Acceleration of the Achievement of SDG6 through Use of Disruptive Technologies Applicable to the Water Sector in Africa.
Eng. Martin Manuhwa
WFEO – CHAIR ENGINEERING CAPACITY BUILDING

Photo by Stefan Els

WFEO Side-event at UN STI Forum "Engineering solutions for water adaptation"

United Nations

World Federation of Engineering Organizations
Fédération Mondiale des Organisations d'Ingénieurs

STI FORUM

Science, Technology & Innovation for
the Sustainable Development Goals

Engineering solutions for water adaptation

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Disruptive Technologies & 4IR Concepts in Engineering – Perspectives Applicable to the Water Sector in Africa

Eng. Martin Manuhwa, FZwIE. mmanuhwa1@yahoo.com

FAEO IMMEDIATE PAST PRESIDENT

World Federation of Engineering Organisations (WFEO) :- Engineering Capacity Building Committee (Chair).

Vice President: World Council of Civil Engineering (WCCE): Education Committee (Chair).

Past President :- Southern African Federation of Engineering Organisations (SAFEO).

Past Chairman :- Engineering Council of Zimbabwe (ECZ).

Past President Fellow:- Zimbabwe Institution of Engineering (ZIE)

Outline

- **Introduction and Context**
- **Disruption defined**
- **The origin of disruptive tech**
- **Disruption model**
- **Internet 4.0 Applications and Models in Engineering**
- **Case – Water 4.0 examples**
- **Internet of Things in Water Systems Management**
- **Disruptions at the horizon**
- **Conclude**

Introduction

- **Engineering and other interventions** are answers and enablers to deliver the **AU AGENDA 2063 and the UN Agenda 2030 on SDGs for peace, people, planet, progress and prosperity** and the Strategies contained in the AU Continental Education Strategy for Africa (CESA) 16-25/ Science, Technology & Innovation Strategy for Africa (STISA) 2024.

- **There is need to remodel engineering to create a Post Covid19 Africa that has creative thinkers, problem solvers and a new paradigm of future jobs that are digitally compliant to meet the needs of sustainable infrastructure through engineering capacity building to change lives of our citizens to live in the new normal.**

- **Engineering makes a crucial contribution to the improvement of the quality of life of citizens, and economic prosperity of nations, across the world, our young population in Africa are a demographic dividend that will capture the next 100 years through the next phases of the industrial revolutions and technological waves and reverse the underdevelopment of Africa and create the Africa we Want.**

Engineering for Sustainable Development to Achieve the Africa we want

Introduction

- Engineering has played a critical role in increasing the health and quality of life before the Covid19 pandemic, but now is the time to create better water supplies, municipal sewer systems, wastewater treatment plants, Covid19 compliant buildings, improved agriculture with new food and precision mechanisation, transportation systems, food security and healthcare for sustainable (new) energy, (new) water, and transport infrastructures for future needs and a sustainable, green and climate friendly world .

- In Africa and other developing countries, engineering challenges are even more pronounced, often coupled with the largest engineering skills shortages and skills gaps.

- The Post Covid19 Decade of Action (2020-2030) should see an accelerated implementation of SDGs and a Creation of new Business Models for Africa to create a new economic order, with equity, prosperity and peace for all its citizens to achieve the Africa we Want.

Engineering for Sustainable Development to Achieve the Africa we want

Introduction

- Water innovations are further pushed by the rapid development of Information and Communication Technology (ICT) applications.

- Smart water grids use ICT to monitor water flow, manage pressure or detect leaks. Smart meters indicate anomalies alerting water companies and customers about leaks or peak use.

- Smart sensors optimize irrigation water by measuring humidity, rainfall, wind speed, soil temperature and solar radiation.

- Smart rehabilitation technologies use image-diagnosing robots to inspect pipes, remove rust and spray new coating materials inside pipes".

