Private sector development in the age of digitalization and the great convergence

DCED, 2019 Annual Meeting Thematic Day
13 JUN 2019
Memedovic Olga
I. New industrial revolution: drivers and characteristics

II. Opportunities and challenges

III. How are we prepared for the NIR?
Industrial revolutions: co-evolution of humans and technology

1.0 **18th Century**
- Mechanization
- Railroads
- Steam and water

2.0 **19th Century**
- Mass production
- Assembly line
- Conveyor
- Electrification

3.0 **20th Century**
- Automation
- Mass production
- Computer
- Electronics

4.0 **Today**
- Cyber-physical system
- Mass productions/customization
- IoT; IoS; IoP; Robotics
- Big Data, AI, 3D, NBCIS

5.0 ?

- Economies of scale
- Economies of Scale and Scope
- Customization at the unit price of mass production
- Material and energy intensity
- Circular economy
What drives NIR?
21st century technology convergence architecture driving NIR
Hybrid materials and systems in manufacturing

Disruptive power of technological change

Speed of change  Widespread implications  Systemic impact

Who we are? How we work and leave?
Accelerating technological change: from incremental to exponential
Accelerating (disruptive) innovation: shorten product life cycles; adoption time shorten from decades to a few years

Disruptive innovation collapses product life cycle; need to identify the early warning signals in order to participate

Source: Larry Downes and Paul F. Nune, Big Bang Disruption
Accelerating price-performance of computing devices power (consistently multiplying in power per unit of time/money)

Ray Kurzweil extending Moore’s law due to paradigm shift
Accelerating price performance in genome sequencing
Accelerating price performance of Photovoltaic Panels

Swanson's Law

Cumulative Module Shipments (MWp)

Module Cost ($/Watt)

$100.00

$10.00

$1.00

$0.10

0.1 1 10 100 1,000 10,000 100,000 1,000,000 10,000,000

Widespread implications:
All economic sectors will be affected
New business models:
New sciences and technologies

Medical Research and Platforms
- Drug design and targeted drug delivery
- Treatment of genetic diseases and genetic security
- Environmental effects on human organism
- Expansion of human potential

Biology and Biotechnology
- Biochemistry and protein factories
- Genomics and genetic engineering
- Immunology and immunotechnology
- Stem cells and cell technologies

Physical Chemistry and Nanotechnology
- Synchrotron radiation source and neutron reactor
- Crystallography
- Chemical synthesis of ultrapure compounds
- Immobilization of biomolecules on the polymer surfaces

Microelectronics and System Integration
- Micro- and nanoelectronics
- MEMS and NEMS
- Microfluidics
- System integration

Department of Engineering
- Sensor and bio-hybrid detectors
- Mechanical and biomimetic engines and actuators
- Drives and transmissions

Computer Sciences and Informatics
- Processing of large volumes of genetic and neural data
- Bio- and neuroinformatics
- Large-scale simulation of brains and cognitive processes

Neuroscience and Cognitive Technologies
- Neurobiology of memory and cognitropic compounds
- Neurobiology of intellect and neuromorphic systems
- Neurobiology of consciousness and brain interfaces

Human Cognitive Research
- Cognitive psychology
- Human neurocognitive studies
- Applied cognitive research

Convergence driving divergence: new value is created by a recombination of complex technology ecosystems and spill-overs.
Intelligent GVCs: horizontal and vertical integration

Dr. Carsten Polenz – SAP SE, presentation at the Bonn workshop on Industry 4.0: challenges for productivity, employment and inclusion, Bonn, 28-29.05.2018
All countries will be affected by the disruption.

All countries have room for improvement. No country has reached the frontier of readiness, let alone harnessed the potential of 4IR.

There are common challenges within each archetype. All countries can learn from each other in overcoming challenges.

As 4IR brings forth a cluster of new industries, there is potential for leapfrogging, but only some countries are positioned to capitalize.

4IR will trigger selective structural changes (e.g. re-shoring, near-shoring), re-distributing and re-creating value in global value chains.

Readiness for the future of production requires global, not just national, solutions.

Systemic impact

- Differences between economic sectors become blurred

- Prospects to radically change economic models: redefying the role of market and the government; the role of public and private sector; the role of the forth sector (the social and solidarity economy, social entrepreneurship); the role of SMEs

- Questioning traditional linear models of economic development
  - From linear to network, and compressed model of economic development
  - From closed to open and collaborative innovation model

- Educational systems reforms and STI mainstreaming
The rise of the Unicorns — startups with a Billion dollar valuation.

Exponential technological progress creates disruptive potential for startups.

