



Finding a path through the maze – the Fourth Industrial Revolution

Implications of the 4th Industrial Revolution for SET, industry, society and education #4IRsciZA

The Fourth Industrial Revolution (4IR) feels like the ghost in the machine. We have a sense about it. We know it's coming or may already be here. It seems to be all around us. However, there isn't a common understanding of what 4IR actually means.

The National Science and Technology Forum (NSTF) held an NSTF Discussion Forum on 'Implications of the 4th Industrial Revolution for SET, industry, society and education'. The event was held in Cape Town from 11-13 September 2018. It ran alongside the [Innovation Summit](#). The aim was to unpack some of the issues around 4IR, with reference to science, engineering, technology (SET) and innovation.

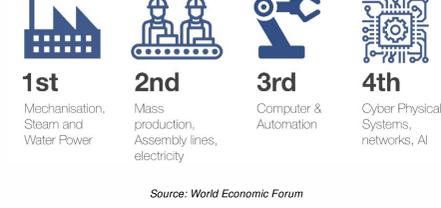
So what is 4IR?

There are many names and definitions for the Fourth Industrial Revolution (4IR). 4IR is the naming convention used for this article as it's a widely-communicated definition from the World Economic Forum (WEF).

WEF positions the First Industrial Revolution to be that of mechanisation and steam and water power. The Second Industrial Revolution looks at mass production, division of labour, assembly lines, and electricity. The third is seen as electronics, ICT, and automated production.

The NSTF provides neutral collaborative platforms where issues and sectors meet

- One of the National Science and Technology Forum (NSTF) functions is to hold [discussion forums](#), bringing the private and public sector together to address important issues and engage with government policy.
- Feedback from these discussion forums is given to stakeholders.
- Recommendations are put forward to government as part of the [SET community's](#) lobbying efforts.



Source: World Economic Forum

The Fourth Industrial Revolution is about the emergence of cyber-physical systems, network and artificial intelligence (AI). Cyber-physical systems involve new ways of embedding technology within larger societies, communities, and even in the human body.

Presenting at the NSTF Discussion Forum, Garth Williams says the dominant narrative is the convergence of technologies and convergence of the physical, digital and biological space. Williams is a Research Specialist: Intelligence at the Technology Innovation Agency (TIA), who previously worked at the Department of Science and Technology (DST). He presented in his own capacity.

There is debate around whether what is happening is, actually, the Fourth Industrial Revolution. There are numerous frameworks available, ranging from this being an extension of the Third Industrial Revolution to Society 5.0. However, we need a name relevant to South Africa.

Is it the name or the aim?

Williams says focusing on what a country wants to achieve is more important than emphasising the name. Across the world, aims and objectives range from improving competitiveness and developing 4.0 technologies to enhancing digital start-ups and ecosystems.

Let's consider South Africa's objectives. Williams says this is an emergent process with various research and policies, such as the National Development Plan (NDP), outlining the challenges. An overarching NDP aim is to eliminate poverty and reduce inequality while advancing the economy and increasing South Africa's competitiveness.

Williams' message is 'Don't use technology just for technology's sake'. It needs to be part of a larger context.

Looking at the 4IR technologies

There are numerous technologies associated with 4IR, and they come with a lot of jargon. Following are some of the technologies:

- Autonomous robots and vehicles
- The Internet of Things (IoT)
- Cyber security, fraud detection, and authentication
- Additive manufacturing (3D printing)
- Big Data and advanced analytics
- Augmented reality, virtual reality, and wearables
- System integration
- Edge and cloud computing
- Smart mobile devices
- Artificial intelligence (AI)
- Blockchain technologies (which is part of how bitcoin works)
- Advanced human-machine interfaces
- High bandwidth networks
- Smart and internet-worked sensors

Impact on economic development

Williams notes that sustainable economic growth relies on productivity growth which is driven by technological change. Furthermore, "key breakthroughs... have underpinned surges in society and the economy".

