



Discussion Forum: The 4th Industrial Revolution

Concept Document

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Venue: SA Innovation Summit, Greenpoint Stadium, Cape Town

Title: Implications of the 4th Industrial Revolution for SET, industry, society, and education

Topics and themes:

- What is the 4th Industrial Revolution or Industry 4.0?
- Legislation and government policies that address the implications of the 4th Industrial Revolution
- Implications for industries and economies
- Implications for science, engineering and technology
- Implications for job creation and job security
- Implications for skills development
- Implications for education

Introduction

Definition:

It is not clear what is meant by the Fourth Industrial Revolution, and there seems to be no agreed definition. Nor can anyone foresee exactly what the implications are for the future of human society. What is clear is that the world is changing along with the dramatic changes that are taking place in technology. There are now powerful technologies that can make life easier and enable human achievements previously (and currently) thought to be impossible. It is anticipated to change everything fundamentally - industries, economies, jobs, transport, skills and education, to name but a few. The negative implications are however substantial – from job losses and the need for high level skills, to the need for reams of new legislation and necessary changes to education and training.

To adapt to this changing world, and make good use of its opportunities, people from all walks of life and all sectors of society and economies need to collaborate and devise some comprehensive – and shared – approaches. Scientists and engineers are crucial in the world of Industry 4.0. Research is more critical than ever. Governments cannot on their own effect the necessary changes. Both public and private sectors should be actively involved.

Background

Industrial Revolutions as they pertained to production:

1st Industrial Revolution: water and steam power were used to mechanise production.

2nd Industrial Revolution: mass production enabled by electric power

3rd Industrial Revolution: automated production through electronics and information technology.

4th Industrial Revolution: more customised production and a fusion of technologies that blurs the lines between the physical, digital, and biological spheres.

Is the 4th Industrial Revolution not just a continuation of the 3rd ?

It is true that the 4th would not be possible without the 3rd, but there are characteristics that are unique – the changes are taking place faster than ever before, they are expected to be dramatic and

comprehensive, and will transform whole systems in the way human beings have organised themselves until now. The change will be exponential as opposed to a steady linear pace. It will challenge all our adaptive abilities as individuals, governments, businesses and societies. Every industry is expected to be disrupted and subject to continual change. Labour will be dramatically impacted. It is anticipated that job losses will be worse than ever and unemployment levels across the world will rise to crisis point.

Technologies that are already being developed and used, will develop faster to unlock unprecedented potential to change our world for better or worse. Artificial intelligence (AI) will take over some human functions and challenge people's sense of self and agency. Robotics will make menial work obsolete, thereby improving the quality of life but also making millions (billions?) of people's jobs obsolete. The internet of things will make it possible to have control over vast systems such as energy transmission, water distribution and transport systems. What does this mean for the security of such systems and consequently that of people? Will it solve the service delivery crisis in South Africa?

Self-driving cars and other vehicles are anticipated to improve safety on the roads. If these works well, it could improve quality of life in cities dramatically, and save millions of lives that are lost to accidents. But what are the implications for a country ravaged by crime and cash in transit heists? Not even the Uber system can guarantee the safety of passengers in our country.

There is much promise in breakthrough scientific discoveries and technologies, such as nanotechnology, biotechnology, materials science, photonics and 3D printing – the potential and implications of which are in the early stages of discovery. Similarly, Big Data is full of both opportunities and challenges. Cybersecurity is making progress but still of major concern. Quantum computing will revolutionise storage and transmission of data. Current challenges such as how to mine data for trends and specifics, are expected to be more effectively addressed.

To add to the complexity of the changed world, the various revolutionary technological developments will impact each other in ways we cannot anticipate.

Already some of the technologies have changed, and are changing, our lives. Cell phones with ever increasing capability and connectedness are a good example. In some African countries, people use cell phones more than fixed line telephones, thereby leapfrogging a stage of development (namely establishing a reliable telecommunications network). Online learning has become common, enhancing education and even replacing traditional face-to-face interaction with teachers/instructors. AI is already built into our cell phones. Digital technologies are interacting with the biological world on a daily basis – from DNA analysis to 3D printing of prostheses. Various experts are collaborating, blurring the distinctions among specialised fields. Designers and engineers, biologists and software developers, are (for example) obliged to work together to solve complex problems and develop innovations to an optimal level. Scientific research on microorganisms is leading to reassessments of health and diseases, the products we consume and how they are manufactured, as well as our environment.

