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# WORKING, EARNING, LEARNING IN THE AGE OF INTELLIGENT TOOLS

The Berkeley WITS Project

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Session T3

## Emerging Technologies and Their Implications for Work and Skills

Andy Wyckoff, OECD

- Three pillars: government perspective, how do we get there, employment concerns
- Scale without mass
  - Firms and organizations are increasingly scaling without mass
    - Ability to do a lot with very little (i.e. internet companies)
    - Ex: Coursera, Whatsapp, Wikipedia
    - Opposite from GM/traditional automobile industries which have a massive distribution network
  - But fixed costs can be significant for some firms
    - Regulatory burdens can necessitate mass
- Panoramic scope
  - Smartphone
    - Reduces transaction and coordination costs
    - Enables scope across a firm
      - Available to every firm, enabling scope across SMEs
      - Enables multi-sided businesses
        - Nightmare for regulators, and necessitates reform
- Speed
  - Speed of policy making does not fit in new era where things are moving too fast
  - Regulations not suited to current conditions
    - Speed within sectors
      - i.e. high frequency trading
      - leads to policy arbitrage
        - take advantage of gap in policy fast enough and then develop a political constituency to change policy in your favour
- intangible capital and new forms of value creation
  - ownership, assets, and economic value
  - value used to be in tangible products such as engines
  - now we put sensors in machines, and then collect data and use data to deliver services
  - bundling data with products
  - we don't know where the value is being created

- huge issue with taxes
    - how to tax firms that have intellectual property
  - transformation of space
    - world is both large and small
      - agglomeration benefits some economies more than others
        - challenges with taxes
          - where do you tax labour
        - consumer protection
        - how do we know where the value is being created?
- empowerment of the edges
  - fundamental
  - end-to-end principle
  - any device can reach any other device
  - policy makers don't get it, and focus on more notion that intelligence takes place in the middle of the process
    - internet of things
    - intelligence is in the device
      - empowers companies like Uber
      - intelligence no longer in the middle where we used to impose regulation
      - empowerment at the edges
    - government must move toward the edge
- platforms and ecosystems
  - change in economy where google has new intermediary function
  - centralized economy around these ecosystems
  - make for great consumer convenience
  - does challenge policy makers, though there are many benefits
- Hadoop ecosystem
  - These open-source systems fall outside economic measure
  - But significant driver of economy
  - How do governments interact with this?
  - Should government create platforms or partner with platform provider?
  - How to we make that interaction seamless?
- Data
  - Non-rivalrous
  - Non-depreciable
  - Combinatorial
  - New powerful force in the economy, new way of creating value
- Whether we have new factor of production that is **data**

### Montserrat Gomendio, OECD

- Horizontal approach
- why is a coordinated approach necessary?
  - many trends shape education and skills
  - skills are important for tomorrows workers
- Trends

- types of skills we need are changing due to:
    - globalization, tech, demographic change; more non-routine
- Skills
  - we need people with non-routine cognitive skills
  - generic cognitive skills
    - basic building blocks
    - more difficult to automate
    - increased demand
  - technical, professional, and sector-specific skills
    - just because you have them, you still need to retrain
  - socio-emotional skills
    - tech can't do this
- high skill proficiency leads to higher social outcomes
  - people with higher levels of literacy
    - have more trust in institutions
    - better health
    - participate in volunteer activities
- skilled workers are less likely to have routine jobs
  - correlation between literacy and skills and routine to non-routine in each country
  - interaction between how people are trained and composition of employment
- many adults lack the basic skills
  - strong correlation with public education systems
  - we see a worrying trend
  - increase in Level 2 but reduction in Level 3 and 4
- literacy
  - 50% of adults are level 2 or below but all AI can do that
  - 30% of adults are level 3 and AI is close
  - 20% at level 4 and AI can't do it
- we can do better than OECD average of 11% at levels 4-5
  - decreased 2 percentage points since 1990
- creating a complex system of actors and decisions
  - actors
    - government
    - education and training providers
      - what is the role of workers and employers
    - other stakeholders
    - they provide the financing and are accountable
  - OECD advises government to no longer work in silos
    - Will talk to different ministries in government and discuss plans for the future
      - Discuss which sectors are lagging and which need to be promoted
  - Education needs to understand the demands of the labour market for example
  - Everyone must talk to ministry of finance to convince them to give them the money
- Horizontal approach
  - Change the frame of mind
    - Coordinating skills and policies across life cycle
    - Used to be higher up the blocks of education you got, the better the job
  - Now early education and care