- In order to have successful innovative solutions in the water industry, both the privately owned and publicly managed water industry needs to implement these new generation technologies (Big Data and IoT).

The Implications of Technology: "Fourth Industrial Revolution" in Infrastructure Development especially in Digital Transformation to Water 4.0

- The advent of technology especially advances in ICTs, artificial intelligence (AI), machine learning and the Internet of things (IoT) should make water 4.0 a lot easier as they bring new means of interconnectedness and unprecedented surveillance.

- The Fourth Industrial Revolution, or Industry 4.0 is an opportunity for the world to use enhanced big data mining, deep machine learning and other techniques to ensure a total transformation to the digital zone.

- With technologies like block chain, IoT and digital identification etc water 4.0 will be easy to achieve.

"Disruptive" technolgies defined

- Generally, a disruptive technology is perceived as one that introduces superior technological qualities to the mainstream product and/or service and thus causes a disruption to the market of the mainstream product and/or service.

- The theory of disruptive technologies has been widely studied as part of innovation theory and modeling.

- Disruptive technologies have gained a considerable amount of interest in technology organisations which incorporate R&D in product and process innovation as well as in techno-economic analysis of technology markets

The Innovator's solution

- **Technological disruptions have occurred throughout history and may come in any form.**

- **Disruptive technological changes and disruptive innovations drive industries to the next phase of development and can significantly protect organisations from destruction.**
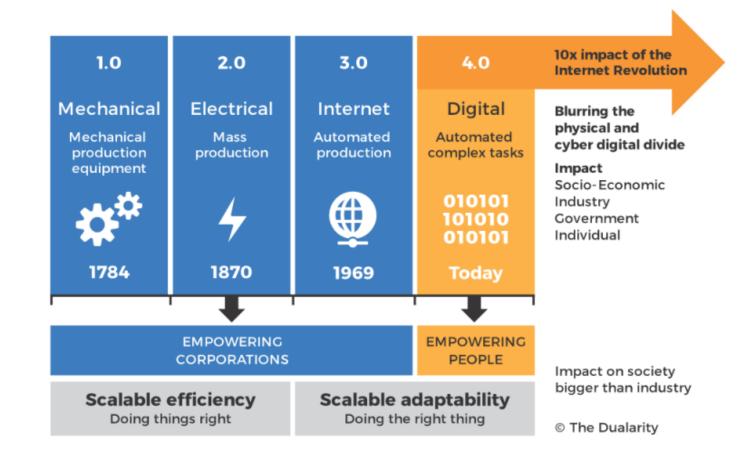
Handling a "disruptive" technology requires

- Knowledge of the new technology
- Willingness and ability to develop a technology for new customers, as well as a need to develop the "sustained" technology
- Willingness to accept new forms of marketing, sales and production
- Willingness to accept new profit margins for each sale
- Willingness to terminate the existing staff, hiring new employees instead
- HENCE WFEO saw it fit to create a CAPACITY BUILDING STC.

Motivation of Paradigm for Disruptive Technologies

IR 4.0 is the main motivation leading to the paradigm shift in the way manage HEIs