For South Africa to catch up and become truly competitive, there are various factors that need to be considered:

- **We need to take the opportunities available in 4IR that are appropriate for South Africa.** Williams specifically notes focusing on indigenous challenges and opportunities. Part of this is using 4IR technologies to create industries for processing raw materials (as opposed to sending raw materials out and buying the manufactured products back). Dr Fisseha Mekuria, Chief Research Scientist from the Council for Scientific and Industrial (CSIR) Meraka ICT Institute, says that connectivity (to the internet) is critical for making the most of opportunities. However, it needs to be affordable to ensure social inclusion for all South Africans.
- **South Africa needs to do its own R&D on technologies and also manage (assimilate and adapt) inbound technologies.** An example of this is some of the work done in scientific computing at the Square Kilometre Array (SKA) Africa. NSTF Discussion Forum presenter, Mr Simon Ratcliffe, is the Technical Lead for Scientific Computing at the SKA. He explains that at various times they had to build their own hardware from scratch or re-engineer. Data storage was developed and manufactured locally, showing how SKA can seed other industries. The homegrown solutions meant not having to use expensive overseas resources nor paying for expensive software licences. Mr Ratcliffe says that the democratisation of tools (ie the access to open source tools) was a key enabling factor.
- **Part of 4IR is building people's capabilities and skills around technology.** Dr Tshiamo Motshewga notes that we need to think about skills that make us relevant in the future. (He is from the Computer Science faculty, University of Botswana. He also represents the Southern African Development Community – SADC – Cyber Infrastructure Expert Working Group.) The 4IR technologies noted above are a guide to some of the future skills needed.

Digital transformation and disruptive technologies

Dr Motshewga explained that digital transformation is about the outcomes achieved when entities, such as businesses, fully leverage the changes and opportunities that digital technologies bring.

Digital disruption refers to the changes that occur when new digital technologies and business models impact an entity's value proposition (offering), market position, and competitiveness. Examples include Uber shaking up the taxi industry and Airbnb changing the hotel industry. Other industries and sectors that have been significantly changed by 4IR technologies are: bookstores, print advertising, music, and photography.

These definitions of digital transformation and disruption are based on those from the Learning Experience, Cisco Networking Academy. Note that other definitions and meanings also exist.

Reacting to 4IR

There is a lot of anxiety around 4IR. One example is 'technology singularity'. This represents the time when machines and AI are so advanced, they surpass humans as the smartest and most capable beings on Earth. For many people, there is a more immediate concern – all signs point to 4IR technologies driving job losses as 'machines' take over jobs. Current thinking envisages rote and routine jobs as being the most vulnerable.

There will most probably be job losses, especially in the low-skilled sectors, says Prof Babu Paul. He is the Director, Institute for Intelligent Systems, University of Johannesburg. Further to that job creation will probably not match job losses, plus the nature of current jobs will evolve. This means education becomes critical, as does reskilling and upskilling. A national dialogue is needed.

Williams says we have a choice, collectively and individually. It isn't an 'either/or' ie being led by technology versus society defining the way. He sees society and technology as co-evolving, where technology is embedded in society. South Africans need to shape their own future, including taking measures to prevent widening inequality and deepening poverty.

South Africa and 4IR

South Africa has plans around 4IR. Williams says these include a government-wide 4IR Country Strategy and Action Plan. It will be led by the Department of Telecommunications and Postal Services (DTPS) and supported by DST and the Department of Trade and Industry (the dti). The group will report to The Presidency. It is looking at various thematic areas:

- Digital society, ICT policy, and regulatory and legislative reforms
- Innovation, research, and development
- Economic policy and inclusive growth
- Industrial restructuring and trade
- Labour market restructuring
- Education and skills development
- Transforming government and service delivery

Science, technology and innovation initiatives will be led by the DST, informing the national strategy and aligned with DST strategies, policies and plans. The department will be supported by TIA, Human Sciences Research Council (HSRC), National Advisory Council on Innovation (NACI), and CSIR.

Ms Nontombi Marule-Director: Innovation and Technology Policy, the dti, notes the regulatory implications for 4IR need to be managed. This is not a simple matter due to the fast-changing pace of technology advances, technology disruption, and the extensive impact on systems. She says that a paradigm shift is needed, such as policy and regulation that is futuristic and agile.

