The fourth industrial revolution – commonly referred to as 4IR – is here, and whether you realise it or not, it’s transforming your life in subtle and powerful ways all the time.

But what exactly is 4IR? What does it mean for South Africa? What does it mean for its people, for its politics and economics, and for its future? In this, the University of Johannesburg’s (UJ’s) brand-new, entirely 4IR-focused digital magazine, “Beyond Imagining”, we explore the ins and outs of this phenomenon and try to answer some of the many questions it raises.

The words in these pages are a small sampling of the huge amount of research that UJ’s educators and students are undertaking in the 4IR space. The university is proud to be initiating the kind of in-depth academic analysis and investigation that 4IR demands, and to be shouldering the responsibility of exploring, debating and acting on the best responses to it.

This edition and those that follow will examine this exciting and unpredictable era, and the way it is affecting everything from how we work and how we interact with our surroundings, to what we think and what we create. In this edition specifically, we’ll be looking at education and what 4IR means for South Africa’s schools and tertiary institutions. One thing’s for sure: 4IR is disrupting everything – and the time to learn about it is now.

Welcome to a world beyond imagining...
As one of the leading research institutions in South Africa and in Africa, we thought it best to begin at home – at the intersection between 4IR and education.

Where does this intersection take place, we found ourselves asking, not for the first time? What are the roles of schools and universities? How does 4IR affect the way we teach? How does it affect the way we learn? How does it affect our curricula? And what does it mean for students who are leaving our space to enter the working world for the first time?

It is the education sector – and especially tertiary education, which so often bridges the gap between high school and employment – that bears much of the responsibility for equipping the next generation of innovators with the skills they need to take on 4IR.

There are many questions that demand answers from universities, and UJ is both asking them and attempting to answer them. In the 4IR space, the answers are rarely simple, clear or contained – they often only lead to more questions – but we nevertheless need to cultivate this curiosity. It is our curiosity, after all, that will enable us to create the world of tomorrow.
Dramatic changes in the world of work, and in how humans live their lives and interact, have captured widespread attention due to their disruptions and opportunities, and are commonly referred to as the next industrial era. Africa has come late, as a passive recipient of each revolutionary phase, and the continent has failed to benefit from the progress made globally. However, the South African government, together with business and educational institutions, have identified and embraced technology as a key differentiator for the future and as a means of competing on the world stage.

UJ VICE-CHANCELLOR AND PRINCIPAL
PROFESSOR TSHILIDZI MARWALA
The driving force behind 4IR at UJ.

UJ’s investment in 4IR is driven from its most senior position, from its Vice-Chancellor and Principal, Professor Tshilidzi Marwala. A widely published 4IR expert and internationally acclaimed 4IR ambassador, Professor Marwala’s expertise lies in the theory and application of artificial intelligence, engineering, computer science, finance, social science and medicine.

He was recently appointed to serve as the Deputy Chair for the Presidential Commission on the Fourth Industrial Revolution.

The Commission is tasked with helping the government to take advantage of opportunities presented by 4IR by identifying relevant policies, strategies and action plans that will position South Africa as a competitive global player.

“Unless we adopt, unless we understand the nature of the profound change that is reshaping our world, and unless we readily embrace the opportunities it presents, the promise of our nation’s birth will forever remain unfulfilled,” President Cyril Ramaphosa said at his 2019 State of the Nation Address.

Professor Marwala, in his private capacity and especially in his prominent position at UJ, is spearheading research and advances into 4IR.

It is through these changes that South Africa will begin to enter a world beyond imagining.
Teaching and learning in AR, VR and XR.

Many of the students walking through the (literal and virtual) gates of universities across the country today form part of Generation Z – a generation that has never known a single day without the Internet. They’re the first cohort of truly digitally savvy students, are equally comfortable in both real and virtual worlds, and accept constant change as a given. What does this mean for how they access, understand and interpret information? And should universities be shifting their teaching and learning methods to take these ways of thinking into account?

