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The Fourth Industrial Revolution – what does it mean to our future faculty?

The future of a country like South Africa is predicated upon policies; whether these policies are effective or ineffective is not primarily an issue. The prospects and realities of the Fourth Industrial Revolution (4IR) have proven to be shaping strategic policies across various spheres of national life already, including the national government, academia, civil society and the private sector. Ultimately, as strategic policies begin to take shape and come along, there is a need to pose certain important questions: what direction(s) and against what context(s) is the 4IR being embraced? In this Commentary, authored by young faculty, we discuss and debate some of the strategic recommendations of the South African Presidential Panel of the Fourth Industrial Revolution[1], specifically 'securing and availing data to enable innovation', 'incentivising future industries, platforms and application of 4IR' and 'building 4IR infrastructure'. We look at the historical context of such recommendations, and identify advantageous positions as well as gaps that may need more discussion. We then ask: What does the 4IR truly mean for our future academics and researchers?

History and context

The descriptive 'Fourth Industrial Revolution'[2] is certainly not a unique term because it has precedents – that is, it is preceded by the First, Second, and Third Industrial Revolutions[2]. The term 'revolution' that the numbers and the word 'industrial' qualify is generative. As such, glossing over this word, as if it does not bear out in consequential ways, is not wise. If South Africa is to fully prepare itself to take advantage of the wave of technological and industrial change wrought by this technological revolution, it needs to take seriously the full implications of what is afoot, including what is meant by the term 'revolution'.

A revolution is by its very nature a violent process. It does not really matter whether such a revolution is literal (as in political) or metaphoric (as in industrial). Revolutions are an existential struggle between two protagonists of history. And as with any other struggles or collisions between two forces of history, the process is invariably violent. Even when it is not spectacularly violent in real time, it is profoundly violent in its cumulative impacts in the longue durée[3], resulting in epochal shifts that leave in their wake winners and losers. Indeed, the ultimate winner goes away with everything – it is a winner-takes-all process. By winners, we mean those who embrace or are taken in by the technological changes, and by losers, we mean those whose reality – technological and educational station, cultures, and subjectivity – presents impediments to their availing themselves of the change.

The First Industrial Revolution began soon after 1784 with James Watts' invention of the steam engine that led to mechanised farming in Britain and beyond. The Second Industrial Revolution was a consolidation of the First. It is marked by the invention and smelting of steel, which resulted in the invention of other locomotive engines, including motor vehicles in the late 19th and early 20th centuries. But without harkening back too far into these past industrial epochs (i.e. 1IR and 2IR), the 3IR provides important lessons pertaining to the losers and victims it has produced, even in the face of the much-vaunted industrial and technological progress. The 3IR probably started earlier, but it took hold in the 1980s and 1990s, consisting of computer technologies and advanced modes of mechanical production, including the use of robots, for industrial manufacturing. With the expansion of the Internet and other uses of digital technology, the 3IR democratised computer technology for individual and civil industrial usage beyond the hitherto military and big government preserve. Despite this democratisation of technological progress, digital technology also rendered obsolete other forms of mechanical production, creating in effect degraded and denuded landscapes and redundant people – workers whose life and culture became 'backward' and divorced from the network and circuits of flows created by the emergent technology.

Think for instance of 'the Rust Belt' from the USA to China, areas left behind by the shifts in the forms of industrial production. The job losses as a result of the migration of industries from one locality to the other more suited to the efficiency (and profits) wrought by the existing technology, are not factored in as part of the technological 'progress'. Think also of the mines in the Congo and other locations where minerals – such as cobalt, coltan and other tantalite materials, uranium, platinum and copper – are extracted for the production of microchips and circuit boards for computers and smartphones. The two sites described here constitute the material detritus of digital evolution and culture, indexical of what Naomi Klein[4], writing in a different context, calls 'sacrifice zones' of people and places: discounted as collateral damage, the essential costs of technological progress for 'the greater common good'[5].

The 4IR is a platform that seeks to accelerate, at scale, the existing networks of flow for goods and services and to transfer all modes and markers of being into the virtual, using artificial intelligence (AI) as a catalyst. What would make this revolution different from the previous? As yet, existing technology suggests that the materiality of the 4IR, and therefore its implicit hegemony, remain the same as that of the 3IR. In fact, it is upon the digital technologies of the 3IR that the 4IR is being built. Moreover, the 4IR seeks, among other things, to design technological models that enable businesses and modes of production to do away with people and, by extension, the community. Thus, accelerated development for some, sacrificial zones and people for others. How do we avoid creating losers in the same manner as the previous IRs? Inevitably, what sites and what people is South Africa prepared to sacrifice in order to achieve the 4IR? And once identified, can South Africa be forthright in informing them for them to prepare themselves for the coming revolution?