High growth

M1   DIGITAL FUTURE & IR4.0

GLOBALISATION   M2

SNAPSHOT

RISING OF ENTREPRENEURSHIP

COMMUNITY LIVING

M3   M4

Inclusiveness

4 megatrends which will have far-reaching impact on HEIs

Engineering for Sustainable Development to Achieve the Africa we want
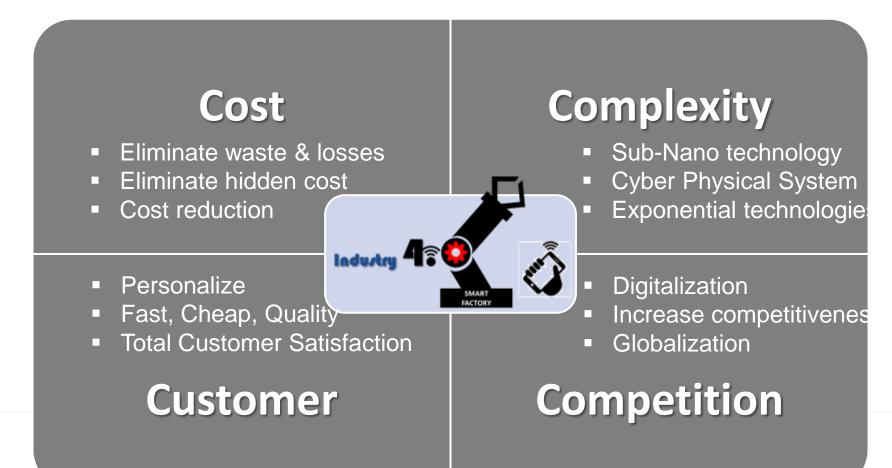
Welcome to the Industrial Revolution 4.0

010101
101010
010101

1.0	2.0	3.0	4.0	
Mechanical	Electrical	Internet	Digital	**10x impact of the Internet Revolution**
Mechanical production equipment	Mass production	Automated production	Automated complex tasks	**Blurring the physical and cyber digital divide**
			010101 101010 010101	**Impact** Socio-Economic Industry Government Individual
1784	1870	1969	Today	

EMPOWERING CORPORATIONS	EMPOWERING PEOPLE

Impact on society bigger than industry

Scalable efficiency Doing things right	**Scalable adaptability** Doing the right thing

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The Industry 4.0 Environment

Internet of Things

Smart Grid

Smart Buildings

Internet of Data

Smart Mobility

Smart Homes

Smart Logistics

Social Web

Internet of Services

Internet of People

Business Web

Cost

- Eliminate waste & losses
- Eliminate hidden cost
- Cost reduction

Complexity

- Sub-Nano technology
- Cyber Physical System
- Exponential technologies

- Personalize
- Fast, Cheap, Quality
- Total Customer Satisfaction

- Digitalization
- Increase competitiveness
- Globalization

Customer

Competition

Industry 4.0: Key Challenges

GOVERNMENT

EDUCATION & TRAINING

(Attitude, Skill, Expertise, Knowledge)

- o New emerging technologies (Augmented reality, Cyber Security, IoT, Big Data Analytics, etc.)
- o Multi discipline role and responsibilities to support the new revolution.
- o Lack on local expertise to create and provide new training program.
- o Develop 'I LOVE TECHNOLOGY' attitude and mind-set.
- o Lack on local content for system hardware and software.

POLICIES

- o Policy on Industry 4.0 related research and development, security of integrated system, legal framework conditions, work, training and further education.
- o New Industry 4.0 technology and skill transfer from overseas as part of pioneer status application. Localize hardware assembly.
- o High level nationwide Industry 4.0 framework and review panel/board.
- o Digitalization in manufacturing technologies will require new incentive.