New possibilities for space exploration are opening up. Discoveries and inventions of our time make it possible to send a mission to Mars, and even for people to live in that desolate landscape and improve it for human habitation. Advances on Mars may even contribute to human adaptation to climate change here on our own planet which is in the throes of major change itself.

Issues to address

- **South Africa**

The country seems underprepared. It is not taking sufficient advantage of 4IR opportunities for establishing businesses and industries, despite its strong scientific base and innovative people. It is at the intersection of the four industrial revolutions. South Africa used to have a strong manufacturing sector contributing 13% of its GDP, fairly diversified, and with a well-developed infrastructure. However the sector has been shedding jobs since 2010. Its growth is curtailed by costs of production (including labour), relatively low productivity, a shortage of high level skills and uncertainty about government policy.

Local manufacturing sectors that are doing well:

- Radio, television and professional equipment
- Food and beverages
- Petroleum, chemical products, rubber and plastic products
- Motor vehicles and parts
- Wood, wood products and paper

It is also close to the rapidly growing markets in other African countries.

The electrical machinery sector is neither growing nor declining

Local manufacturing sectors that are not doing well:

- Basic iron, steel and metal products and machinery
- Textiles, clothing
- Furniture

If our manufacturing sector is not ready for this industrial revolution, it will haemorrhage jobs and markets will be lost to foreign competitors.

“Human capital is important,” emphasised Saunders. Without adequately prepared human capital, a country will not be able to harness the new production technologies.

- **Policy**

Governments are struggling to keep up with the rapid pace of change and the arrival of new products on the markets. They need to transform to a mode of “agile governance”, with policy development no longer limited to government but more of a multi-stakeholder effort. Policy making should be adaptive, human centred, and inclusive.

era of agile governance –

Government should write policies that allow opportunity for the private sector to innovate, e.g. focusing on the purpose of technological innovation instead of only technical specifications.

One of the problems with each of the industrial revolutions is that they enabled more sophisticated technologies to kill people, which led to increasingly cruel and efficient warfare. Ironically defence industries also contributed substantially to the development of these industrial revolutions. Will this one be any different? The line between military and civilian use of current technologies seems already to be blurred in the case of drone technology.

Revolutions in the political sense are driven by dissatisfaction among the ordinary populace with their quality of life. Industrial revolutions partly bring about improvements and partly exacerbate the conditions under which people live, often resulting in increased levels of inequality in living standards. Is there a way of improving the chances of improvement as opposed to deterioration

in the current industrial revolution? Will the angry actions of the ordinary people this time ensure that they are included as beneficiaries of the industrial revolution?

- **Business**

- **How will existing businesses be disrupted?**

- **Customer expectations:** Customers will want the same level of service from all businesses, i.e. they would want to enjoy seamless, simple, digital service.
 - **Cryptocurrencies:** will change the way transactions are done.
 - **Product enhancement:** Likewise there will be pressure on all businesses offering products to supply customers with products incorporating cutting edge technology.
 - **Collaborative innovation:** People can now collaborate separated by long distances and without being in the same room. As the demands on business increase, so the need for innovation will become more critical, with collaboration as a more efficient way of innovating.

- **Organisational structures:** Business resource and skills requirements will evolve, with likely changes to business models. New jobs will come into being. Businesses will be forced by these changes to transform rapidly.

- **Research**

- Increasingly, research tasks previously only performed by human scientists and technicians will be done by machines. It may be useful to identify what machines will not be able to do, instead of what they will be able to. Many tasks involving human interaction or creative coordination and decision-making will still require real humans.