AN INTEGRATED AND INTERACTIVE LEARNING EXPERIENCE

“As academics, we need to engage with young people in ways with which they are most familiar. We have to understand how social media and other forms of technology influence how students enter the university and the expectations they have of higher education.” — Professor Angina Parekh, Deputy Vice-Chancellor: Academic at UJ

But being innovative in the teaching and learning space doesn’t mean making course material available online – the mere idea would simply induce eye rolls from any Generation Z student. Instead, it means integrating technological advances into ordinary classrooms in ways that are meaningful, compelling and effective.

Imagine using augmented, virtual or extended reality (AR, VR and XR) to enable students to experience an operating theatre, the Louvre, the heart of a volcano or Mars first-hand.

“We have an obligation to put people at the centre of teaching and learning and to put technology at the service of people,” explains Professor Thea de Wet, Director: Centre for Academic Technologies.

Offering these sorts of experiences can help students reason better, make informed decisions, collaborate, solve problems and think critically. “It’s all about immersion and interaction, and the benefits of experiential learning,” she adds.

THE IMPOSSIBLE IS HERE

And while some of these suggestions might sound outlandish and impossible, the truth is that they’re already a reality in many departments at UJ.

The School of Tourism and Hospitality is using a virtual laboratory and simulation training to help students gain a better understanding of food production, and the School of Architecture’s fabrication laboratory gives students access to industrial-grade digital fabrication and programming tools. The Mine Engineering and Mine Surveying department, Dr Hennie Grobler, the Head of Department, says, has “created a virtual mine to supplement teaching and learning, which enables students to experience life inside a mine shaft and to be able to understand the environment in a safe and controlled way”.

When it comes to teaching and learning, technology can’t be an add-on or a gimmick. It’s got to be properly integrated into the design of modules, from inception through to outcome. The result is an active learning environment filled with students who are stimulated and inspired.
There are no clear answers but there is no doubt that universities have a responsibility to open up these conversations and ask critical questions if we want our graduates to be ready for the end of the world as we know it.

DR KIRTI MENON AND GLORIA CASTRILLON
UJ SENIOR ACADEMIC PLANNING EXPERTS
University curricula have never been static beasts. When new research emerges, or when learning objectives shift, their content soon changes and new programmes are developed. But with the advent of 4IR, the time has come for many curricula – many more than usual – to be thoroughly interrogated and, in some instances, completely overhauled. Today’s courses have to ensure that they provide students with the diverse range of skills they’re going to need to succeed in the future. It’s no small task.

4IR galvanises change in university curricula.

ADOPTING AN INTEGRATED APPROACH

“At UJ we want to turn the curriculum around so that students acquire these skills of the future, we must create knowledge and plan ahead for industries that are going to exist but are not yet here.” — Professor Tshilidzi Marwala, UJ Vice-Chancellor and Principal.

UJ’s approach is to integrate disciplines as much as possible. "Those in humanities must learn about technology, and those in technology must learn about humanities," says Professor Marwala.

Nurturing innovation is another priority, as is the establishment of firm connections with other institutions across South Africa and the continent. Of course, UJ isn’t alone in its pursuit of 4IR-friendly curriculums. Indeed, the race towards 4IR is gaining pace at institutions throughout the country.

SECTOR-WIDE SHIFTS

The University of Pretoria is working with pay TV provider MultiChoice to develop and sustain scarce AI and machine learning technology skills in South Africa. A research chair in machine learning has been set up at the university. And at Wits University, a tech space in Braamfontein called the Wits Tshimologong Digital Innovation Precinct has been established. Here, the university says, start-ups will be incubated, research commercialised, and high-level digital skills among students, working professionals and unemployed youth will be developed.

“I sincerely hope that we, as a university, with our partners, will develop the next generation of scholars who will change the future of Africa through developing the tech required for us to leapfrog across eons of poverty, unemployment and inequality, and in so doing create a new world order that prioritises humanity before profits and power,” says Professor Zeblon Vilakazi, professor of physics and Deputy Vice-Chancellor for Research at Wits.

