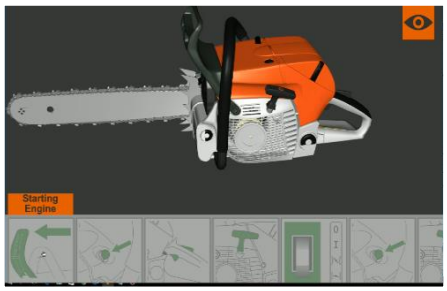
The Naledi3d Factory
What is Virtual And Augmented Reality (VR & AR)

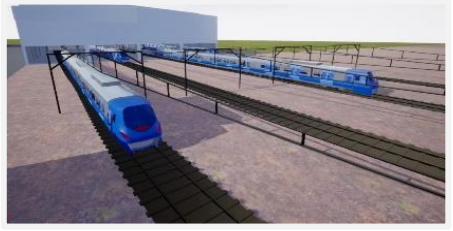
Virtual Reality can be defined as "*an artificial environment that is created with software and presented to the user in such a way that the user suspends belief and accepts it as a real environment. On a computer, virtual reality is primarily experienced through two of the five senses: sight and sound*".

Other distinct types of VR-related approaches include *augmented reality* and *mixed reality*; now commonly referred to as XR (Extended Reality).



Today, looking at hardware requirements, commonly used virtual reality systems typically use either:

1. **Virtual reality headsets:** (using two small screens in front of the eyes)
2. **Multi-projected environments:** (specially designed rooms with multiple large screens).
3. **Smartphones and tablets:** the advent of which has led to the pervasive and mass-use of VR content and which has today brought VR to the forefront, in a way that it is playing a major role in the so-called ***"4th Industrial (or digital) Revolution (4IR).***



FThere are many headsets (low to high cost) available today -
but lest we forget the humble smart phones and tablets (which many of us carry around every day

Why?

Today, smartphones and tablets are commonly used, most of us have one. This means that it is now possible to connect with millions of South Africans through 3D interactive Apps.; which can address topics across the education and TVT training, industrial process and design, building management and heritage sectors, to name but a few…

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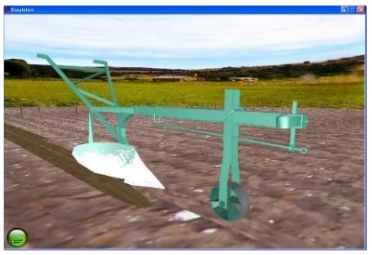
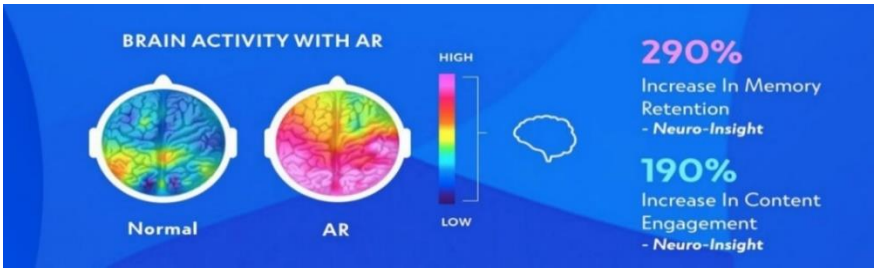
1 Why VR is effective and important - now



Looking at the ongoing 4IR digital transformation, as well as ongoing concerns around the digital divide, it has already been established that VR can, and will be a powerful and important empowerment tool, more so in the context of Africa and for three very good reasons:

1. VR (and AR) can and has already had a huge positive impact on how we communicate and learn:
   - VR is a **visual and interactive** experience that enhances engagement with the learning material
   - VR's intensely visual nature overcomes these barriers by showing – and not just telling. It does so in a way that allows the learner to interact, and experiment. Memory retention and comprehension are so much higher as a result



   - Its visual and interactive nature increases significantly comprehension (understanding) and memory retention
   - VR is a communication and learning tool that is very close to how our (human) brains work, which is visually… So why do we still rely on text and static images to explain concepts?

2. In Africa, where higher illiteracy levels and language barriers (in especially European languages) pose a huge challenge to effective learning, this is where VR comes into its own - and can have a tremendous impact, and more so when it is introduced as one element of the adaptation of new 4IR technologies into the learning process, as well as into the workplace.

3. As a new learning paradigm and pedagogy tool, VR and AR is an integral part of "*Fourth Industrial Revolution (4IR)"* thinking. By taking advantage of these new visual and interactive 3D worlds, our youth and adults from all backgrounds, will have the advantage of being able to experience, and play equally in this new (digital) space.

4. Our poorer, rural and township schools and communities also need to participate in these new, visual learning paradigms if we are to meaningfully reduce the "*digital divide*".