Dr Mekuria advocates strongly for technology test beds as part of evidence-based research to inform decision making. Test beds are "crucial platforms to perform a controlled testing of relevant 4IR use cases before introduction commercially".

Implications of 4IR for industry

NSTF Discussion Forum presenter, Dr Nimrod Zalk from the dti, says that there have been no cases of successful catch-up by developing countries with advanced economies without industrialisation. Furthermore, successful industrialisation has to have an industrial policy. Countries best placed to benefit from 4IR are those with an established industrial base.

Dr Zalk sees 4IR, specifically technological change, as "often more evolution than revolution". Various 4IR technologies aren't that new (for example, robotics and additive manufacturing). It has just taken a long time for the technology to spread. He suggests integrating 4IR considerations into organisational, sector, and industrial strategies rather than 'dropping everything' for the 4IR.

In terms of industry opportunities around 4IR, Dr Zalk provides the automotive-mining nexus as an example. With the global shift to electric vehicles, there is a reduced need for fossil fuels. However, this shift means an increased demand for platinum group metals (PGM) minerals. He says that South Africa needs to be in at the start with developing new sources of demand for PGMs.

Collaboration and partnerships – including a regional perspective

For South Africa, Williams notes that the overriding aim is to tackle big societal problems such as high youth unemployment and water scarcity. This is a multi-disciplinary endeavour and that means partnerships. The issues also straddle the mandates of various government departments. This means more collaboration between traditionally-siloed government departments.

We need collaboration and integration at all levels so we can all benefit. This is the message from SADC's Dr Motshewga. To move forward with regional 4IR strategies, we need alignment with the various regional and national policies. We need to invest in supporting infrastructure and human capital development and skills for regional collaboration.

The importance of Big Data

The general definition of Big Data describes large volumes of structured and unstructured data that can be mined for information. How we use this data (analysis and interpretation) can reveal patterns and trends, and more. Dr Motshewga says we need to share data, and that includes data from government departments.

Dr Motshewga notes the emerging policy consensus of FAIR data – findable, accessible, interoperable, and reusable. He explains that FAIR data is extremely important within the SET and innovation environment. Considering that research data is publicly funded it should automatically be a public asset. Open research data also provides the evidence, allowing for reproducibility and self-correction while reducing replication.

Open data practices have transformed certain areas of research, such as genomics and astronomy. Furthermore, research data often have considerable potential for reuse and reinterpretation. All this fosters innovation and accelerates scientific discovery.

How does the smart city fit into all of this?

According to Prof Babu Paul, the Smart City uses smart technology and Big Data, for example, to improve quality and performance in services (energy, transportation and utilities). This can reduce resource consumption, waste, and overall costs. Prof Paul is the Director, Institute for Intelligent Systems, University of Johannesburg.

Components of a smart city include: smart manufacturing, smart energy grids, smart waste management and other utilities, and smart transport.

Examples of potential smart city job titles of the future are: urban informatics analyst, energy efficiency engineer, autonomous transport technician, virtual reality technician, and cybersecurity officer.

Finding clarity

There was much discussion around the presentations. Following are some of the points raised:

- There needs to be a common understanding, definition, and standards for 4IR – specific to the South African context. Information needs to be clear and practical – and cover the entire ecosystem. There should also be clear communication about the limitations, potential harm, and ethics with the various 4IR issues.
- The process of coordination and collaboration for 4IR needs to be made clear to all. Individuals and entities should be able to 'plug into' the larger coordinated structure. The SET community need specific goals and actions around 4IR. These should include real-life examples rather than conceptual terminology.

Speakers can be contacted through the spokesperson, Ms Jansie Niehüß. Video clips with the full presentations can be found on the NSTF website.

About the NSTF
The National Science and Technology Forum (NSTF), established in 1995, is a broadly-representative stakeholder body for all SET and innovation organisations in South Africa, which seeks to influence policy formulation and delivery.

The NSTF Awards are unique in SA, recognising the outstanding contributions of individuals and groups to SET and innovation.

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