- Need to start before compulsory education
    - Need to put together to improve vocational training and post-secondary system as well
  - Many countries have poorly designed systems
    - Or systems are oriented toward low skill jobs
  - We need lifelong learning
  - Need to understand the costs of the lifecycle approach
  - Need to have right incentives in place so that firms participate in this training
- Tertiary education does not guarantee skills
  - Even people with tertiary education don't have the basic skills in some countries
    - These systems have advanced rapidly at the expense of quality
- Tax policies
  - Need the right incentives for skills development
  - Sometimes the costs that people incur to learn don't outweigh the benefits
  - What are the incentives for employers to provide training
- Participation of women in digital economy is abysmal
  - Male dominated sectors
  - We need to find ways to promote participation of women
- Policies influencing adoption of new technology

Some people don't trust the technology and we need to educate them on the real benefits or costs

### Mark Keese, OECD

- Skills shortages
  - 40% employers say they have trouble filling vacancies
- There exist skill mismatches in the form of employees filling occupancies irrelevant to their college majors—is there a structural problem?
- displacement of workers adding to mismatches
  - if you don't manage this properly, you will have mismatched and underqualified workers
- retraining costs, slower adoption of technology, increased vacancies increases inefficiencies
- OECD developed a data base
  - Measure where pressures are in the labour markets
  - use objective data with ONET classification
  - did this for Europe and South Africa
  - overall,
    - Europe seems to be worse off than the US
      - Except when it comes to health sector
- Policy side
  - Training-programs
    - Automation is affecting lower skilled people who are having trouble adapting
    - Higher skilled tend to get training later
  - We should focus policies on those that need it most
  - Need policies to bridge this "skill divide"
- Small to medium sized businesses
  - Have trouble finding the skills and can't adopt the technologies
  - Need to focus on those businesses

- Subsidies for SMEs
- Programs that make it easier to access tech
- SMEs exempt from apprenticeship levy in the UK
- Belgium
  - Every individual is entitled to free career guidance
  - Lifelong learning and reskilling should be supported
- New forms of work
  - People not attached to single employer
    - Individual Learning Account
      - Transferable (keep the training applicable to any industry)
      - Low skilled get more training
      - But we need sector training funds, levy's and partners

### Alexandre Bayen

- Institute of Transportation Studies
  - 70 years old
  - During world war two, needed more investment in public infrastructure
  - Partners with department of transportation
  - Train workforce of practitioners
  - Digitalization work for google
  - 9 research centers, \$25M research budget, 200 members, 10+ successful start-ups
- ITS and shared mobility and transportation require attention
  - Bay Bridge's metering lights
  - ITS invented self-driving cars
  - Automated snowplows
- How can we reduce degradation of urban mobility? Will automation be good or bad for congestion?
  - Congestion will go up 200% or down 90%
- Data sample
  - Today Uber has 40,000 drivers in SF
  - With the explosion of smartphones
    - Allow companies to get data for free
    - Traffic information can be given to everyone for free
    - Can help with traffic congestion
      - But people don't like when their neighborhoods get busy – Waze
      - Implementing speed bumps, lawsuits, etc
    - We need regulation that embraces technological growth and innovation
  - In process of embracing tech growth—policy needs to step up its game
    - One thing we see emerging in an automated world are smart cities
    - i.e. in Saudi Arabia – being urbanized
    - if we have separate networks
      - every vehicle is automated
      - everyone can travel faster and things can be more efficient
      - no traffic lights needed
      - system can route you the way that is optimal
    - regulation will play a role

- regulators need to be willing to work with engineers
- next revolution is in the third dimension
  - drones: 1M produced a year
  - this revolution will become a 3D revolution
    - we experience these problems in the air
    - we will need to divide the airspace
    - urbanization at the offset can help correct for these issues
    - Flying cars have been around for 15 years
    - Making them a reality in urban environment is a challenge