INDUSTRY

FRAGMENTED LAYOUT

- o Merging the old and new system, techniques, machinery, protocols with complex protocols will be complicated.
- o Traditional IT infrastructure merging with new IIoT system integration will require massive reorg and reskill of the workforce.
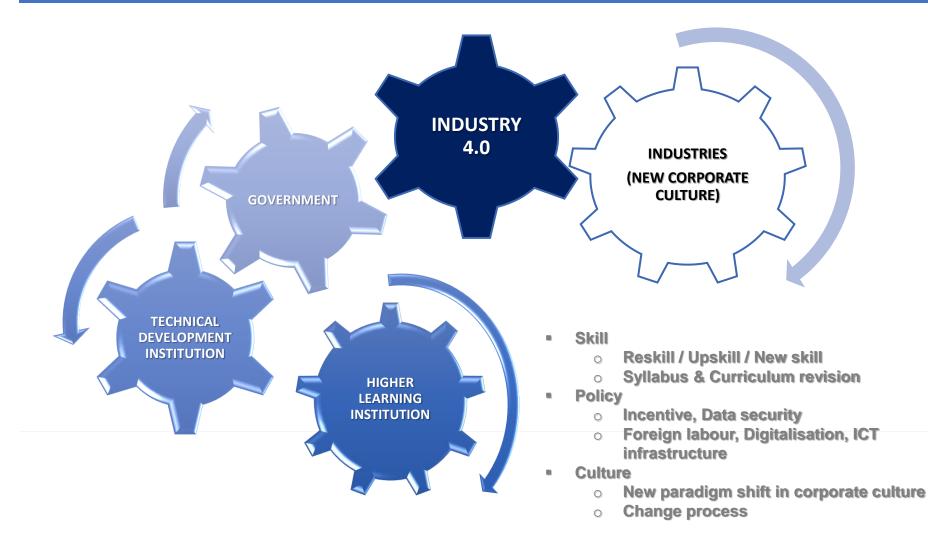
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Industry 4.0: Key Challenges
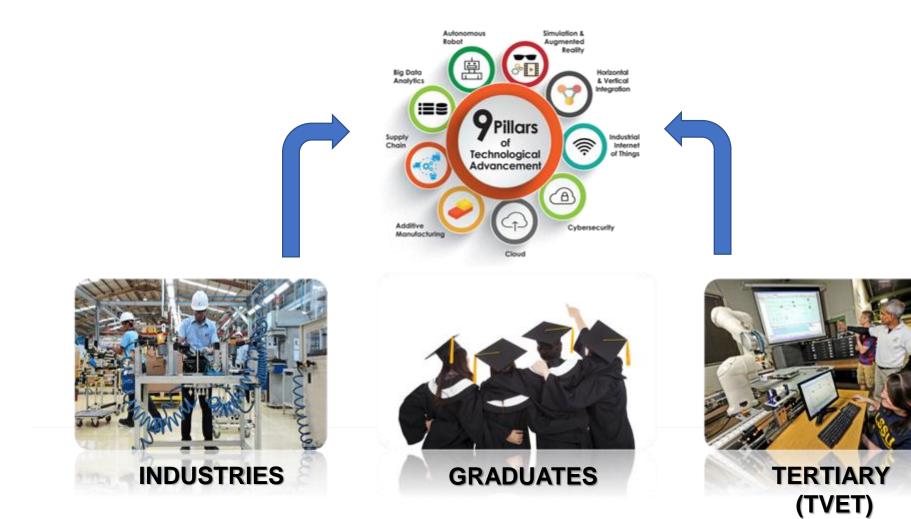
INDUSTRY

DATA SECURITY & PRIVACY

o Data ransom at the rise of the focus by hackers and system attackers.
o Manufacturing sector are more vulnerable to attack with interconnectivity through cyber physical system.
o Require more white hacker to develop full proof security system as attacker continue to look for loop hole.

BIG DATA

o More data scientist needed means more statistician with operational background.
o More complex bid data analytics from industrial data source. Not typical consumer based data anymore and transforming into well structured data format.

**CORPORATE
(CULTURE, FINANCIAL, STRUCTURE)**

o Industry 4.0 is about transforming the organization into new culture and promote technology as the way to move forward. Top management must endorse on it first before the rest follow.
o Need more systematic master framework to ease the deployment plan.

Industry 4.0: Key Driver [Skill, Policy, Culture]

INDUSTRY 4.0

INDUSTRIES (NEW CORPORATE CULTURE)

GOVERNMENT

TECHNICAL DEVELOPMENT INSTITUTION

HIGHER LEARNING INSTITUTION

- **Skill**
  - Reskill / Upskill / New skill
  - Syllabus & Curriculum revision
- **Policy**
  - Incentive, Data security
  - Foreign labour, Digitalisation, ICT infrastructure
- **Culture**
  - New paradigm shift in corporate culture
  - Change process