If we don't do this now, then we will surely be guilty of helping to grow our digital and knowledge divides not only in South Africa but also across Africa.

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2 4IR and Digital skills

The Fourth Industrial Revolution (4IR) is here and it is making global manufacturing that much more competitive. Traditional industrial economies such as Germany and the US expect 4IR-based technologies to produce many competitive advantages - and to also reverse the trend of locating manufacturing capacity to low-cost countries. This implies that the creation of new high-tech opportunities (and jobs) in their own countries will be the outcome.

As a consequence, we are seeing strong government funding for industry 4.0 and advanced manufacturing initiatives in these countries. China's shift in recent years from the manufacturing '*Made in China*" based-economy to a more innovation-driven '*Designed in China'* economy.

The experience of China illustrates that emerging countries can indeed also be early adopters and also harness these 4IR technologies to not only increase their global competitiveness but also to increase their global market share.

2.1 The leapfrog potential for South Africa and Africa

Compared to Northern hemisphere countries, today's adoption and the impact of industry 4.0 (4IR) on the African continent remains low.

However, it is increasingly acknowledged by industry leaders and policymakers across Africa that 4IR and its related new smart technologies will also have a significant impact at the economic and social levels.

The biggest challenge in South Africa and Africa remains connectivity and accessibility. Further progress in this space will drive broader adoption of industry 4.0 applications in businesses, manufacturers, consumers as well as by Community. More public, as well as private investments and other incentives, are needed.

South Africa and Africa however has one huge advantage over other developed markets. We are not weighed down by legacy infrastructure issues and may have less difficulty in embracing change.

Great potential exists for companies and state entities to adopt specific industry 4.0 applications, develop unique local high-tech products and services and in the process, leapfrog global competitors in the global marketplace.

VR and AR Apps. are and will play a major role in the 4IR "revolution" space.

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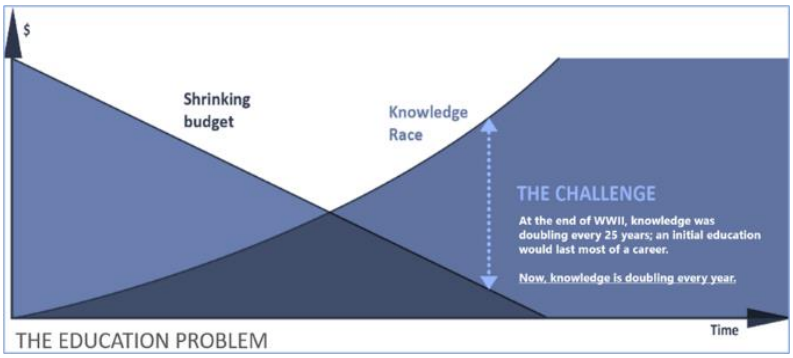
User Case 1: VR in Education (STEM) and Vocational Training

There are many ways that 4IR technologies can play a huge role in effective education and training, especially the use of VR and AR content. This is more so following the COVID Pandemic, as there is now a much wider understanding of how digital and online content can have a positive impact.

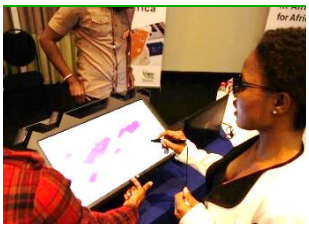
The Training Challenge: We need to harness new learning paradigms to address the increasing gap between:

(1) The ever-growing knowledge race

(2) Ever shrinking budgets for education and training.



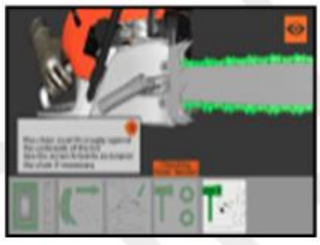
VR and AR (Virtual and Augmented Reality) allows us to create learning material that is content as well as context-rich, in realistic, engaging and stimulating three-dimensional environments.

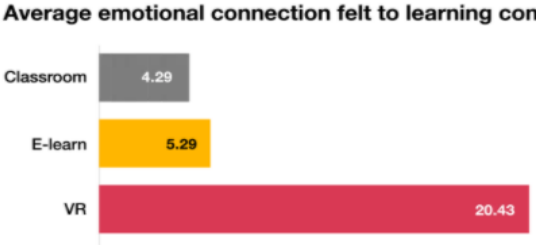


Unlike traditional teaching approaches, VR works directly with the visual cortex, thus allowing learners to contextualise learning material.

It also transcends literacy and language barriers by not just ***showing*** as opposed to ***telling*** *but by also* interaction; allowing the learner to view and manipulate virtual objects in the same way as in real environments - and in a way that heightens multi-sensory, multi-perceptual and multi-dimensional capabilities.

- Today's students tend to be bored and uninspired in the traditional classroom and prefer to engage with digital content
- *Recently, major disruptions to traditional face-to-face classroom teaching after the COVID – 19 pandemic will have long-lasting consequences*.