According to a study by Oxford University, the following professions are the least likely to be replaced by machines:

- Choreographer
 - Psychologist
 - HR Manager
 - Anthropologist
 - Archaeologist
 - Sales Manager
 - CEO

- Those most likely to be replaced include:

- Telemarketer
 - Insurance appraiser
 - Umpire/referee
 - Legal secretary
 - Messenger/courier

- **Implications for the environment** - The technologies associated with the Fourth Industrial Revolution can bring significant ecological benefits. For example:

- **Efficient use of materials:** There is a great reduction of wastage of material when applying 3D printing.
 - **Reduced material load:** 3D processes can produce highly complex lightweight structures. This can have positive effects on energy needs and the lifecycle of the components.
 - **Reduced transport:** Proximity to the markets of manufacturing sites reduces long distance transport requirements and CO₂ emissions. Instead of semi-finished and finished products, it is mainly raw materials that are transported. These are more suitable for cost- and energy- efficient mass-transport modes such as railways and ships

- **Online surveys on opinions on the topic**

- Impact of the 4th Industrial Revolution on the Waste Management Sector by the International Solid Waste Association: <https://www.surveymonkey.com/r/4thindustrial>
Report:
https://www.iswa.org/index.php?eID=tx_iswaknowledgebase_download&documentUid=4945
- Deloitte: <https://www2.deloitte.com/insights/us/en/deloitte-review/issue-22/industry-4-0-technology-manufacturing-revolution.html>
Industry 4.0 readiness report by Deloitte:
https://www2.deloitte.com/content/dam/insights/us/articles/4364_Industry4-0_Are-you-ready/4364_Industry4-0_Are-you-ready_Report.pdf
- The World Economic Forum’s 2015 study “When Will the Future Arrive?” In this study technology executives and experts were asked to predict tipping points—that is, the technology advances which could be truly mainstream by the year 2025. For example:
 - **Ninety-one percent of the technology executives and experts think ten percent of people will be wearing clothes connected to the Internet.** That could change how health, healthcare and related research is conducted,
 - **Eighty-one percent of participants think five percent of consumer products will be printed in 3D.**
 - **Seventy-nine percent of participants think ninety percent of the world will have regular access to the Internet.** providing access to populations who have never had it before, enabling social research across the globe to be more accurate.
 - **Forty-five percent of tech experts expect to see the first Artificial Intelligence machine take its place on a corporate board by 2025.** Those half-remembered facts and challenges in synthesizing a multitude of ideas in such meetings will suddenly be accessible and manageable.

Potential for Africa and South Africa:

- ability to address negative externalities – hidden environmental and social costs.
- Nothing that is made in a circular economy becomes waste. The “Internet of Things” allows us to track material and energy flows to achieve new efficiencies along product value chains. Even the way energy itself is generated and distributed will change radically, relying less and less on fossil fuels. renewable energy offers the possibility of devolved, deep and broad access to electricity. A smart grid can distribute power efficiently across a number of homes in very remote locations. Children will be able to study at night. Meals can be cooked on safe stoves. Indoor air pollution can basically be eradicated.
- The Internet of Things and blockchain technology cast a vision for financial inclusion that has long been elusive or subject to exploitative practices.

Risks for Africa and South Africa:

- Rising joblessness.
- Developing countries have moved away from manufacturing into services. Manufacturing is still the primary channel through which to modernise, create employment (especially by absorbing unskilled labour) and alleviate poverty.
- The social effects of joblessness are devastating. Demographic modelling indicates that Africa’s population is growing rapidly. For optimists this means a “dividend” of young producers and consumers. For pessimists, it means a growing problem of youth unemployment colliding with poor governance and weak institutions.

- That means driverless trucks and robots, all fully digitised, conducting non-invasive mining. A large proportion of the nearly 500 000 people employed in South African mining alone may stand to lose their jobs.
- Unequal societies tend to be more violent, have higher incarceration rates, and have lower levels of life expectancy than their more equal counterparts.

How Africa can harness this revolution while mitigating its risks?

- avoid a proclivity back towards the import substitution industrialisation programmes of early independence.
- governments need to employ systems thinking, operating in concert rather than in silos.
- Rapidly improving access to electricity should be a key policy priority.
- be proactive in adopting new technologies. To do so they must stand firm against potential political losers who form barriers to economic development.