This is certainly the hope all of all universities who are using 4IR to guide their curriculum, teaching and learning, and investment decisions. And with tech and innovation at the heart of these actions, students are sure to be as well prepared as they can possibly be for the world of 4IR when they graduate.
Hey Siri! Do you understand me?

UJ is currently working on a speech recognition tool similar to Apple’s Siri or Google Assist. “Current systems don’t understand African accents,” says UJ Vice-Chancellor Professor Marwala.

“If I were to ask Siri, ‘Who is Tshilidzi Marwala?’ it would respond with, ‘Sorry, I can’t help you’. But if I use a fake American accent, Siri is more likely to understand my request.”

Google Maps can be similarly problematic, sometimes failing to understand the indigenous names of streets and places. “For these reasons and more, we’re working on our own technology,” says Professor Marwala. “Our approach is simple: we want to solve domestic problems with our own innovations. And our students are driving this change.” The university is currently applying for patents for its technology.
What is:

**4TH INDUSTRIAL REVOLUTION**
4IR is the coming together of technologies that blur the lines between physical, digital and biological spheres.

**VIRTUAL REALITY**
VR is a computer-generated 3D environment that people can interact with through special electronic equipment.

**ARTIFICIAL INTELLIGENCE**
AI is the simulation of human intelligence, including learning and problem solving by machines, especially computer systems.

**INTERNET OF THINGS**
The IoT refers to the billions of computing devices around the world that are connected to the Internet and are able to collect and share data.

**AUGMENTED REALITY**
AR is an interactive, reality-based environment where real-world experiences are enhanced by computer-generated information that affects your senses.

**EXTENDED REALITY**
XR refers to all immersive technologies, including AR, VR and those that still need to be developed, that extend our experience of reality by combining real and virtual worlds.

4IR is full of acronyms, and getting your head around them can be confusing. Here, we outline a few of the key acronyms you should know:
It’s never too early: what 4IR means for schools.

“Schools can do three things when it comes to 4IR,” says Professor Kerry Kennedy, a distinguished visiting professor at UJ. “They can teach learners about 4IR, they can teach using 4IR technologies and they can prepare learners for 4IR in the future.” Whatever they do, it’s important that they do something. Learners are going to have to have the tools on hand to tackle it.

TEACHING LEARNERS ABOUT 4IR

Science, technology, engineering, arts and mathematics all have 4IR relevance, and studying them will help learners understand the world around them. Learners need to realise that 4IR isn’t just about technology, but about the arts as well, and subjects in the social sciences and the humanities shouldn’t be forgotten.

4IR also has a strong social element — at its heart, it’s about bettering humanity and creating a safe, fair and just world.

Learners should be taught to be innovative and creative when it comes to new technologies, but they should also be able to question the underlying values of these technologies. Gene editing, robotised workforces and 3D-printed automatic weapons raise important and complicated ethical questions. The next generation needs to know how to think about them.

TEACHING WITH 4IR TECHNOLOGIES

4IR not only affects what children learn, but also how they learn. Robots in classrooms are becoming commonplace in some parts of the world, AI is able to provide useful feedback to learners on how their studies are progressing, and VR is helping to make teaching more exciting and to improve learning. 4IR technologies can also help learners to access information and move forward at their own pace.

Of course, engaging with these technologies means that they become more familiar to learners, who are bound to engage with them again (or more advanced versions, at least) down the line.
PREPARING LEARNERS FOR 4IR

“The key skills and values required by 4IR are creativity, critical thinking and problem solving,” says Professor Kennedy. “There should be nothing in the school curriculum that doesn’t facilitate them.”

Many people advocate computer coding as a component of the 4IR curriculum, he goes on to say, but this misses the point. If coding leads to innovative, creative and critical thinking then it has a role to play. If it is just about applying rules again and again then it does not.

