Machines, robots, people and skills
Changing jobs, work and skills
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Presentation of findings from Cedefop's 'Digitalisation and future of work programme'
Part 1
• Impact of future of work on skills and tasks
  • Structural change

Part 2
• Impact of automation on jobs
  • Impact of technology on skills and labour market outcomes

Part 3
• Challenges for policy
  • Are we prepared for the future of work?
Impact of future of work on skills

How does structural (and technological change) translate into changing skill demand?
Technological change is affecting EU workers

- 43% (47%) of EU adult workers experienced recent changes in the technologies (methods) used in their workplace.

- From 3 in 5 in ICT to only 1 in 4 in hospitality and personal services.

**Extent of changing technologies (machines, ICT systems) by sector, 2014, EU28**

Source: Cedefop European skills and jobs survey (ESJS)
New jobs driven by technological progress

Net job growth (%), 2016-2030...

IT, science and engineering professionals

Other high-skilled

Sales and services

Skilled manual

Elementary

...2000-2016

Source: Cedefop skills forecasts 2018 (forthcoming); EULFS
Future jobs in need of 21st century skills

Difference between «jobs» with positive vs. negative anticipated employment growth rate, 2014-25, EU28

Source: Cedefop European skills and jobs survey (ESJS); Cedefop skills forecasts 2016
...in non-routine, non-physical, social jobs

Change in task profile, 2016-2030, EU

Change (indices go from 0 to 1)

Source: Cedefop skills forecasts 2018 baseline scenario plugged into Eurofound’s EJM framework
The risk of automation

How may technology affect jobs?
Why now?

- Rapid advances in machine learning, AI, visual-space perception, natural language processing, text mining etc.
- EU: From 0.6 robots to 2.6/1000 workers between early 1990s-2000s.
- US: 0.4 to 1.4.
- Eurobarometer (2017): 61% positive view of robots/AI 72% robots may steal jobs

*Level and growth of the Operational Stock of robots in EU28*

Source: International Federation of Robotics
One day in the 1760s James Hargreaves, a hand-loom weaver from Oswaldtwistle, was struck by the way an overturned wheel kept on spinning. What would happen, the weaver wondered, if several spindles were to be placed upright, side by side? Might it not be possible to spin several threads at once?

Working with a knife, Hargreaves shaped a primitive engine, a ‘jimmy’ – and the initial reaction from some was disgust. Angry neighbours raided Hargreaves's barn, on the grounds that the machines would ‘ruin the country’. If one jenny could do the work of eight spinners, reasoned the neighbours, that would put seven out of work.

In fact, the spectacular new spinning capacity provided the basis for a cotton boom. In the 1770s, as earnings rose, spinners and weavers took to parading the streets on paydays with £5 notes in their hatbands. Their wives drank tea out of the finest china.

(R.T. Lacey, Great tales from English History)
Are robots stealing our jobs?

Doom

- Inequality - SBTC
- Job polarisation - RBTC
- Sectoral/job restructuring
- Technological unemployment

Bloom

- Product innovation - ETC labour friendly for high-tech firms
- Scale/price effects
- New consumer demands & markets
- Technology does not cause jobless recoveries
- New (within job) tasks & jobs
Growth of platform/‘gig’ economy

* % projects carried out in five major English-speaking online platforms

Source: University of Oxford Online Index
7 in 10 EU workers need fundamental digital skills for their jobs

Level of importance of ICT skills in jobs, adult workers, 2014, EU28

Source: Cedefop (2018) Insights into skill shortages and skill mismatch: Learning from Cedefop’s European skills and jobs survey (ESJS)
Is it different this time?

- AI is making non-routine/white collar jobs vulnerable
- Faster innovation cycles
- Demography
- Falling labour income share

The KnowledgeDoubling Curve

<table>
<thead>
<tr>
<th>Doubling of human knowledge</th>
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<tbody>
<tr>
<td>1st doubling: 1500 years</td>
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<tr>
<td>2nd doubling: 250 years</td>
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<tr>
<td>3rd doubling: 150 years</td>
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<tr>
<td>4th doubling: 50 years</td>
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<tr>
<td>5th doubling: 20 years</td>
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<tr>
<td>...</td>
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<tr>
<td>Now: 1 year</td>
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<td>2020s: 12 hours</td>
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Disconnect between productivity and a typical worker’s compensation, 1948–2014

Note: Data are for average hourly compensation of production/non-supervisory workers in the private sector and net productivity of the total economy. "Net productivity" is the growth of output of goods and services minus depreciation per hour worked.