Source: PwC *VR Soft Skills Training Efficacy Study 2020*

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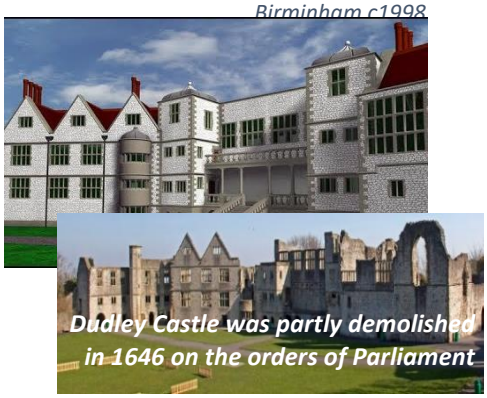
User Case 2: VR in Heritage / Tourism - Naledi3d's "*Living Museums*"

Virtual Heritage can be defined as "*the use of computer-based interactive technologies to record, preserve, or recreate artefacts, sites and actors of historic, artistic and cultural significance; and to deliver the results openly to a global audience in such a way as to provide formative educational experiences".*[1]

Virtual Stonehenge. University of Birmingham c1998

Virtual (VR) and augmented reality (AR) are often employed in virtual heritage applications, for example, to show realistic reconstructions of archaeological sites or artefacts.

The first use of virtual heritage as a museum exhibit, and the derivation of the name "*virtual-tour"* was in 1994[5] as a museum visitor interpretation that presented a 'walk-through' of a 3D reconstruction of Dudley Castle in England as it was in 1550.[6]



Virtual reality (VR) is an ideal medium to digitally recreate historic sites as they were in their heyday - by creating faithful 3D reconstructions and interactive narratives.

VR also allows us to interact with digital versions of museum exhibits and artefacts that are normally preserved behind glass.

*Recently, **360° tours** have also been used effectively by museums around the world to offer online fours. This trend exploded during* the COVID Pandemic as museums found new ways to remain relevant, and also, to access new, global audiences.

360° tour: Museum of Beirut

The next innovative step in virtual heritage is linking 360° tours with VR. This will offer an enriched visitor experience, *and where we are taking our "Living Museum" concept*…

Taking museums into a digital space has many advantages:

- We can make the museum accessible digitally to a broader and even a global audience
- Marketing of the institution is taken to new levels with new ways to position it in the online world
- Potential to offer a Premium virtual tour and generate new revenue streams from a global audience
- It offers a new 3D information class for museum collection archiving systems.

Our innovative "***Digital Living Museums***" concept connects 360° video museum tours with embedded **VR and AR interactive Apps** of selected exhibits in the museum space.

The digital VR experience brings the artefact to life as something that can be engaged with, dismantled, turned around – in other words, **exploration through interaction…**

[1] *[Stone, R.J. "Virtual Heritage: "The willing suspension of disbelief for the moment…" UNESCO World Heritage Review; October 1999; pp.18-27.].* University of Birmingham

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User Case 3: VR, Digital Twins and Infrastructure Management

Three trends are driving digital transformation in the building sector:

- Building Information Modelling (BIM)
- Virtual Reality (VR)
- Internet of Things (IoT)

BIM and VR are however the two most important and impactful trends. Both work hand in hand with 3D modelling to help architects, engineers and building infrastructure managers to collaborate better in good decision-making, based on accurate data. Everyone has the same level of visual information which makes the process more reliable, productive and more cost-effective.

Many companies in the AEC (Architects, Engineers, Construction) sector now work with BIM models, but few have yet to adopt VR into their construction process**.**

BIM models include metadata that links names and the properties of specified equipment. This information is a good basis for long-term 3D documentation and to better train and inform facilities staff.

Information gathered during construction can be taken into a VR environment, which allows you to see the building information in a real-world, interactive environment. This helps building maintenance staff have a clear understanding of the location, type and spec. of equipment installed in the building. This supports maintenance planning, the creation of safety and evacuation plans**;** or providing a visual record of the building, its installed assets and fixtures and fittings.

The latter, which may even be a 360° scan of the building interior and exterior can be crucial for planning should a disaster (for example n earthquake or major fire) destroy the fabric of the building. Not only can the 3D scan help in building restoration and of its various assets, but will also be very useful when working with insurance companies after the event.

Case Study: Use of VR as a Gauteng Public Works solution for Charlotte Maxeke Hospital:

A good example where VR can address institutional memory loss is the Gauteng Public Works Department's recent challenges in repairing the Charlotte Maxeke Hospital resulting from the 2020 fire.

Building plans on record were outdated and could not be readily used for reconstruction, leading to non-certification and delays in the reopening of the hospital – with dire consequences amid the COVID-19 pandemic.