Industry 4.0 centre in South Africa by the World Economic Forum: The World Economic Forum is planning to open at least 12 Centres for the Fourth Industrial Revolution in the coming year across various countries, including South Africa.

These centres will be hubs for public-private collaboration to shape the development and application of emerging technologies.

Purpose of the Discussion Forum

- Platform to present and assess to what extent government policy takes account of the challenges and opportunities of the 4IR
- Platform for researchers to present their research work and thoughts
- Opportunity for all who are interested to interact and engage the speakers
- Opportunity to reflect on the implications of the 4IR, particularly in relation to innovation (as the discussion forum takes place on the side-lines of the Innovation Summit)
- Collating recommendations for government, which will be publicised and sent to the relevant authorities
- Identifying what issues need further discussion and determining possible follow up actions

Further reading

Klaus Schwab

Executive Chairman of the World Economic Forum

Professor Klaus Schwab is Founder and Executive Chairman of the World Economic Forum (WEF), the International Organization for Public-Private Cooperation. He founded the Forum in 1971, the same year in which he published *Moderne Unternehmensführung im Maschinenbau* (Modern Enterprise Management in Mechanical Engineering). Schwab has championed the multi-stakeholder concept since the Forum's inception, and it has become the world's foremost platform for public and private cooperation. Under his leadership, the Forum has been a driver for reconciliation efforts in different parts of the world, acting as a catalyst of numerous collaborations and international initiatives.

Schwab has encouraged the establishment of communities providing global expertise and knowledge for problem-solving. Among them is the Network of Global Future Councils, the world's foremost interdisciplinary knowledge network dedicated to promoting innovative thinking on the future

An engineer and economist by training, his latest books are *The Fourth Industrial Revolution* (2016) and *Shaping the Fourth Industrial Revolution* (2018).

in 2017, WEF launched the [Fourth Industrial Revolution \(4IR\)](#) for the Earth Initiative.^[54] In 2018, WEF announced that one project within this initiative was to be the [Earth BioGenome Project](#), the aim of which is to sequence the genomes of every organism on Earth.^[55]

Policy documents

Department of Telecommunications and Postal Services

https://www.dtps.gov.za/index.php?option=com_content&view=article&id=135&Itemid=332

“Human Resources Development Council of South Africa (HRDCSA), the e-Skills Council, the MICT Seta, Knowledge Production Hubs, and the National e-Skills Dialogue Initiative (NeSDI) were all established to prioritise skills development.”

“The National Development Plan calls for an e-literate society by 2030”

Quotes from the Green Paper:

https://www.dtps.gov.za/index.php?option=com_phocadownload&view=category&id=22:national-integrated-ict-policy-green-paper&Itemid=143

National e-Skills Plan of Action (NeSPA), DoC

NDP Priority Area

Taking into account the WEF report and the call of the NDP, the Department, through its e-Skills Institute, cited amongst others the ... shortcomings/opportunities for developing the required e-skills human capacity.

NeSPA 2013 Action

Pillar 1: Unite around a common pillar to fight poverty and inequality

Developing e-social astuteness across society is an essential component in developing a united approach to fight poverty and inequality. Without this essential ingredient it is difficult to see how society can be effectively engaged in dealing with these key issues facing South Africa.

Pillar 2: Active citizenry (e-participation, e-democracy)

Developing active citizenry in current times when more than 90% of poor people in townships have access to a cell phone is heavily dependent upon a national approach that recognises the essential value of new forms of ICT including social media. In turn this is then dependent upon a National e-Skills Plan of Action.

Pillar 3: Inclusive economy

An inclusive economy simply cannot be developed without a clear recognition of the impact of increasingly powerful, mobile, accessible and affordable modern ICT devices. Without a plan to develop capacity (e-social astuteness) right across society to use these devices effectively as customers, clients, consumers, businesses, SMMEs, families and communities, an inclusive economy will remain an elusive dream.

Pillar 4: Build capabilities

An evaluation of addressing poverty and inequality identifies capabilities to socially appropriate ICT for local benefit as an essential requirement. Hence the delivery of a national collaborative and integrated plan to e-skill South Africa lies at the very heart of capacity building for more equitable prosperity.