Source: EPI analysis of data from the BEA and BLS (see technical appendix for more detailed information)
Important reflections

- Jobs at risk of automation posses certain ‘attributes’
  - routine tasks
  - standardised or ‘digital’ content
  - less social interaction
  - non-complex problem solving
  - precise physical manipulation

- AI as opposed to robotics is making non-routine jobs vulnerable

- But estimates of automation subject to ‘task measurement’ (Biagi and Sebastian, 2018) and routinisation between and within occupations

  E.g. a great paradox: fewer routine jobs but more routine work
  also in white-collar jobs (EWCS, 2000-2010) (Eurofound, 2016)
Risk of automation in EU jobs

Source: Cedefop European skills and jobs survey (ESJS)
Estimated marginal probability of automation by 2-digit occupation, EU

Source: Cedefop European skills and jobs survey (ESJS)
Risk of automation in EU jobs

Odds of being in automatable job

- Male
- Age: >55
- Ed: High
- Ed: Medium
- Previously...
- Private sector
- Workplace many
- Small firm size
- No formal contract
- Part-time
- No training

Source: Cedefop European skills and jobs survey (ESJS)
Impact of technology on skills

How does technological change affect labour market outcomes via skills obsolescence?
Technological skills obsolescence

43% new technologies at work

33% very high likelihood of skills obsolescence

Source: Cedefop European skills and jobs survey (ESJS)
Technology: a high-skills affair

- 16% of EU adult employees at risk of TSO:
  - Individual: older, males, higher education, longer tenure
  - Job: non-routine tasks, learning, large size, training, private sector
  - Occupation: mostly high-skilled/clerical/building and machine ops

- In contrast to automation, technological change (inc. digitisation) is dependent on high-skilled workplaces and workers in place!

- If TSO is tantamount to labour-saving/job tasks replaced by technology -> lower productivity, job insecurity, lower job complexity, higher overskilling, lower job satisfaction....BUT...
Even though technology raises job insecurity…

Percentage of adult employees with fear of job loss by TSO

...technological change ‘raises the bar’ for skills

<table>
<thead>
<tr>
<th>Impact of technological skills obsolescence on LM outcomes, adult employees, EU28</th>
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<tbody>
<tr>
<td>Skill complexity of job</td>
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<tr>
<td>Underskilling</td>
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<tr>
<td>Overskilling</td>
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<td>Earnings</td>
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<tr>
<td>Job Satisfaction</td>
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<td>Job Insecurity</td>
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</tbody>
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Notes: Propensity score matching estimates – ATT of LM outcome by TSO propensity

Challenges for policy
The power of Big Data

- Fast-deep LMI
- Skills matching
- Reskilling

- Average no skills per vacancy
- % vacancies per occupation with skill ‘i’
- Typical skills per vacancies of occupation
- % job-specific/transversal skills
- Occupation proximity by skills
- Regional concentration of vacancies

Big data on vacancies

- 2018-20: Pan-EU tool
- Hundreds of job boards
- Tens of mil. vacancies
- All languages
- ESCO ver1
- 10.6 tsd. skills

- Most sought-after skills and credentials.
- New and emerging jobs, skills and skills patterns.
The Upwork Skills Index
The top 20 fastest-growing skills, Q1 2017

1. **ASANA WORK TRACKING**
   Track and manage projects with clear responsibilities and next steps.

2. **ARTIFICIAL INTELLIGENCE**
   Harness the processing power of computers and AI algorithms to bring intelligent decision-making capabilities to systems.

3. **RAPID PROTOTYPING**
   Quickly think up an idea and have a model in-hand that same day.

Additional Skills:
7. A/B testing
8. Twilio API development
9. C++ development
10. Swift development
11. Brand strategy
12. Marketo marketing automation
13. Penetration testing
14. Docker development
15. Relationship management
16. Application security
17. AngularJS development
18. Accounting (CPA)
19. Machine learning
20. JIRA administration

4. **IMMIGRATION LAW**
   Navigate evolving policy changes and nuanced implications for your workforce.