INDUSTRIES   **GRADUATES**   **TERTIARY (TVET)**

Five important drivers for Water Utilities Success

- **Supportive water utilities culture,**
- **Effective water infrastructure maintenance culture,**
- **Creating an enabling environment for data collection**
- **Financial capability to conduct research and implement improvements and,**
- **Regulatory government policy that promote innovation in the water sector**

WFEO-FAEO CECB WATER TRAINING - THE CONCEPT

In the Number and Needs Study by Alison Lawless sponsored by the SA (DSI) and SADC **et al**, posited that SADC has a shortage of quality, fit for purpose engineers. The major findings of the study were that graduates were expected to be professionals immediately, which is not how engineering qualifications are designed.

There is need to develop and promote structured graduate training programmes. However, it is a mistake to focus just on graduate engineers. Training technicians and craft engineers is of equal importance.

To this effect the Department of Science and Innovation (SA) and the Federation of African Engineering Organisations have teamed up with the WFEO-CECB, WFEO WATER STC, **CSIR, WRC, South African Local Government Association (SALGA) and the Water and Sanitation Sector Leadership Group (WSSLG), Selected Professional Engineering Organisations, The Commonwealth Business School, Selected WASH Centres of Excellence** to build the capacity in water and sanitation initially to respond to the Covid19 pandemic and solve other infrastructure problems in Africa.

OUR BENCHMARK- WATER 4.0

The case of GERMANY (Bufler et al., 2017).

- The German Water Partnership framed "Water 4.0" from Industry 4.0 concept

- Water 4.0 is referred to as Water Digitalization which incorporates the same features found in Industry 4.0 in the value chain of water management systems.

- Water 4.0 is expected to create and make available large sets of data that are relevant for management of water and goal-oriented data analysis and processing and more so, value-added knowledge can be generated from the available data.

- For a successful Water 4.0 concept or implementation globally, the water industry needs to work from the bottom up, and installation of appropriate monitoring equipment (i.e. right water infrastructure and sensors) are required in order to capture or collect required data to drive informed decision-making.

- This is where Artificial Intelligence Hierarchy of Needs come into play for the water industry.

Application of Internet of Things in Water Systems Management

- The Internet of Things (IoT) is rapidly growing and continues to evolve at an exponential rate. IoT is recognised as a disruptive technology creating new opportunities and innovative solution for various the industry.

- IoT definition by Alliance for Internet of Things Innovation is "dynamic global network infrastructure with self-configuring capabilities based on standard and interoperable communication protocols where physical and virtual 'things' have identities, physical attributes, and virtual personalities using intelligent interfaces for seamlessly integrating into the information network" (AIOTI, 2018).

- In recent times, Internet of Things applications have been moving in the direction of network of intelligent systems that have to address the interactions between autonomous systems and humans.

- Internet of Things is assisting the water organizations and municipalities to manage water infrastructure and water supply efficient using smart devices.

- Application of IoT for water management system and its distribution together with optimization techniques and predictive analytic of IoT are to bring reduction in cost and improve efficiency of the water management systems.

- Internet of Things enables measurement of the water pressure through the pipes to identify water leaks quicker in the water distribution/transportation system.

The sensing or actuating capabilities enabled by Internet of Things improves the following water management systems/operations (AIOTI, 2018):

- Quality control on water reserves

- Efficient systemic water management

- Water leakage detection

- Water quality and safety monitoring

- Transparency of consumption

- Prescriptive maintenance on infrastructure

BENEFITS OF IOT-BASED SYSTEM TO THE WATER UTILITIES INDUSTRY.