Pillar 5: A capable and developmental state

A capable and developmental state in a modern world clearly requires a state that is e-ready. Achieving a capable and developmental state simply cannot be realised without a concerted effort to address the issues underlying South Africa’s e-readiness rankings.

Pillar 6: Leadership throughout society to work together to solve problems

Developing leadership across the breadth and depth of society to solve problems is heavily dependent upon the effective use of modern ICT to bridge socioeconomic divides, share discussions across wide groups, build consensus and deliver collaborative approaches. Without a well-developed e-social astuteness across the full spectrum of social media, it is difficult to see how a collaborative approach to problem-solving can be developed.

An economy that will create more jobs

NDP proposes to create 11 million jobs by 2030 - e-skilling people for employment and entrepreneurship.

NDP Priority Area

NeSPA 2013 Action

Improving infrastructure e-skilling (including building e-social astuteness) for the infrastructure planners and operational staff.

Transition to low-carbon economy

e-skilling (including building e-social astuteness) for sustainability development.

An inclusive and integrated rural economy

e-skilling (including building e-social astuteness) for rural communities and small-scale farmers.

Reversing the spatial effect of apartheid

e-skilling (including building e-social astuteness) the townships' population for Digital Inclusion.

Improving the quality of education, training and innovation

Giving educators and learners various e-skills (including building e-social astuteness) at all levels of education: Early Childhood Development (ECD), primary, secondary, tertiary).

Quality health care for all

Providing e-health skills.

Social protection

e-skilling (including building e-social astuteness) citizens and government officials for using ICT in social protection services

Building safer communities

e-skilling (including building e-social astuteness) citizens and the safety and security related government officials regarding effective use of ICT for building safer communities.

Reforming the public services by professionalising them

Providing e-government and e-governance skills.

Fighting corruption Providing e-Government and e-participation skills for greater transparency.

Transforming society and uniting the country

Providing e-Skills (including building e-social astuteness) for digital and social inclusion.

11.3 Institutions involved in skills development

The following are institutions involved in skills development:

☐ SETA (Sector Education and Training Authority):

☐ Media, Information and Communication Technologies Sector Education and Training Authority (MICT Seta);

☐ National Association of Broadcasting of South Africa (NAB); and

☐ the e-Skills Institute.

11.4 Employment and skills gap

Approximately 180 000 people are employed in the sector, of which roughly 15 000 are software developers. There are nearly 8 000 companies in the ICT sector, most of them employing fewer than 50 people.

11.4.1 Skills Gaps in the ICT Sector

An assessment of the industry conducted by the MICT Seta identified the immediate needs in each sub-sector with the IT sub-sector experiencing the greatest skills crunch. Software developers, programme developers, mobile apps development, computer network and systems engineers, ICT system analysts, computer network technician and call-centre agents are all in demand. In telecommunications, ICT business development managers are needed, in electronics, electrical engineering technicians, software developers, IT and network engineers, in advertising, multimedia designers, and in broadcasting, authors and radio journalists. Other skills identified include that of ethical, security, spectrum management, business analytical skills and e-leadership capabilities.

11.5 e-Skills for the Future & Global Trends

NeSPA 2013 identified key global trends that will affect South Africa, and pinpointed ways that the ICT sector could develop in the country: These trends included the following:

- ☐ The developing world – with more than half the world’s population – provides the biggest opportunity for ‘new-use’ users for many ICT providers and developers.
- ☐ ICT development is converging, becoming more mobile, more affordable and more accessible in ways that suit developmental agendas for many countries.
- ☐ There can be no sustainable progress in developing equity of life chances in developmental states without the effective social appropriation of ICT.
- ☐ The rate of ubiquitous development of ICT is moving past the current capacity (for effective deployment and adoption) and attitudes of many societal, organisational and service delivery structures.
- ☐ Collectively these trends are irrevocably changing the fundamentals of many services, businesses, educational approaches, the praxis of governance and the way in which life is led. These impacts are likely to be greatest in places with large equity gaps.