Potential for startups creating new companies have never been greater

- Startup Ecosystem building crucial: for job creation and as a hedge towards the social security of the future!
- Start ups are much better at new disruptive innovation than large companies.
- Large companies' role is in growing acquired products and applying their capacity for efficiency and scale. Developing a more symbiotic relationships with start ups (e.g. Apple; Microsoft; Amazon, providing infrastructure and platforms for start ups; general electrics)
- Convergence of non-ICT companies becoming ICT companies
Moving to open innovation and ecosystem building requires connectivity and collaboration to strengthen resilience

Source: WEF, AT Kearney
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Extraordinary opportunities for realizing the SDGs

**ENVIRONMENTAL RETURNS**
- 25% decrease in pollution
  - High resource efficiency and effectiveness, particularly energy efficiency
  - Significant cuts in CO2 emissions
  - Better access to electricity and water
  - New materials and production processes: products and services, can be designed to save natural resources

**ECONOMIC RETURNS**
- 25% productivity gain
  - Higher efficiency, productivity and opportunities
  - Economic diversification
  - Increased revenues from lower transaction costs, increased productivity, higher quality products, increased market share
  - Customization at the unit price of ass production

**SOCIAL RETURNS**
- Increased quality of life
  - Enhanced human physical and cognitive capabilities
  - Improvements in health and safety of workers
  - SMEs inclusion: e-commerce
  - Inclusion of women, youth
  - A push for changes in education, training systems, as well as for research and innovation
  - Government capacity and transparency to increase; better government services
Huge challenges

- Skill mismatch
- Slow technological diffusion and technology gap widening
- Infrastructure gap
- Institutional mismatch; rules, regulations; norms standards
- Industrial safety &security
- Inclusiveness
Unequal distribution of and access to digital technologies, widening technology gap

- Concentrated in few sectors
- Concentrated in few countries
- Infrastructure gap driving the digital divide and technology gap
Estimated annual supply of industrial robots at year-end by industries worldwide 2016 - 2018*

- Automotive: 2018* = 116, 2017 = 123, 2016 = 123, -6%
- Electrical/electronics: 2018* = 113, 2017 = 122, 2016 = 122, -8%
- Metal: 2018* = 48, 2017 = 29, 2016 = 29, +10%
- Plastic and chemical products: 2018* = 23, 2017 = 21, 2016 = 20, +7%
- Food and beverages: 2018* = 12, 2017 = 9, 2016 = 8, +24%
- Unspecified: 2018* = 47, 2017 = 38, 2016 = 25

*preliminary result

Source: IFR Statistical Department
Estimated worldwide annual supply of industrial robots at year-end 15 main markets 2018*

- China: 133.2
- Japan: 52.4
- United States: 38.1
- Rep. of Korea: 37.6
- Germany: 27.9
- Taiwan, Prov. of China: 11.3
- Italy: 8.3
- France: 5.6
- Mexico: 5.5
- Spain: 5.3
- Thailand: 5.0
- India: 4.8
- Singapore: 4.5
- Vietnam: 3.8
- Canada: 3.4

*preliminary data

Source: IFR Statistical Department
Number of installed industrial robots per 10,000 employees in the manufacturing industry 2017

<table>
<thead>
<tr>
<th>Country</th>
<th>Units per 10,000 employees</th>
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<tbody>
<tr>
<td>Rep. of Korea</td>
<td>710</td>
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<tr>
<td>Singapore</td>
<td>658</td>
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<td>Germany</td>
<td>322</td>
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<td>Japan</td>
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<td>Sweden</td>
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<td>Denmark</td>
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<td>United States</td>
<td>200</td>
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<td>Taiwan, Prov.</td>
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<td>Belgium</td>
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<td>Switzerland</td>
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<td>Czech Rep.</td>
<td>119</td>
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<tr>
<td>China</td>
<td>97</td>
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Average Europe: 106  
Average America: 91  
Average Asia: 75  
Average world: 85

Source: IFR World Robotics 2018
Digital divide (4b people not in digital economy)

The digital economy is developed, and key enablers are in place; there are opportunities for WBG to invest in disruptive use cases (e.g. e-health, online education, etc.)

Although connected, the country is gradually moving toward a digital economy; WBG can develop key foundational elements (e.g. e-payments, etc.)

The country is disconnected; WBG can develop digital infrastructure and enable the private investment environment

1% of countries affected does not reflect population represented within each archetype
http://uis.unesco.org/apps/visualisations/research-and-development-spending/
Cloud Computing & Cybersecurity

Geographical distribution

Geographical distribution of attacks on industrial automation systems, H1 2018, percentage of ICS computers attacked in each country

ICS-Industrial control system
TOP 20 countries by percentage of ICS computers attacked, H1 2018

10 countries with the lowest percentages of ICS computers attacked, H1 2018
Labor market/Inclusiveness

Job displacement faster than job replacements + demographic trends = rise in global **unemployment, inequalities and migration**

Affect nearly entire spectrum of professional groups, but mostly low skilled, routine tasks and even white collar jobs; appearance of new occupations

Impact of developing countries: technologies diffuse slowly and labour remains cheaper: can competition between I2.0 and I3.0 countries/locations and I4.0 countries/locations sustain?