Reacting and not leading

It is imperative to understand the disruptiveness that the 4IR presents, and the pros and cons that it constitutes to our livelihoods, which will require substantial effort to educate and inform society at all levels. Several of the

technologies driving this revolution are blockchain, artificial intelligence (AI), biotechnology, nanotechnology, quantum technology, cloud computing, the Internet of things, 3D printing and autonomous vehicles.[2] It has been identified that the major common thread through many of the different technological pillars of the 4IR is the manipulation of data and information processing. By 2025, it is projected that the world will have 163 trillion gigabytes of data. As connectivity is the underlying pillar of the 4IR, there is a dependence on a communication infrastructure that is trusted and secure. The security risk these technologies pose is identified, and the growing importance of data coupled with underestimation of the cybercrime threat has contributed to the vulnerability of South African businesses.

Software improvement techniques are not the only method to mitigate these vulnerabilities: a full scope of recent advancement in technology needs to be considered. Quantum technology and nanotechnology have the potential to play a vital role in enhancing encryption techniques. Conventional methods of ensuring the security of information are based on the complexity of a mathematical construct. However, with the current increase in powerful resources, the security of information is not guaranteed; more so a breakthrough in mathematics could instantaneously make classical cryptography vulnerable. With the growth of resources, it is imperative that secure methods of transferring information are achieved. 'Quantum information processing and communication' brings together the science of quantum mechanics and information science. The aim of the field is to provide the next generation of information and communication tools in the form of quantum computing and quantum communication providing a secure and trusted network. The potential applications of quantum technology, although it is in its infancy, should be considered to address the needs of the challenges faced with upholding the security of information. As an emerging technology, the potential for innovation and subsequent commercialisation is enormous and needs to be optimally exploited for the benefit of society and to address the socio-economic challenges of the current times.

To ensure that we are leading and not reacting, it is necessary that we tap into the resources and skills available to build an ecosystem of equal opportunity in the 4IR space across all provinces in South Africa, including training the workforce for the skill transformation that is required to benefit from the rapidly changing trends. This should not be limited to artificial and machine learning; instead, there should be an incentive to develop 4IR centres/hubs for research and development across all the provinces.

It has been identified that for South African enterprises to remain globally competitive, there is a necessity to adopt technologies that improve the efficiency of operations. To address these needs, we will require further investment into research and development and the establishment of internship programmes in the industrial sector. Universities can play a vital role in the research and development phase, as this will provide a pipeline of skilled individuals to enter the workforce. The graduate unemployment rate is 10% for those aged 25–34 and 33.5% for those aged 15–24. By encouraging linkages between universities and the private sector, this rate could be curbed. Imperatively this would encourage closing the gap between industry and academia. Industrial stakeholders would need to be encouraged to partner with universities and Technical and Vocational Education and Training colleges, with equal opportunity across all provinces, to drive the change that is essential. To a large extent, this would also require training society to identify 4IR opportunities, as it is not fully understood how these technologies can be embedded into our daily lives.

There should be an incentive for industry to invest in these high-tech projects that could lead to the growth of the country in the 4IR space and place South Africa at an opportune position in various areas of expertise. A substantial influx of investment would be required to advance towards 4IR, which includes encouraging SMMEs and an ethos for entrepreneurship. Ultimately it summates to, are we as a country ready to make this paradigm shift?

Getting the basics right

On a global scale, the 3IR brought about the advent of computers leading to the development of electronics, smartphones, the Internet and automation which is said to have increased productivity, efficiency and worldwide virtual connection. As with the current report[1], 3IR also promised to eliminate income poverty and inequality, as well as increase employment for South Africans. However, this has not come to life, and South Africans still face high unemployment rates and inequality has been vastly exacerbated. If we look at our basic education system, according to the Department of Basic Education's Action Plan report, it concedes that technology-enhanced learning has not advanced in South Africa as predicted.[6] About 48% of schools do not have any digital devices available to them, let alone the skills to utilise these devices.[7] Furthermore, the gap to access digital platforms in the current education system became very clear during the 2020 lockdown in South Africa due to the COVID-19 pandemic. Only 7.7% of households in Africa were estimated to have a computer at home prior to lockdown.[8] Many public school learners were (and still are) restricted to radio or television broadcasts, or printed textbooks and worksheets distributed to them. Furthermore, 68.4% of learners with access still reported that they had difficulty adapting to the online environment. This highlights the general lack of digital literacy among learners and educators; and even where there is digital literacy, there is a lack of access to the tools needed.

At the tertiary education level, a recent survey of undergraduate and postgraduate lecturers conducted by a local university investigating the perceptions and implementation of 4IR in university modules, revealed that some academics were confused by the terminology of 4IR and unsure if digital platforms already employed in modules were part of 3IR or 4IR (Steenhuisen S-L, Department of Plant Sciences, University of the Free State, 2019 November). Lecturers commented on using various software in statistical analyses and perhaps digital control systems in some research methodology, but few could confidently state that they were implementing or developing AI systems, drone technology or likewise in their research endeavours. Many commented that they would implement these technologies if funding and training were available. This clearly shows that even at a tertiary level we are still catching up on the 3IR without access to basic computing skills and hardware meant to have been implemented in 3IR. During the lockdown in South Africa, lecturers were forced to use social communication platforms such as WhatsApp and Telegram to teach full modules to learners without access to university communication channels off-campus, stemming from a lack of devices. While universities competed to buy limited stocks of laptops in the country to loan out to staff and students in 2020, many students expressed that they were uncomfortable receiving digital devices due to fears of safety and expense. Lecturers furthermore needed to train colleagues and students in the basic use of mobile scanning apps and the like in order to operate digitally and share handwritten student assignments. With the current evidence, it is clear that the lag in the development of basic digital literacy skills in learners and lecturers handicaps South Africa's academic cohorts in implementing 4IR without intervention.