A robot can apply rules: if the coding learners do is going to be relevant in the 4IR space, it must make use of both technical and human skills.

The message here is for politicians and policymakers.

Schools must be equipped to teach about and with 4IR.

Schools, teachers and learners need to be provided with the resources and opportunities they need. And if those in a position to influence these decisions don’t act on them, they’re not only letting down young learners and the next generation of 4IR leaders, but the country’s future development, too.
Musing on the modern-day Mashinini.

In June 1976, 19-year-old Tsietsi Mashinini led his fellow students in the Soweto Uprising—a pivotal protest against the government’s introduction of Afrikaans as a medium of instruction. He was fighting for an education that was fair, and a future that was free.

A WORLD IN CRISIS

As we look at the world today—a world beset by climate change, conflict, poverty and inequality—we can’t help wondering what kind of people are needed to set it on course. People who are willing and passionate, certainly, but also people who are educated, informed and inspired.

The world needs open-minded, critical thinkers.

“The world needs people who understand that solving problems is more important than working unthinkingly,” says Vice-Chancellor of UJ Professor Marwala. “Creativity is more important than copying the ideas of others, that collaboration is more important than individual success. The world needs people who are in touch with the developments of 4IR and who know how to use them for humanity’s benefit.

One person who fits the bill above (although there are undoubtedly many) is Linford Molaodi. Linford is a UJ graduate who has his Master of Education in Information and Communication Technology and who won a major teaching award earlier this year.

At the Department of Basic Education’s National Teaching Awards in February 2019, Molaodi won the best teacher award in the “Excellence in technology-enhanced education” category for his work in the rural community of Ga-Masemola in Limpopo.

Molaodi has been using experiential learning techniques in his lessons in Ga-Masemola, and is helping a network of other physical science teachers do the same. He is also a founding member of TeaSterl Projects, an organisation that encourages educators to use ICT in their teaching methods.

As universities give young students access to information and technology, they need to recognise that they are simultaneously crafting the next generation of activists (and teachers) that the world so desperately needs.
Scientific research that universities and other institutions produce can often be difficult to understand if you’re not a scientist yourself. The research is often filled with jargon and complicated explanations, which means that its value is usually lost on the layman.

Pint of Science brings science to the people.

In 2012, scientists in the United Kingdom came together to create Pint of Science, an annual international festival that makes science easy, relatable and interesting to everyone.

The festival allows members of the public to chat to researchers about their work in public places. No prior knowledge is required and there are no stupid questions.

In 2016, South Africa became the first African country to join the festival, which is held in Cape Town every year.

“Often a mistrust of science can arise from a lack of understanding,” says Clare Garrard, computational biology lecturer at the University of Cape Town, “and the direct interaction between scientists and the public at Pint of Science helps to dispel that by allowing people to address questions directly to the people doing the research.”

The next time you feel like a pint – and a healthy dose of interesting research – you know where to go.

The universities of the future are going take two forms. Traditional, world-class universities – such as the University of Johannesburg, and Harvard, Cambridge and Oxford Universities – are going to remain as bricks and mortar, although they will have many programmes, facilities and infrastructure that reflect the mode of 4IR. And there will also be new types of universities emerging. These universities will be completely virtual and students will not be expected to come onto campus. I think the world needs both of these institutions.

UJ VICE-CHANCELLOR AND PRINCIPAL PROFESSOR TSHILIDZI MARWALA

Often a mistrust of science can arise from a lack of understanding.
Universities bridge the gap.

The phrase has rung true for some time now: many children entering school today are being prepared for jobs that simply don’t exist yet. In some sectors, the same can be said for students entering university. The 4IR space is disrupting the labour market in such swift and seismic ways, it can be difficult to predict what’s around the corner.

In its 2018 Future of Jobs Report, the World Economic Forum says that, in the short term, new types of jobs will emerge that will either partly or completely displace existing jobs. And the skills needed for both old and new jobs will likely change in most industries and will shift how and where people work.