Educational systems weak in developing countries/LDC especially, lacking basic skills; need for digital skills; **STEAM**; cognitive and social skills
Rebound effect

- *Industry 4.0 related technologies may facilitate more sustainable production, but* can also be accompanied by **rising demands for scarce resources** such as (certain) metals
- *Increasing consumption of energy*
- *Additive manufacturing: increasing efficiency and reducing waste but can result in shortening of product lifecycles and increase in consumption in some industries; health issues*
- **Waste issues (electronic waste)**
Revolutionary but no revolutionary effects so far:
*IT boosting productivity but not yet reflected in global GDP and productivity*
No revolutionary effects so far, but we are likely at the very beginning of a

*Tsunami of changes*

- Preparedness is crucial for all countries!

Negligent applications of new technologies could lead to social tragedies and even global catastrophes, more devastating, than predictions of climate change.
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New Industrial Policy

- UK
  Catapult-High Value Manufacturing
- Belgium
  Made Different
- Netherlands
  Smart Industry
- Spain
  Industria Conectada
- Germany
  Industrie 4.0
- France
  Industrie du Futur
- Portugal
  PRODUTEC
- Sweden
  Produktion 2030
- South Korea
  Manufacturing Innovation
- China
  Made in China 2025
- Japan
  Industrial Value Chain
- India
  Make in India
- Australia
  Next wave of manufacturing

Strategic program for smart industries, 2015-2026

Industrial Policy Action Plan
WEF: Readiness for the future of production

Exhibit 7 – Global Readiness

Level of readiness...
Low  Medium  High

INCLUSIVE AND SUSTAINABLE INDUSTRIAL DEVELOPMENT
WWW.UNIDO.ORG
Company readiness
Singapore: Companies to use index to learn, evaluate, design and implement transformation initiatives

Source: The Singapore Smart Industry Readiness Index Whitepaper (2017), Singapore Economic Development Board, Ministry of Trade & Industry
Private sector challenges:

**HUMAN RESOURCES**
- Develop talent: through Companies/Unions/Government cooperation
- Identify new skilled needed
- Support continuous education, learning and capability building

**INNOVATION & ECOSYSTEM BUILDING**
- Model factories to foster technological learning and innovation
- Promote open innovation
- Start up programs

**BUSINESS ENVIRONMENT REFORMS**
- Norms, standards, regulatory
Empowering start ups: Innovation system building

Regional Innovation System

Flows of resources: knowledge, finance & skills

Building trust and confidence in institutions and their reliability

Knowledge application & exploitation and transformation subsystem

ICT/IIoT/CPS/AI

Customer
Competitors
Collaborators
SMEs/Clusters

Governance system embedded structure
local politicians
park managers
cluster organizations

Venture capitalist, Lawyers for patents and IPR

Business incubators

Technology mediating organizations
Public research organizations

Market mediating organizations

Workforce mediating organizations

Education provision organizations

ICT/IIoT/CPS/AI

Knowledge generation & diffusion subsystem

Memedovic after Cooke 2006, UNIDO
UNIDO 4IR STRATEGIC APPROACH

**UNIDO 4IR STRATEGIC APPROACH**

**UNIDO CORE FUNCTIONS**

- **smart agro-food**
  - precision agriculture
  - vertical/urban farming
  - controlled environment agriculture

- **smart manufacturing**
  - smart factory
  - smart value and supply chains
  - smart materials, products, processes, services

- **smart energy**
  - IEE
  - e-mobility
  - renewable energy/Smart grids

- **smart circular economy**
  - effective monitoring of materials use
  - turning waste materials into nutrients
  - eliminating waste

**Knowledge, skills, innovation**

**Institutions (norms, standards and regulations)**

**Inclusiveness of women, youth, disabled, SMEs**

**Partnerships**
4IR TECHNICAL COOPERATION

- **CONVENING/AWARENESS RAISING**: Establishing multi-stakeholder knowledge sharing platforms to create awareness on Industry 4.0 opportunities and challenges for pursuing ISID in developing countries.

- **ROADMAPPING & POLICY ADVICE**: Support governments in the development of industry roadmaps and innovation-friendly policies, business environment regulations and standards.

- **READINESS ANALYSIS & INDUSTRY 4.0 OBSERVATORY**: Maturity and readiness analysis at the macro, meso, micro and SME level, Development and application of indicators and measurement tools for an assessment of 4IR readiness. The capacity building to independently undertake readiness analysis for roadmapping and monitoring implementation.

- **DEMONSTRATION, LEARNING & INNOVATION CENTERS**: Technological learning and innovation.

- **I4.0 ABSORPTIVE CAPACITY BUILDING**: Vocational education and training to meet demand of Industry 4.0.

- **INTERNATIONAL TWINNING**: Innovation management.

  Creating international networks between local and renowned international institutions to strengthen local capacities.
THANK YOU