11.6 Teacher Training, Curriculum Development & Further Education & Training Sites (FETS)

11.6.1 Teacher and Lecturer Training

The future of the classroom whether it be in schools, colleges, universities or private institutions will be very different from the form the previous generation knew, with the move across to digital online teaching and knowledge and information sharing via the Internet. There is also the potential to centralise teaching where one teacher’s training of a class can be distributed to multiple classes simultaneously with in-class teachers becoming facilitators. In the near future, teachers need to be equipped with the necessary ICT skills to utilise the online e-education platforms and undergo routine ICT skills training.

11.6.2 Curriculum Development

The Department of Higher Education & Training (DHET) together with the MICT Seta can facilitate, monitor and evaluate innovations in future curriculum development that support diversity in skills. This is only for the ICT Sector and again only for the levy payers. The Institute, comprising e-SI, Nemisa and the Institute for Space and Software Applications (ISSA), together with business, government, civil society and education embarked on a process towards developing an e-skills National Curriculum and Competency Framework (NCCF) that looks at targeted needs against the NDP, and then maps and links pathways to attaining those skills to meet the needs.

This plan includes building an e-Skills curriculum and a competency framework and aims to focus on e-Literacy/e-astuteness as the foundation level. This is the ability of an individual to use digital devices and services in their day-to-day activities, whether it is at work, home or for personal interactions.

11.6.3 Further Education & Training (FET)

A comprehensive Turnaround Strategy has been developed by the DHET for the 50 FET Colleges, which includes all 264 campuses. The aim is to improve the quality of both the teaching and the learning taking place at FET colleges. The NDP aims to increase graduation levels to 75% in 2030

from the 40% experienced in 2010. A comprehensive and thorough evaluation of new courses and curricula is required that include careers in the ICT sector.

11.7 Workplace Training

On-the-job training and short courses have been identified as the approach to take for workplace training. Advances in technology require on-going learning in the workplace to continuously improve efficiencies. This requires self-learning, and both informal and structured on-the-job e-Skills transfer between employees.

11.8 Adult Training

The Department of Higher Education and Training (DHET) is currently reviewing policies and programmes to restructure adult basic education and training (ABET). This includes being more responsive to needs and expanding programmes and access to these programmes. The MICT Seta will need to consider these policies and plan accordingly for ABET programmes in the sector.

11.9 Promoting Innovation and Supporting Research & Development

Greater access to technology opens up a world of possibilities, and with South Africa's mobile penetration of 136% and Internet access of 35% we are on the cusp of being able to grow and develop our e-astuteness. With more people accessing smartphone technology, Internet access will increase and with it access to information that can inspire and grow potential and knowledge across all ages.

To promote innovation, a thriving and coordinated research focus is needed, which in turn promotes further innovation. The unstructured and fragmented research that has characterised South Africa's approach has not been able to address its capacity needs.

A fully integrated and coordinated framework is required that aligns to the priorities of the NDP and the national skills plan. To this end an aggregated data analysis of South Africa's needs and skills gaps in relation to new global technological trends is urgent.

1. Sources

<https://www.weforum.org/agenda/2016/01/the-fourth-industrial-revolution-what-it-means-and-how-to-respond/>

<https://www.weforum.org/agenda/2018/02/can-policy-keep-pace-with-fourth-industrial-revolution/>

http://www3.weforum.org/docs/WEF_Impact_of_the_Fourth_Industrial_Revolution_on_Supply_Chains.pdf

<https://www.nebula.co.za/2017/10/03/fourth-industrial-revolution-business/>

http://www.engineeringnews.co.za/article/the-fourth-industrial-revolution-is-upon-us-and-south-african-industry-must-adapt-2017-10-27/rep_id:4136

http://www.dti.gov.za/industrial_development/fipt.jsp

<https://m.siemens.com/en/innovation/research-topics/shaping-the-fourth-industrial-revolution.htm>

<https://www.surveysampling.com/blog/the-fourth-industrial-revolution-and-its-implications-for-research/>

<https://trailhead.salesforce.com/en/modules/impacts-of-the-fourth-industrial-revolution/units/understand-the-impact-of-the-fourth-industrial-revolution-on-society-and-individuals>

<https://www.itweb.co.za/content/VgZeyvJAONaqdjX9>