creation depends on productive solutions that shape innovation within and between companies and other stakeholders. Decisions though occur at different levels. **BEYOND4.0** draws on three frameworks for this investigation: the innovation diffusion framework to structure findings into an evolutionary maturity model of Industrie 4.0 implementation; a more radical model of winner-takes-all, usually led an outsider challenger (start-tup or scale-up), and a dynamic resource-based framework detailing the organisational capabilities underlying different Industrie 4.0 based strategies and maturity stages. These perspectives help understanding of developments at ecosystem and company levels.

Applying this approach to Uberisation is tricky. However BEYOND4.0 posits that existing platforms economy business models can be illusory. Often in discourse about innovation and the future of work, it is taken for granted that it is the private sector entrepreneur, owner, or shareholder who is taking on the risk while other actors (the state, taxpayers, workers, users/customers) are relatively passive, merely enjoying the consumption 'spill-over' benefits from 'open innovation' and new technology but contributing little to the innovation itself. This narrative is often used to justify the sometimes super-normal profits and/or share values that companies are able to generate from new forms of 'intangible assets' (Haskel & Westlake, 2018), not least in the platform economy. BEYOND4.0 takes a critical approach to understanding the processes of value generation and extraction in the digital industries, recognising that innovation in digital/internet industries is characterised by strong network effects (the more subscribers, the more value of the product) and first-mover advantages. Anyone who gains an initial advantage, in setting a standard or capturing part of a 'sticky' market, can be very hard to displace (Mazzucato, 2018). As a platform economy firm's market share rises, so does its capacity to attract users, which in turn increases its market dominance. Many platform economy business models rely on loss-leader models funded by massive venture capital or other leveraged forms of investment to establish monopolistic control over markets that then enables the rapid extraction of value via returns to scale (Langley & Leyshon, 2017). This possibility is partially due to the way debt is favoured over equity in modern taxation regimes, including the EU.[12] It is not clear that such business models necessarily generate optimal product quality, enable competitive markets or are likely to support high quality, secure employment. Indeed, given the need for fast returns to investors and creditors, let alone create high quality jobs. Many platform economy business models operate in 'multi-sided' markets, developing both the supply and demand side as intermediaries/brokers of information. The service they provide is ostensibly free, promoted as part of a participatory culture in the putative 'sharing economy'. However, these firms rely upon users voluntarily providing commercially valuable information about themselves or their (consumer) preferences in return for access to the platform. As such, users could be considered to be key but unrewarded, stakeholders in the creation of value for these platforms. Paradoxically, in national accounting terms, platform economy firms' value is

[12] However see reference to a new perspective in Saez & Zucman (2019).

recorded as relating to profits made from selling advertising and information, not activities generating added value or productivity increases for the wider economy, rather than from the direct services they provide (which are free) (Mazzucato, 2018).

Although the venture capitalist business model allows rapid market capitalisation, it is not a given. Alternative business models exist. For example, a digital taxi hailing app can be owned by: a US start-up owned and funded by Silicon Valley venture capitalists or a metropolitan municipal government or a city-region cooperative of taxi drivers. Indeed, Schor and Fitzmaurice (2015) have been arguing for a (re-)emergence within the platform economy of more genuine collaboration and peer-to-peer sharing, i.e. a new high road appraoch. These different ownership, financing and governance structures may lead to different business models and impacts on job quality (Warhurst et al., 2017) and to other non-commercial considerations such as environmental sustainability. The business models need to be identified that address the value creation/value capture issue (or the problem of economic rents), with public policy that disincentivises unsustainable business models (Findlay et al., 2017). As Soros (2018) points out, platform companies are innovative and transformative of business in the short-term. However, because of their monopolistic behaviour, they are also a potential obstacle to long-term innovation. Their business model is unsustainable. These companies have neither the will nor the inclination to deliver wider socio-economic benefits and it falls to government policy, particularly EU, to ensure that technological innovations do so.