5. **NATURAL LANGUAGE PROCESSING**
   Use computers to understand human speech as it is spoken - what powers Alexa and Google Assistant.

6. **INSTAGRAM MARKETING**
   Engage your customers and build your brand with organic and ad-based promotion.
MOST IMPORTANT QUALITIES OF A TOP EMPLOYEE?

- Being a good coach
- Communication skills
- Possessing insights into others and different values and points of view
- Empathy toward one's colleagues
- Critical thinking
- Problem solving
- Drawing conclusions (making connections across complex ideas)
- STEM skills
Implications for education & training

The promise
- ‘Individualisation’
- Massive, online, open
- Non-credentialism
- New learning platforms

The challenge
- Biases
- Inequality
- Homo adaptus
- Quality assurance
- EQF responsiveness
- Governance
- ‘Personalisation’ (learning & career guidance)
- Humans-in-command
The digital divide fosters social exclusion

Use of advanced ICT skills in jobs and risk of digital skill gaps in jobs, 2014, EU28

Source: Cedefop European skills and jobs survey (ESJS)
Initial VET policy clusters in 2015-17

Continuing VET policy clusters in 2015-17

Source: Cedefop based on Refernet
Complementarity between ICT/other skills for work

- Advanced ICT level
- Basic/moderate ICT level
- No ICT needed for work

**Interpretation:** In ‘average’ EU jobs requiring advanced ICT skills there is an 0.10 estimated probability that numeracy skills are also of high importance, while there is a 0.05 probability of them not requiring communication skills.

Source: Cedefop European skills and jobs survey (ESJS)
% adult workers who experienced changes (e.g. in technologies used) in workplace and were supported by training activities paid for by the employer

Source: Cedefop European skills and jobs survey (ESJS)
Strengthening system adaptability

Labour market and skills intelligence
Collecting and analysing data and information on current and future labour market trends and skill needs.

Skills governance
The system of institutions, operational processes and dissemination channels aimed at facilitating stakeholder interaction and policy responses based on labour market information signals.

Setting the framework for feedback loops

Formal feedback mechanisms
Legislative framework
Anticipation and monitoring mechanisms as part of 2020 strategies

Source: Cedefop based on Refernet
...by overcoming barriers to effective skills governance

Cedefop’s skills governance framework

<table>
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<tr>
<th>Organisation</th>
<th>Resources</th>
<th>Stakeholders</th>
<th>Use of information</th>
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<tbody>
<tr>
<td><strong>Foundations</strong></td>
<td></td>
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<tr>
<td>A</td>
<td>Legal and institutional framework</td>
<td>D Funding and human resources</td>
<td>G Cooperation arrangements</td>
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<tr>
<td><strong>Processes</strong></td>
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<tr>
<td>B</td>
<td>Management and control</td>
<td>E Data, methods and expertise</td>
<td>H Feedback and validation</td>
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<tr>
<td><strong>Sustainability</strong></td>
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<tr>
<td>C</td>
<td>Vision and strategy</td>
<td>F Stability</td>
<td>I Integration of stakeholder needs</td>
</tr>
</tbody>
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culture, history, economy, demography
Rewards and risks of online labour

- More & diversified income
- Flexibility
- Creativity
- Talent management
- Skills matching

- Income uncertainty
- No social safety net
- Discrimination
- Health and safety
- Skill underutilisation
AI fair, reliable, private, safe, inclusive, transparent, accountable

A new regulatory model for digital labour

Upskilling and reskilling...

...with labour market reforms, innovation/competition policy, social equality
Cedefop and future of work

How technologies change demand for jobs and skills?

- Cedefop's skills forecast (2016-2030)
- Skills Panorama
- European skills and jobs survey (2nd wave)
- European company survey (4th wave)
- Skills demand in online job vacancies
- Skills development and matching in online platform work

How technologies change the way we work, collaborate, connect and learn?
Skills, careers and learning

- Skills utilization
- Work context
- Motivation & search strategies
- Skills gaps
- Learning and skills development
- Career development

Actors, institutions & policy

- Actors and institutions investing in crowdworkers’ skills
- New forms of skills ‘signalling’
- Role of commercial entities in certifying skills
- Implications on skills portability
- EU VET/employment policy?

Cedefop's project:

Skills formation and matching ...

... in online platform work (2018-2020)

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