Cisco[9] reported that South Africa, as an emerging economy, is less 'digitally ready' than its peer middle-income countries such as Chile and New Zealand. Besides the lack of infrastructure, the general affordability for access to and usage of technology for the general public remains another growing concern. Costs of airtime, data and electricity are increasing at an exponential rate, and the lack of growth in the economy leads to further inaccessibility and availability of tools brought about in 3IR for education and the economy at large to fully embrace 4IR in a way that will achieve goals such as poverty alleviation.

While the report[1] makes it appear that South Africa wants to fit in with the growing interest around the 4IR, and rightly so, significant resources are being spent by policymakers on promoting the 4IR. This is despite the limited information on what it actually means and to what extent it may impact South Africans, given that we are in a different stage of development in comparison to the global developed and developing countries. We need to understand how we can benefit from 4IR and not be harmed further by it as a result of compounding on the current

resource constraints our country faces. For example, electricity, which is a much-needed commodity for 3IR and even more so for 4IR, is still a luxury for some and is becoming rather erratically available in the country as a whole.

Technological developments offer many opportunities for sustainable development, but its advancements cannot address the underlying inequalities still at play. In order to participate and lead in 4IR, South African policymakers need to avoid following what is set out by developed countries and instead focus on certain innovations and their uses in a way that can establish our country and its people. This will also assist in carving a feasible and tenable space for ourselves in the global community.

To what end?

Ultimately, as a country, we need to have a clear set of strategic goals that we are working towards. As such, we can place the report[1] within a framework of understanding how it adds to clearer strategic goals. Are we as a country going to build upon new capabilities that will make us as a nation more competitive in the globalised economy? Have we identified our strengths and weaknesses? Will we build on our strengths and address some of our weaknesses? The overarching envisaged future from the report of the Presidential Commission on the 4th Industrial Revolution[1] is that:

> *South Africa will have a globally competitive, inclusive and shared economy with the technological capability and production capacity that is driven by people harnessing the 4IR to propel the country forward towards its social and economic goals, instead of falling behind.*

When reading the report in terms of strategy and competitiveness, one does see that human capital, as well as technological development, is a top priority. The question, though, is to what end? The report correctly highlights that our current industrial strategy, or the National Development Plan, is not specific in terms of what direction it will take. We posit that the 4IR report also is affected by this challenge. If the competitive strategy will be for South Africa to export technology to the rest of the African continent, we need to identify the current strengths and opportunities, and how we can realign our different sectors to meet this goal. If we will be looking at advanced manufacturing, is it for internal consumption (can we compete against imports) or will it be the most competitive country on the continent or in the world on the specific technologies in manufacturing? The report highlights countries such as Germany and China that have benefitted from clear competitive advantage strategies that require an integrated approach to reach.

At the beginning of this Commentary we highlighted the challenges of 'losers' in this revolution, but we should be clear to 'what end' and 'how' these challenges can be used to create opportunities. What are our assets (physical, human, intellectual) as a country that we can build on for global competitiveness? What are our unique strengths, processes and procedures that give us an advantage on the continent, and beyond? Which sectors can we scale to increase both our advantage and solidify our competitiveness?[10] These questions can guide how we come to more defined strategies.

There are emerging local technologies that the country can harness by investing in them to become advanced enough to create the necessary networks for local industrial production and services. For example, we have pockets of advanced manufacturing technologies in aerospace, and an emerging AI ecosystem (with growing research, but also the need for industrial development). We have quantum technology capability that is nascent. We need to move from the 4IR as a buzzword to the reality with mid- to long-term strategies for which the country can aim. This requires a common understanding of the concepts and bringing different sectors of society into this understanding. More importantly, we need to get the basics right.

There are no shortcuts. There may be temptation to pick the low-hanging fruit in taking advantage of what this country may be able to exploit in the short term, but we need to refrain from choosing interventions that are quick and look ostentatious but ultimately have a low impact (if at all). Without thought, in both the public and private sectors, how we set up the basics as a foundation to build upon may end up being a disastrous omission. We need not look far for examples. The COVID-19 pandemic exposed the cracks in many a government's readiness to use data for decision-making.[11] This highlighted the need for better data policies and infrastructure and the implementation thereof. This was not only a challenge in South Africa but in many countries across the globe. For us in South Africa, it might have led to less situational awareness, less information available for decision-making (especially for those outside health departments as COVID-19 affected more than just health) and delays in our collective understanding. This was not because of a need for a high-tech solution, but because of the lack of a strong integrated digital foundation on which to build.

We are at an interesting point in our human development, with the rate of emerging technology disruption at a pace not seen before. We need to evaluate different directions quickly, but, ultimately, we have to make a choice on the directions we take and work to get society behind those choices.

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We have no competing interests to declare.

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