BEYOND4.0 explores the possibilities for public policy to shape and co-create the market development of platform economies along different models reflecting wider socio-economic objectives. This exploration will include an examination of how such companies should be effectively taxed and regulated in regard to issues as privacy, information sharing and intellectual property. One option for example, could be a 'harvest tax' in which part of these companies' captured wealth is redistributed to the state on the basis on the number of users and their data that are harvested by these companies. Another idea developed by Saez and Zucman (2019) is that rather than trying to tax companies that can evade taxes by allocating financial losses from all over the world to their accounts in other countries, countries can calculate the 'owed taxes' on a world scale, and then just tax these companies for this rate. For example if IKEA earns 20 per cent of its income in the US, the American IRS should just claim 20 per cent of the tax rebate from IKEA. This approach is easy to do because all the tax data are available, no new legislation is needed, it is completely legal and, above all, it is lucrative for a state to do. It also reduces the drive for these companies to develop tax constructions etc. and so the need for tax evasion disappears (Witteman, 2019).

More generally, **BEYOND4.0** challenges standard narratives about the role of the state and wider public sector in the innovation and value creation process in relation to technological and digital transformations. The ambition to achieve a particular type of economic growth (smart, inclusive, sustainable) is a direct admission that economic growth has not only a rate but also a direction. In this context, industrial and innovation strategies are key pillars to achieve desirable change. In particular, by identifying and articulating new missions that galvanise production, distribution and consumption patterns across various sectors (Mazzucato & Perez, 2014). Making this shift requires investment by both private and public sector actors. Many successful tech companies, such as Apple, and technological innovations more generally (e.g. the internet) have benefitted from early stage public investment in high-risk R&D that the private sector is generally unwilling to provide (Mazzucato & Perez, 2014). The public sector can thus be seen to have a role in 'market shaping' just as much as its traditional role in solving 'market failures' or providing a safety net for citizens in the face of rising inequality. Recognition of this role is important when assessing risks and rewards of different actors in an innovation process being a collective not individual process (Lazonick &

Mazzucato, 2013). What is happening at the ecosystem level depends on understanding this institutional surrounding.

6. Conclusion

BEYOND4.0 examines the impact of new digital technologies on the future of jobs, business models and welfare in the EU. It is ambitious in its scope and multi-faceted in its approach. This guidance paper has provided outlines of the key concepts, issues and developments that are the starting point for the project. Whilst digitalisation impacts on many facets of work and life, the particular foci of BEYOND4.0 is the digitalisation of production, commonly termed Industrie 4.0, and the digitalisation of work, now not uncommonly termed Uberisation. These foci are selected because of their prominence in current policy and academic debate and because, within those debates, they also cause much consternation: in different ways, there are concerns that both developments potentially herald the death of jobs and the hollowing out of welfare in Europe and elsewhere.

Nevertheless, while concerns are high, evidence is short. BEYOND4.0 addresses this evidence deficit. Taking a pan-European perspective, it has four specific areas of empirical enquiry: the quality, content, and distribution of work; the skill needs of the labour market; the education and training to support development of these skills; and the creation and capture (extraction) of value (and wealth) by companies. Moreover its analysis is rooted in historical context and the lessons from previous technological revolutions. The evidence generated will significantly advance scientific understanding of digitalisation and its impact on work and welfare. The evidence will also help identify other, non-dystopian futures for Europe from that in which work and welfare collapse.

In this regard, whist it primary function is to generate new scientific understanding about the future of work and welfare beyond current debates about Industrie 4.0 and Uberisation, BEYOND4.0 is also explicitly intends to shape EU policy, specifically the delivery of an inclusive European future for all as the digital transformation unfolds. By generating new scientific evidence and policy development around these issues, BEYOND4.0 helps further the EC's *Europe 2020 strategy* promoting smart, sustainable and inclusive growth by responding to the challenges and maximising the opportunities of digitalisation in Europe for the next decade and beyond.

Acknowledgments

The authors would like to thank Peter Fairbrother of the Royal Melbourne Institute of Technology, Angie Knox of Sydney University, and Wil Hunt and Sudipa Sarkar both of Warwick University for discussions in and around the preparation of this Working Paper.

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