VR applications, 3D infrastructure digitisation and the updating of digital plans is a good way to maintain public sector assets - through the creation of *Facility Digital Twins*.

This is an affordable and effective response to record-keeping, but also for accurate, maintenance and repair operations, especially when managing many public facilities throughout their lifecycles.

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Annexure 2:
Naledi3d Factory: Examples of projects 2000 - 2022

Examples of current projects in progress or development: 2020 / 2022

Project Name	Description	4IR Anchor / Pillar	Value Sector	Consumption Sector
Demystifying COVID-19	Use of 3D video to clarify the basic prevention methods against COVID19	3D modelling	NPO UNESCO	Public
XR (AR/VR) Incubation for the Creative Sector	Application of AVR for performance and visual arts with the South African Creative Industry Incubator (SACII)	Virtual and Augmented Reality	NPO/Public - SACII	Creative Enterprises
Introduction to Metrology	Developing online course content for Metrology curricula	Virtual Reality	State Agency - NMISA	Educational for Private and Public entities
Hydrogen Fuel Cell	Visualising the benefits of hydrogen fuel energy as an alternative for public transport services	Virtual Reality	Public City of Cape Town	Municipal
XR Skills Academy (Seeking funding partners)	Development of a skills academy in AVR for unemployed IT graduates	Virtual Reality	Private	Public
XR Digital Centres (Seeking funding partners)	XR digital centres to build VR/AR product/solution development capacity and human capital development alongside industry partners, e.g., manufacturing, health, education, mining and government service delivery.	VR, IoT, AI and 3D modelling/printing	Public & Private	Public & Private

Examples of past projects: 2000 – 2019

Refer to the full list on the Naledi3d website – http://www.naledi3d.com/portfolio

Project Name	Description	4IR Anchor / Pillar	Value Sector	Consumption Sector
SR71 - USA	Development of 1960's SR71 spy-plane and Aluminaut Submarine applications for Virginia Science Museum	Virtual Reality	Public- USA Tourism	Public – Tourism
Mining Safety - SA	Safety training applications for the mining industry	Virtual and Augmented Reality	Private – Anglo Gold Ashanti	Mining
HIV Education - Ethiopia	Demystifying HIV and AIDS, and showing the correlation between hygiene, diet, exercise and ARVs in preventing AIDS and prolonging lifespans	Virtual Reality	UNESCO	Public Health & Education

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Project Name	Description	4IR Anchor / Pillar	Value Sector	Consumption Sector
Chainsaw simulations and Sawlog Optimisation - SA	VR safety training tool and optimisation tool for lumberjacks in the forestry industry	Virtual Reality	NPO- UNIDO	Agriculture
USCAP – USA & Canada	Biopsy training procedure application for medical practitioners	Virtual Reality	Private – US & Canadian Academy of Pathology	Health
Agriculture - Zimbabwe	Application in the prevention of Soil erosion, machinery maintenance, sorghum farming, farm water conservation and Beekeeping for smallholding farmers	Virtual Reality	NPO- WK Kellogg - Foundation	Agriculture
Basic Hygiene - Uganda	Application to train in building proper pit latrines and water table conservation	Virtual Reality	UNESCO	Health and Water
Tshwane Interactive Digital Centre - SA	Launched and operated AVR Digital Centre for the City of Tshwane with a skills academy, VR showroom and development lab	Augmented and Virtual Reality	PPP: City of Tshwane and EON Reality Inc.	Energy, Municipal, Education, Telecoms, Defence, Health
Metrology for SMME Owners - SA	Introduction to Quality Infrastructure for SMME enterprises	3D videos	State Agency - NMISA	Public
Freedom Park Visualisation - SA	3D Animated videos for the launch of Freedom Park, and Visualisation of Freedom Park Development	3D videos	State – Freedom Park Trust	Public - Tourism
How a Laser Works - SA	Educational introduction to how a laser works for learners in the basic education phase	VR	State Agency – National Laser Centre	Public Education
Sustainable Energy Technologies - SA		VR	State Entity – Eskom TSI	Public Education
Virtual Locomobile - Netherlands	Developed VR content to demonstrate innovative ways to show and interact with museum exhibits	VR	Delft and TweenSense Techniek Museum	Public - Tourism
Lathes and Milling Simulator - SA	Training VR simulations in lathes milling operations to address safety operations.	Virtual Reality	Public- Dept. Of Labour SA & National Skills Fund	Public - Enterprises
Water Sampling, Water Pump Start-Up Procedure	Training applications on proper procedural processes for water sampling and pump operations	VR	State Agency – Rad Water Board	Public service delivery
VR as a visual teaching aid in Geology	The use of VR and 3D interactive simulation to visualise geographic features and geological formations	Virtual Reality	Grant Funding – Australian Aid & University of Limpopo	Higher Education

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