## Bjoern Hartmann

- Likely future of 3D printing
  - Not new at all (available since 1987)
  - Commercial systems
    - We just didn't hear about them because they were confined to helping engineers to design new products
  - 3D printing application is still mainly for prototyping or proof of concept but now available to complete other tasks
  - giving same capabilities to same core users
    - FDM patents on core projects
    - Price dropped dramatically
    - Suddenly, many more people had access to technologies
      - Developed many more uses
  - In bioengineering
    - Bio printing tissue is a big strand of research
    - Fashion
    - Lots of experimentation with food
    - Building scale
  - More people are thinking about it as an ingredient in their domain
- We went from mainframe computing to computers everywhere
  - Completely changed the nature of media industries
- We can maybe do the same in 3D printing
  - Everyone can have it
  - That has impact on manufacturing and assembly jobs
    - Logistics (fewer things need to be shifted out)
    - Market for selling designs might grow
- Two key barriers:
  - Materials
    - Making stuff that is not plastic is hard
  - Design expertise
    - How do I tell a printer what I want to be printed?
    - Better design software can help
      - Embed domain knowledge into the tool
- More likely
  - take software tools and put into smart machine
  - make domain specific tools to complement skills for trades and professions

- may reduce expertise needed on the part of the person & requires different skills than before
  - new training is necessary
  - easier because incentives well aligned
    - having this training enables me to deliver more services
- Customization: invisalign in Orthodontics
- Counter-case study: Google Photos Live
- Semi-automatic fabrication
  - Hammer, no intelligence no automation
  - 3D printing has automation and no intelligence
  - new augmented smart tools
  - augment drill
    - can download set of instructions
    - displays real time feedback on what you should be doing
  - smart router
    - if you want to a carve complex pattern, it corrects your path
    - C&C robot
- Technologies can augment human skills
- Andy Wyckoff: Asked about environmental impact
  - BH: looking to make materials bio-degradable

### Phil Kaminsky

- Logistics is important but inefficient
  - 8.5% of GDP is linked to transporting and storing stuff
  - we still aren't very good at it (mass scale coordination)
  - quarter of the trucks seen on the road are empty , warehouses are empty
  - growing shortage of truck drivers
  - 30 billion gallons of fuel used each year
- problems continue to grow
  - between December and January, amazon hired 120K seasonal workers
  - warehouses growing rapidly
  - volume of freight in the country will increase
  - important industry that is becoming more challenging
- given this current setting, where will industry be in 20 years?
  - collected ideas from government, businesses, and asked for **trends** that could **disrupt** the economy
  - market
    - growth of ecommerce
    - relentless competition
    - mass personalization
  - society
    - urbanization
    - Gen Y and millennials
    - Changing workforce
    - Sustainability
  - Technology

- Wearable computing
  - Additive manufacturing
  - Robotics and automaton
  - Data used for predictive analysis
  - Sensors and IoT
- Pressure on producers
  - Increased customization, how to balance this and low-cost, you can now order anywhere, etc
- Emerging anticipatory logistics
  - Cybersecurity and risk
  - Cloud computing
  - AI
  - Industries 4.0
- Warehouses used to be designed for pallets
  - Now designed to house individual products because of Amazon
  - Autonomous vehicles are helping people out
  - Training must be quick (Amazon uses AR/VR)
- Technology makes new things possible in logistics
  - Low cost and efficient
- Competencies that firms need to develop
  - Total supply chain visibility
  - Standardization
  - Workforce was the most important
    - Workforce was number one priority
    - What will industry demand from supply chain professionals in the future
    - What will the potential workforce demand for the industry
    - How will we find people who cannot do the work?
    - How do we find people that are trained?
    - People are retiring and we can't find people to replace them
    - Freelance economy changing expectations of workers
- Three categories/challenges
  - Find people
  - Train & improve their skills
  - Retain and manage workers
    - Worried that they don't understand millennials
    - Design technologies to enhance existing skills
    - Designing technology so that skills are transferrable
      - i.e. google glass technology
      - AR/VR training
- Industry groups have textbooks so skills can be transferred to students
- Blue/grey/white collar distinction is changing
- We can do more to move toward more efficient delivery systems
  - what does labor become in a world with radically different, heavily automated, and rapidly changing supply chains?