More than ever before, people entering the workplace need to be creative, critical thinkers, with malleable minds and high emotional intelligence. Whose responsibility is it to fine-tune these traits?

Facts:

**What is generation Z?**

Millenials, believe it or not, are a thing of the past. If you’re walking around a university campus, it’s likely that most of the young people around you are part of Generation Z. But what does that mean?

**WHEN WERE THEY BORN?**


**ARE THEY INTO THE INTERNET?**

Absolutely – they’ve never known a world without it.

**HOW DO THEY COMMUNICATE?**

It’s fair to say that their entire world centres on smart phones and devices – communication for them is very mobile and very social.

**ARE THEY SOCIALY AWARE?**

Mostly yes, this is a generation that has always known conflict.

**WHAT ARE SOME OF THEIR KEY CHARACTER TRAITS?**

They’re realistic, communicative, ethical, entrepreneurial and the world’s true digital natives.

**WHAT ARE YOUR THOUGHTS ON MONEY?**

They’ve seen their parents and millennials battle in the wake of various financial crises. They’re largely quite conservative financially.

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The jobs of South Africa’s future.

Are you entering university and deciding on your subject choices? Or perhaps you’ve reached a turning point and are reconsidering your career? Whatever your situation, knowing what jobs are likely to be on South Africa’s most-wanted boards going forward is an excellent way to guide your decisions. According to the World Economic Forum’s 2018 Future of Jobs Report, the following jobs are sure to be in high demand in the future:

1. Software and app developers and analysts
2. Data analysts
3. Scientists
4. Financial and investment advisers
5. Industrial and production engineers

“Universities need to embrace the onset of technology,” says Professor Moeketsi Letseka, UNESCO Chair on Open Distance Learning at Unisa. “A university that isn’t responsive to the rapid technological changes that are taking place will be left behind. Keeping up is key because information passes through a whole range of digital passages, and if we are not keeping abreast with that, then the world will pass us by.”

Reskilling: it’s a thing.

Between 2018 and 2022, more than 50% of jobs will need employees to be reskilled – that means that employees will have to be retrained to keep up with the shifting demands of their work. In some sectors, this training will only take a few months, while in others it will take more than a year.

RESKILLING GRAPH

Studying at UJ as easy as one, two, click.

By shifting to online learning, UJ is creating a generation of informed and connected global citizens.

- UJ students who aren’t able to study on campus full time now have the option of completing their studies virtually through the university’s 100% online degree programmes. The new programmes not only help students acquire an internationally recognised qualification without attending face-to-face lectures, but also position UJ alongside other global institutions.

“Universities of the future need to be flexible, agile and adaptive in order to remain relevant in the long term,” says Professor Rory Ryan, Executive Director: Academic Development and Support. “We can’t continue to educate students for careers that will not exist in the future, or stay stuck in providing brick-and-mortar options only.”

UJ’s online undergraduate courses include Bachelor’s degrees in International Accounting and Human Resource Management, and Advanced Diplomas in Financial Markets and Transportation Management, among others. Post-graduate courses are also available, such as Master’s degrees in Public Health, Educational Management, and Education in Information and Communication Technology.

“By shifting to online learning, UJ is creating a generation of informed and connected global citizens,” says Professor Amanda Dempsey, Senior Director of the CBE School of Accounting. “Moreover, we are contributing to the needs of an adaptable, sustainable, knowledge-based economy, which in turn nurtures a democratic, diverse and inclusive society.”
UJ Cloudebate™ answers (some of) 4IR’s questions.

4IR is an area rich with questions – in fact, at this stage, there are undoubtedly more questions than answers. In one of our recent Cloudebates, our experienced panel explored some of the questions that come up when we look at the intersection of 4IR and education, and they had some brilliant answers to share, too.

You can listen to the full Cloudebate™ at the link below:
The Future. Reimagined.