Applications of Internet of Things to Water Sectors	Description of how IoT-Based Technology has empowered the water industry.
Water Leak Detection	For many years, identifying and repairing leaks in the water distribution networks quickly is one of the biggest challenges for the water industry. IoT technologies provide smart ways of running of water facilities and operation and makes it easy to detect leaks more precisely and increases the rate at which the leaks are being detected. IoT is currently promoting more efficient water consumption and loss rates using the data generated to further give insights into how to enhance water management operations by lowering the losses and increase efficiency.
Water Quality Monitoring	The quality of water is an important aspect of water management system, even before the advent of IoT technology. Traditionally, the process involved manual testing and sampling. With IoT devices, smart water monitoring equipment can be deployed to collect and monitor pH, turbidity, pressure, flow rate and temperature of data and dispatch it to water management network that allows the water utility companies to view and analyse the water quality real-time.
Real-time Water Control	The widespread of wireless communication networks have created a good platform for IoT to assist the water industry to integrate the technology easily. IoT provides real-time access and control to allow the water industry to monitor and configure various aspects of water management operations remotely which allows the field engineers/technicians to work from any location and thereby save travel cost and time.
Centralization of the Water Management System.	IoT technology provides centralization of water network system, i.e. it allows inherent connectivity of smart devices with IoT devices which allows all the connected devices to operate on the same network. The water management network can be monitored centrally by the water engineers/personnel at the same time.
Predictive Maintenance of Water Infrastructure	Predictive maintenance technique is regarded as one of the significant ways to reduce unplanned downtime and avoid unexpected repairs. Use of IoT technology combine with other technologies and tools such as computer vision, machine learning, Big Data and analytics are to assist the water sector to monitor and determine when the scheduled maintenance is needed for the water infrastructure.

RECOMMENDATIONS

- **We should Commit for further development of capacity building to increase the number and quality of engineers, technologists, and technicians, who meet international standards.**

- **After the Ugu District (SA), Victoria Falls (Zim), Windhoek (Namibia) Pilot study there is need to role out of the project in all South Africa Districts and the rest of Africa**
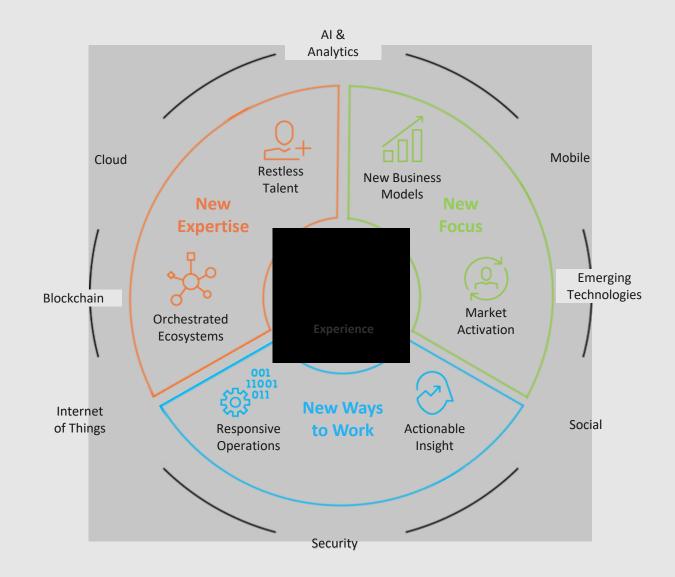
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CONCLUSION

- **There is a shortage of quality, fit for purpose engineers in AFRICA.**

- **Stakeholders should commit to Diversity and Inclusion Policies** in Engineering and encourage youth, women and minorities to take up **STEM subjects** leading to engineering careers!

- **We should Engage in Partnership for the Goals with Stakeholders** to increase mobility and recognition of engineering as a major force to achieve the SDGs.

Engineering for Sustainable Development to Achieve the Africa we want

In Conclusion: Africa should stake in the claim in the dynamic digital space and surf the digital wave!

"It is not the strongest of the species that survives, nor the most intelligent, but the one most responsive to *change*."

~Charles Darwin, 1809

African Proverb

If you want to go **FAST**
Go **Alone**,
If you want to go **FAR**,
Go **Together**

Thank you

Photo by Stefan Els