- AI
  - 1740 applicants to PhD program in AI
    - accepted 35
    - everyone is concerned with the impact with AI
    - imagine interposing a robot between you and your daily tasks
    - go about interacting in the world but the robot is doing all the work
  - concerned with reorienting AI research toward systems you can prove are beneficial, aligned, and safe
  - when we delegate decisions to systems and the systems are increasingly powerful, with all nuanced preferences with values
  - Game theory
    - Guesses what people will do given certain circumstances
    - Imagine you can know what a person is doing
      - You can open up a machine the AI and know what it is thinking

### Stuart Feldman

- There is huge potential when it comes to AI
- But there are still enormous challenges- we are very good at predicting who will suffer due to automation and labor disruption, but we are not good at predicting where new kinds of value are likely to come from
- Nobody is smart enough to know what is going to happen today, there will be challenges with the status quo
- Forecasts and time scales (3 horizons):
  - 5 years
    - we know what's going to happen
    - in terms of technology and implications
  - 10 years
    - will start worrying about real things
  - 25 years
    - biggest risk is mono-causal reason
    - too chaotic
    - impossible to predict
- FOUR HORSEMEN:
- death
  - medical improvements will improve lifespan in 25 years, maybe over 10 years
  - behavioral impacts unclear
- famine
  - GMOs offer significant benefits (increased productivity, fertilizer reduction, stress attainment)
  - But droughts and other climate shifts will change things
- Plague
  - Expect at least one pandemic in 25 years
- War
  - Cyber and robotic
  - Targeted as well as mass action
- BASIC TECHNOLOGY-DRIVEN TRENDS:

- No huge impacts in next 10 years when it comes to climate and environment
  - Significant impact in 25 years
  - Ocean levels rise, reduction in the rain forest
  - Will change shipping routes and oil discovery
- Scientific research enterprise
  - Acceleration of results, increased sharing and uses
  - New paradigms with automation in the loop likely leading to a new solution
  - Data science, big data, machine learning
  - Next generation of scientists will start here
- BASIC SCIENCES:
  - Biology
    - Improvements in our understanding of molecules to ecosystems
    - Major advances in medicine
  - Chemistry and materials
    - Understanding fundamentals of chemicals and materials
    - Whole families of materials that weren't possible a year ago
  - Earth sciences
    - Predictions and modeling will get better
- IT-HARDWARE
  - Networking
    - 100Gbs will be more common
    - 5G coming in 5 years
  - storage
    - cost curves will continue, solid state becoming more prevalent
    - exponential implications for Google and Amazon computational clustering
  - memory
    - densities sill continues to improve, costs may not
  - Computation speeds
    - Basic speeds not changing very much
    - Density will continue to increase
    - Specialization already important
      - Boosts through archenteron
      - Adaptability
      - Heterogeneous cores
    - Quantum is coming
      - But will be niche for next 10 years (25?) years
  - Data Centers
    - Will continue to grow in scale
    - Real advantage is scale
  - Local computing capabilities
    - Continuing to grow
  - Visual display
    - Small screen/personal/direct on various time scales
  - Other senses
    - Important for emotional involvement
- Software
  - Not in great shape but hasn't fallen apart

- Is going to change rapidly
- AI
  - Machine learning- dominant technology
    - Where all the achievements have been made
  - AI
    - General AI still an aspiration
    - Empathy coming (maybe?)
  - Robots on autonomous devices
    - Humanoid and human facing
    - Mechanical (moving and forming)
    - Vehicles (air, land, water)
- Economic Activities
  - New materials in manufacturing
  - Assembly technology
    - Automation increases precision (ie agriculture)
  - Distribution and delivery
    - Distribution is changing due to algorithms and data economies of scale
    - Amazon has squeezed costs
  - Technology changes the skills and skill options
  - Transportation
    - Campus/building level will be highly automated
    - Long-distance will depend on regulation
  - Infrastructure and construction
    - Smarter buildings, smarter sensing, and maintenance
    - Better modelling, better materials
    - On-site and off-site work
    - More use of data
    - Greater automation steps
    - Ways you can get much better results by the physical world becoming better
    - Many purposes done with fewer people
    - the implications for lower staff numbers, better construction management, smarter building and smarter sensing. This will make infrastructure both better and cheaper
  - These shifts make up half of the economy
  - But you want human compatible technologies